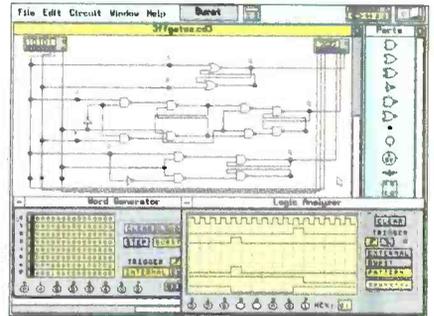


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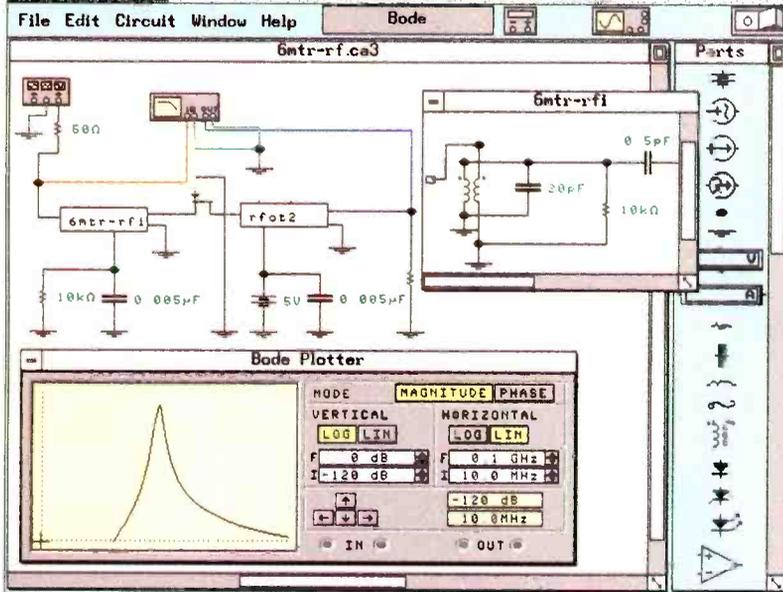
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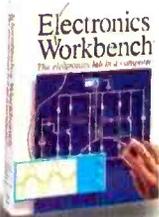
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# Popular Electronics®

DECEMBER 1994

Vol. 11, No. 12

A  
**GERNSBACK**  
PUBLICATION

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# EDITORIAL

## A HOLIDAY GIFT

Believe it or not, another year is almost at its end. It has been a fun year for all of us here at **Popular Electronics**, and we hope that you have enjoyed your 1994, too.

We have gone through a few changes in how the magazine looks and is prepared this past year, and the changes are not yet done. On the drawing board are some exciting plans that I think will make **Popular Electronics** look even better, and provide you with even more of what you look for from one of the best electronics magazines around.

But 1994 is not over quite yet—we still have this last issue to go, and I think it is a great one. That's because, in addition to all of the projects, articles, columns, features, and more that you've come to expect every month, we are also presenting a couple of stories that are sure to make the coming holiday season special.

For starters there's our cover story—a neat little flashing Christmas tree that's easy-to-build and is sure to light up your holidays for many years to come. The story begins on page 33.

Then there's **Gizmo's** annual Holiday-Gift Buying Guide. If you are looking for the perfect electronics gift for that special someone, it is the first place you should turn to. The story begins on page 9.

Those selections are our holiday gift to you, our readers. It is our thank you for helping to make **Popular Electronics** the magazine that it is. On behalf of everyone here at Gernsback Publications, I'd like to wish you a joyous holiday season and a happy New Year.



Carl Laron  
Editor

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# LETTERS

## EDUCATIONAL DEFICIENCIES

I am a 16-year-old student who studies electronics at the local Vo-tech center. I know that you don't want to get into the debate over the educational system in the United States, but I think it is extremely important. Our nation's future rests on the youth of America.

When I first entered the electronics program, I thought that I could do the math and handle the technical jargon without any problem—and I could, with a calculator. My teacher showed us that without a calculator, we were useless. I couldn't even calculate percentages. The thing is, three years ago, I could do percentages; I simply forgot how!

That led me to believe that American teachers focus on subjects that are not extremely relevant in today's society, i.e., trigonometry and complex algebra. I think that American teachers need to concentrate on the elementary, important stuff before expanding into more

complex forms of mathematics. That can be said for every subject. You need to be able to understand Shakespeare before you can read it, or else it's useless.

The average Japanese student has the equivalent of a Masters degree upon graduating from high school. Does that mean that the Japanese are smarter than Americans? Of course not! They are just taught differently, and they are taught better. So I don't think that it's totally the American students who are at fault; it's the poor educational system. Every time I want to recap an old technique, I look it up in a book, when it should be in my head!

I hope that this letter explains a few things about our education system as seen through a

person who is living through it. A.S.

Taneytown, MD

## PRACTICAL PROJECTS, PLEASE

I appreciate the editorial that appeared in the September issue of **Popular Electronics**. I certainly don't agree that the magazine should be trashed. You do cover a lot of territory, from the latest innovations to antique radios. However, the letter-writer deserves some credit for expressing frustration with your articles and taking the time to inform you.

From an economics and time-consuming view, many of the articles featured in **Popular Electronics** simply are not practical. Who wants to shell out several hundred dollars and spend many hours constructing a project that gets used once or twice and looks like a piece of junk?

On the other hand, the SCA detector that you featured a few months ago is very practical. It is inexpensive and will give many years of enjoyment. How about running more articles of that type?

You are correct: You can't please all of us. But practical projects can please most of us for years.

H.R.  
Indianapolis, IN

## PLEASING EVERYONE

I've been an avid reader of **Popular Electronics** for years. I'm 28 years old and I'm involved in an electronics training course. Your magazine is probably the number one reason for my interest in electronics in the first place. My main interests are in robotics and computers.

Upon receiving my September 1994 issue, I did my usual scan to see what "goodies" were inside. I then started my reading-from-cover-to-cover process—that is, until I read the "You Can't Please Everyone"

editorial. The letter that trashed **Popular Electronics** could only have been written by a (hold your breath until you turn blue or get your own way) child.

I personally love the amount of advertisers in the magazine. If not for them, we wouldn't be able to get the parts we need for our projects. I would, however, like to see more "build it" projects, possibly a robot or a robot arm. It's not that I'm dissatisfied, but I'm a firm believer in the do-it-better-yourself rule. I would be willing to pay more for an expanded "build it" issue(s). I also love the consumer and computer coverage in **Popular Electronics**.

As for that letter-writer, if he hates the magazine so much, why does he read it?

Keep up the excellent work! J.G.

Willow Grove, PA

## HAVES & NEEDS

I am in need of an Aerovox type 88-366 electrolytic capacitor, which is no longer being manufactured. The capacitor is a dual-can unit, non-polarized, 0.6 and 2.2  $\mu\text{F}$  at 300V. It is used in the synchronous motor circuit on a reel-to-reel tape recorder. The recorder is a type M-7SP, made about 30 years ago by Akai.

Thank you in advance to anyone who can help me find that capacitor.

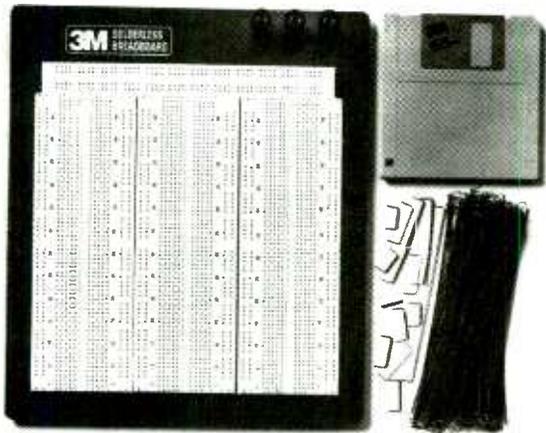
JOHN H. RODRIGUEZ  
123 Colonels Lane  
Weymouth, MA 02189

I recently purchased a used Gould oscilloscope, model OS-260, and I am looking for an owner's manual. I am also interested in finding out its specified bandwidth, its age, and the recommended calibration procedure.

If anyone has access to that information, I would be grateful for his assistance.

JOHN S. SEYBOLD  
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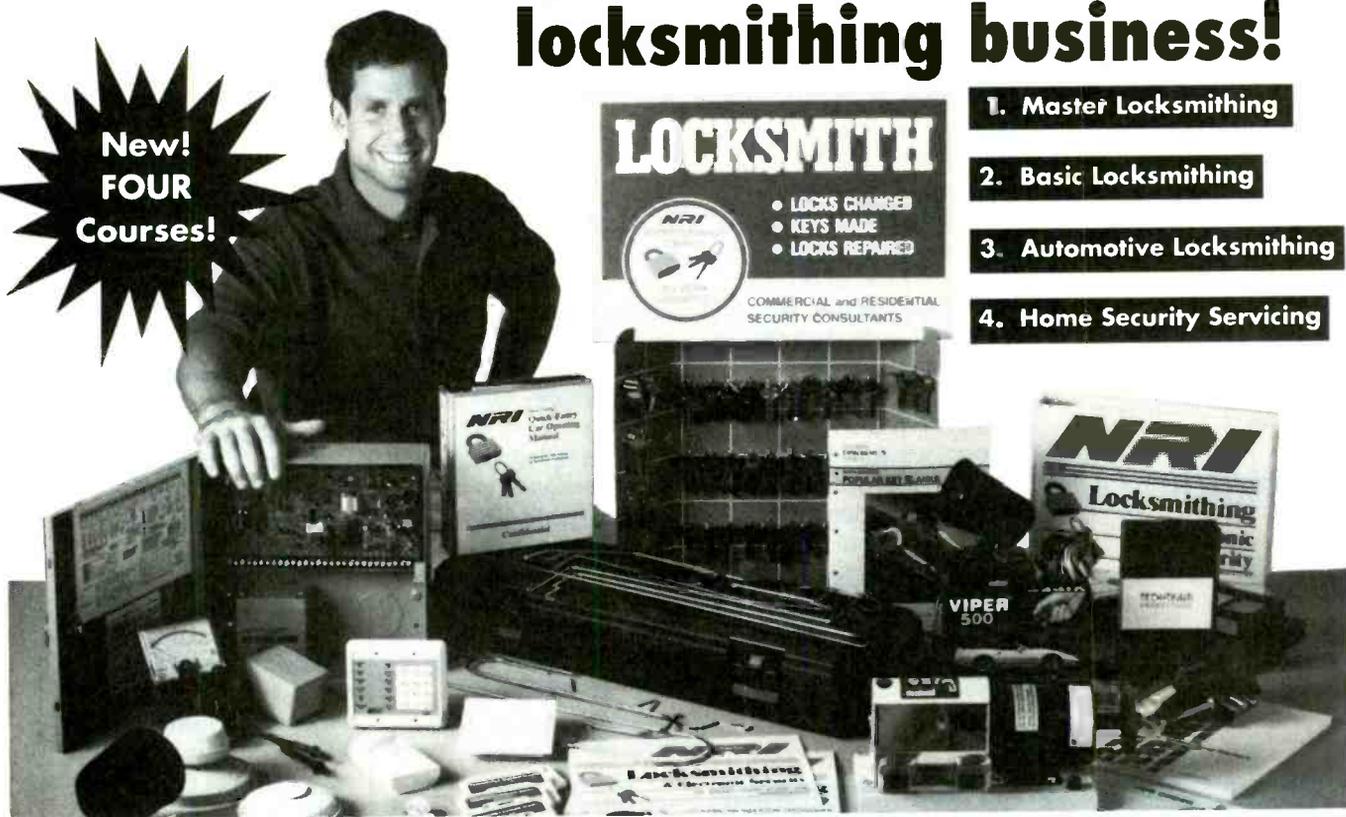
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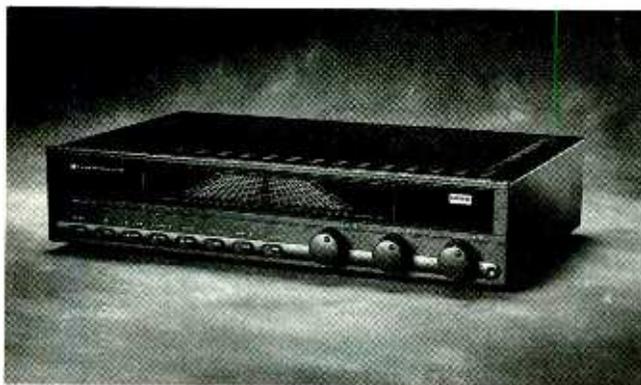
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# MULTIMEDIA WATCH

MARC SPIWAK

## Sounding Off



The AK-100 can do wonders for any audio source whether it's of excellent or poor quality to begin with.

**T**rying to predict the evolution of computer hardware has become almost as futile as asking what the weather will be like next week. If somebody comes out with a 10-gigabyte hard drive that's the size of a match box next year, I wouldn't be surprised in the least. Hardware evolution is happening so fast these days that it actually gets boring talking about it. But, recently, I had to wonder whether that mad hardware race does us, the users of that hardware, any good at all.

My Gateway 2000 at home is almost three years old, although it's still perfectly useable. And the best thing about it is that I rarely have trouble getting hardware or software to work with it. That's because it has an older 486-DX2/50 motherboard with no VESA or PCI local bus. What little trouble I have had is with my accelerated video card.

If you are at all familiar with multimedia, that should

not surprise you. In the race to get the hottest hardware on the market, manufacturers often deal with incompatibility problems by issuing updated drivers. Unfortunately, certain manufacturers, including the maker of my video card, are notorious for that, sometimes issuing new drivers on a monthly basis. It is relatively easy to get new drivers as the need arises, but it is still a pain to have to do so.

What's the point of all of this? We recently purchased a couple of new Gateway 2000 P4D-66's for the office. The machines are not cutting edge, sporting only a DX2/66 486 CPU, but each came with a PCI local-bus motherboard, an accelerated video card, and a double-speed CD-ROM drive. The only thing that kept those machines from being top-notch multimedia systems was the lack of a sound card. Not a big deal, I thought, since we usually have a couple of demo units laying around. Then I tried installing one, and the fun began.

### THE ARIA 16

I recently received a demo unit of what sounded like a great new sound card, the *Aria 16* from Prometheus. That new sound card is capable of 16-bit, 44.1-kHz sampling rate, CD-quality stereo sound. In addition, it features wavetable synthesis for much better sound than older frequency-synthesis cards. On top of that, the card is 100

percent Sound Blaster compatible, so it is guaranteed to work with most software. But the best thing about the card is that it has a list price of only \$99 without a SCSI adapter. The higher-priced *Aria 16se* model includes, among other added features, the SCSI adapter. In most set-ups, however, the SCSI adapter on a sound card goes unused.

When we tried to install the card in one of the new Gateway machines, all seemed to be going fine for a while. But midway through, the installation software hung during the IRQ-test portion of the setup. Nothing we did could get us around the problem, and tech support could provide no meaningful help, aside from telling us that they had problems getting the card to work in Gateway PCI machines.

Curious, we next tried to install the card in an older 486/50 machine. It installed flawlessly. It also installed without a hitch in my Gateway at home.

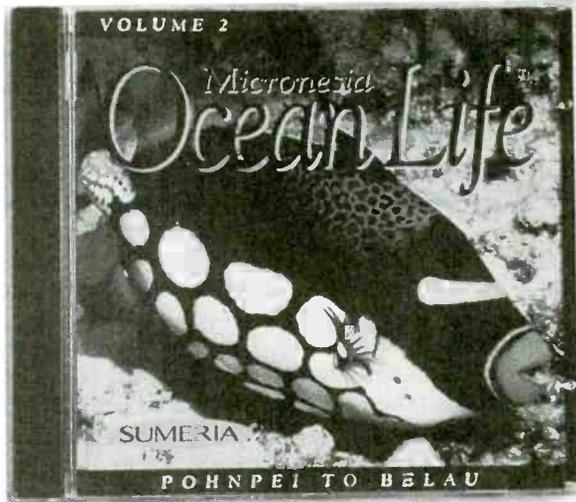
The problem was not just limited to the *Aria* card. When we tried a Logitech *SoundMan Wave* that installed effortlessly (and was still working happily) in that 486/50, the installation software would not even load.

That does not mean that nothing would work in the new Gateway. The Sigma *ReelMagic* MPEG card installed without a hitch, and the Sound Blaster section of that card worked flawlessly, as did an Advanced Gravis *UltraSound* card.

Compatibility problems like those are nothing new. And the introduction of new hardware, software, and operating systems serves to just make the situation worse. Anyway, the Aria does work very well in my 486/50 at work and in my older Gateway 2000 DX2/50 at home. It has good clean sound and has worked with all the software I've tried with it. And, for the moment, the card has a price that can't be beat.

### TOTAL SRS

Last month I talked about a sound card from Media Vision that featured a built-in Sound Retrieval System, or SRS circuitry. SRS was originally developed by the audio division of Hughes Aircraft Company. I mentioned that the first time I saw SRS being demonstrated was in a high-end



*The Ocean Life discs from Sumeria will really appeal to lovers of saltwater fish.*

Sony TV. The SRS was amazing; it made a movie soundtrack sound full and surround-sound like from anywhere I stood. When the SRS was turned off, the sound "returned" to the TV cabinet.

I've got one of SRS Labs' AK-100 Sound Retrieval Systems at home. It's a fantastic addition to any audio, video, or multimedia system. That stand-alone device is about the size of a VCR, and it can add dra-

matic special effects to any audio source, even a mono signal. The AK-100 sells for \$299, which is a very reasonable price considering what it can do.

SRS processes sound in such a way as to account for how recorded sound reaches your ears. We don't have the space to get into details here, but SRS adds depth and realism to movies, CD's, CD-ROM's, cassette tapes, and more.

I've presently got the AK-100 hooked up to my home entertainment system because the sound card in my PC (Media Vision's 3D sound card) happens to have SRS built in. It livens up any compact disc or hi-fi video tape, even though I already have surround sound added to the setup. The SRS works with the surround sound and gives me even more

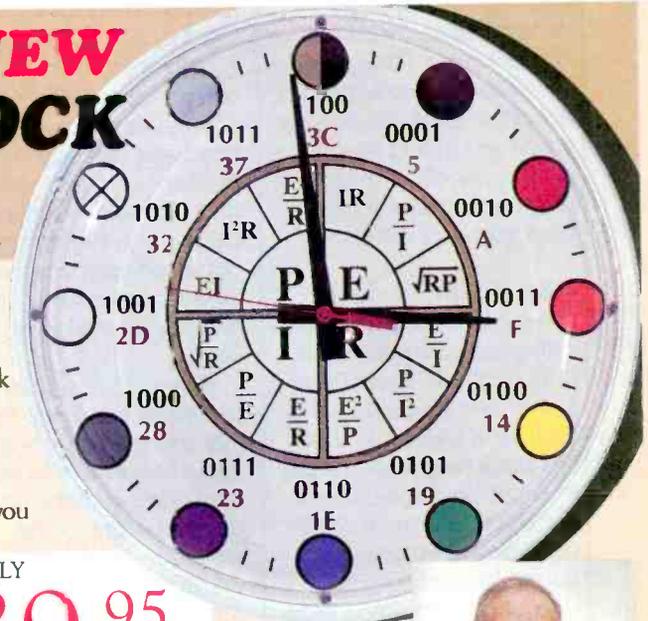
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buttons to play with to get the sound just right.

In addition to SRS, the AK-100 includes a switch to trim reverb, a 3D mono feature to add depth to a mono source, a noise filter, and a fun-to-watch graphical display of the center and spatial levels. The display can work in bar or dot mode. The unit has line-level pass-through inputs and outputs, and a separate pair of inputs and outputs for a built-in loop that lets you add on to the unit.

Three controls—Center, Space, and Level—let you adjust sound to “fit” a particular room and source. Those three controls, in combination with the other special effects, can do wonders for both lousy and excellent recordings. Whether you have a poorly recorded mono VHS tape or a digitally mastered compact disc, the AK-100 can enhance it, but not at all in the same way that an equalizer does. All I can say is that you should listen to what an AK-100 can do for your audio. You won't believe your ears either.

## NEW STUFF

I've got a mixture of interesting software this month. I'll start off with *Corel Draw 5*. That one package is the complete solution to desktop publishing. If you've got the right hardware, there's nothing that Corel 5 can't do to process material bound for print.

To begin with, *Corel Draw* lets you draw, shape, color, dimension, extrude, twist, and do just about anything else you can think of to pictures and text. Of course you can do simple text editing as well. The package also lets you process color photos. Over 22,000 clip-art images and 825 fonts are included. I could go on, but

you get the idea.

About the only drawback I can think of is *Corel Draw 5's* price. It has a suggested list price of \$695 for the CD-ROM-only package, and \$895 for the package that includes 16 diskettes and the CD-ROM. A free CD-ROM containing royalty-free photo samples is also thrown in. You really have to need *Corel 5's* powerful capabilities to justify the investment. Of course actual street prices are lower, and earlier versions of the product that lack certain high-end features of version 5 are still being sold at drastically reduced prices.

Other new software this month includes two reference titles, two health-related titles, two fish discs, and some neat games. The reference titles are *Time Almanac of the 20th Century* and *Bookshelf '94*.

*Time Almanac of the 20th Century* from Compact Publishing contains an archive of over 4000 articles from issues of *Time* magazine since the beginning of the century. Audio, video, and photos are also included. The information is accessed from a decade-by-decade timeline. The disc has a list price of \$69.95

Microsoft's *Bookshelf '94* is a versatile reference disc that anyone might find useful at home or work. The single disc contains updated versions of *The American Heritage Dictionary*, *The Original Roget's Thesaurus*, *The Columbia Dictionary of Quotations*, *The Concise Columbia Encyclopedia*, *Hammond Intermediate World Atlas*, *The People's Chronology*, and *The World Almanac and Book of Facts 1994*. Need I say more? The disc has a list price of \$99.

Health-related discs include *PharmAssist* and

*Bodyworks 3.0*, both from Software Marketing Corporation. *PharmAssist*, *The Family Guide to Health and Medicine*, contains everything you need to know about prescription and non-prescription drugs. A phonetic-search feature lets you look up a medication even if you don't know how to spell it. *Bodyworks* is devoted to human anatomy. The disc lets you explore the entire body, multimedia-style. Animations bring body functions to life on your PC. Both discs retail for \$69.95.

I like fish—as pets. I've had both fresh and salt-

water fish. The saltwater fish are a lot more interesting. So naturally I like two new discs from Sumeria: *Ocean Life Volume II* and *Ocean Life Volume III*. *Ocean Life Volume II*, a double-disc set, focuses on the fish of Micronesia and *Ocean Life Volume III* focuses on those of the Hawaiian Islands. These are basically “fish encyclopedias” containing text, photos, video, and narration. *Ocean Life II* and *III* come on Mac/PC discs that sell for \$49.95 each.

*Return to Ringworld* is an adventure game. In it you must repair a 29th century spaceship, evade aliens, and save Ringworld. Besides 3D animation, the game contains digitized speech, sound effects, and a stereo soundtrack. The game is available from Time Warner Interactive for \$69.95.

*AEGIS: Guardian of the Fleet* is an action game that puts you in command of the most powerful and technologically advanced warship in the world. The graphics in this game are great, and it's very realistic. The game, also available from Time Warner Interactive, sells for \$89.99.

Also available from Time Warner Interactive is the *Short Attention Span Theater: Dating & Mating*. Lots of famous comedians (male and female) are here with plenty of jokes to tell in live video. *Dating & Mating* is \$49.99.

Last but not least, *Return to Zork* from Activision is now available for Mac users. While I don't have a Mac to play with anymore, I thought some readers might be interested to know about it. It is one of the most involved games I've ever seen. The game is perfect if you play through most other games too quickly.

## WHERE TO GET IT

Activision  
11601 Wilshire Blvd.  
Suite 1000  
Los Angeles, CA 90025  
Tel. 310-473-9200

Compact Publishing  
5141 MacArthur Boulevard  
Washington, DC 20016  
Tel. 800-964-1518

Corel Corporation  
The Corel Building  
1600 Carling Avenue  
Ottawa, Ontario  
Canada K1Z 8R7  
Tel. 613-728-8200

Microsoft Corporation  
One Redmond Way  
Redmond, WA 98052  
Tel. 206-882-8080

Prometheus Products, Inc.  
9524 S.W. Tualatin Sherwood  
Road  
Tualatin, OR 97062  
Tel. 503-692-9600

Software Marketing Corporation  
9830 S. 51st St.  
Building A-131  
Phoenix, AZ 85044  
Tel. 602-893-3377

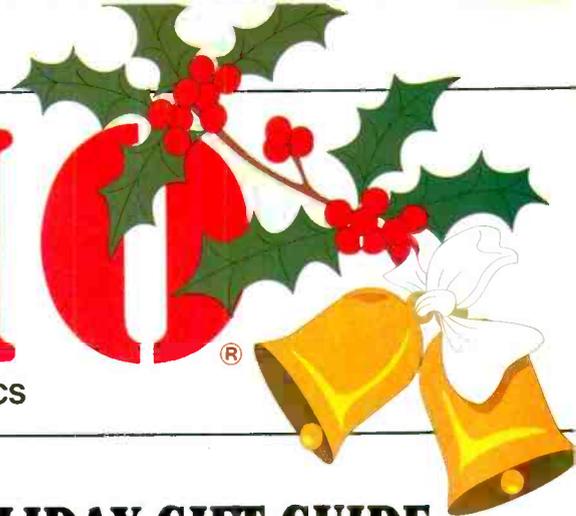
SRS Labs  
2909 Daimler St.  
Santa Ana, CA 92705  
Tel. 800-2HEAR3D

Sumeria, Inc.  
329 Bryant St., Suite 3D  
San Francisco, CA 94107  
Tel. 800-478-6374

Time Warner Interactive  
2210 West Olive Ave  
Burbank, CA 91506  
Tel. 818-955-9999

# GIZMO®

A CHRONICLE OF CONSUMER ELECTRONICS



## GIZMO'S HOLIDAY GIFT GUIDE

Christmas is just around the corner, and chances are that you haven't even begun making lists, let alone started shopping for presents. If you're at a loss as to gift suggestions for the kids, for your wife, for your parents—and haven't even decided what to ask Santa to leave under the tree for *you*—read on.

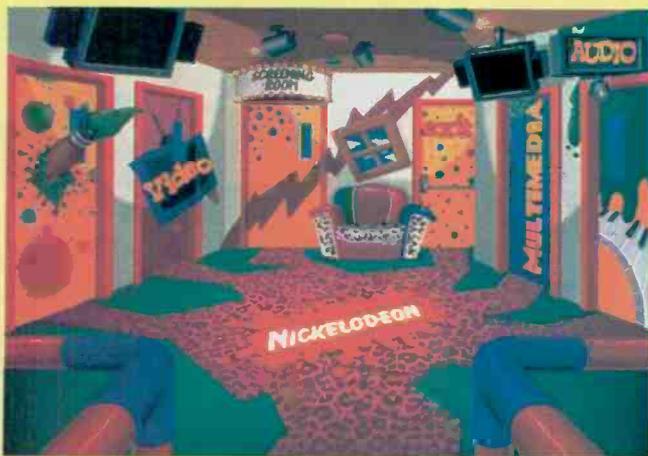
We've compiled ten pages of ideas from the world of consumer electronics that will make your holiday merrier—or at least less stress-filled. We've grouped the gift suggestions by family member, and if our selections seem to be stereotyped—kitchen gadgets for Mom, sports-related stuff for Dad—they are! It's up to you to use your imagination, and your insights into the people on your own gift list, to decide who gets what. The *KitchenVision* TVCR—or a *Smart & Easy Sensor* microwave, for that matter—would make a great gift for a twenty-something “kid” who is finally leaving the nest and knows nothing about cooking. A *CB Help!* package, which we recommend for Grandma or Grandpa, is a practical present for anyone who spends time driving alone. And whoever plans the family vacations would love *Map'N'Go* software.

You get the picture. We've come up with the goods—now you mix-and-match them with your friends and family members, and watch them smile as they open their gifts!

Keep in mind, also, that we left out many more items than we could possibly include in ten pages. If we've inspired you to buy consumer-electronics gifts for your friends and relatives, visit your local electronics store to see a broader selection of gift ideas, and to comparison shop on prices and features.

**Happy holidays  
from all of us at Gizmo!**

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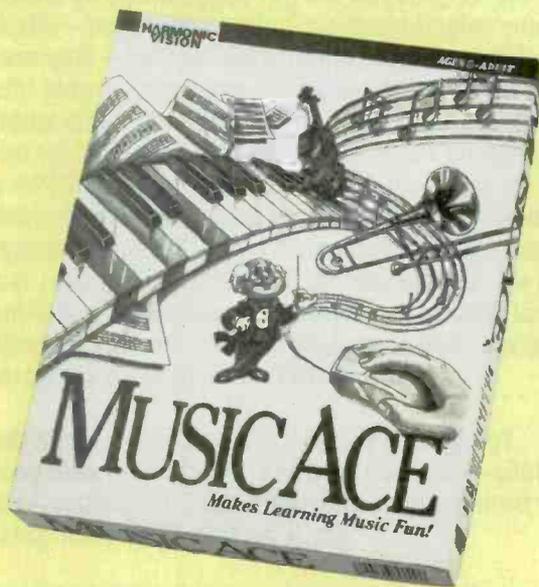


Kids can create their own professional-looking multimedia presentations, mini-movies, video greeting cards, music videos, and mini-cartoons with *Nickelodeon Director's Lab* on CD-ROM, from *Viacom New Media*. Melissa Joan Hart, star of *Clarissa Explains It All*, provides pointers, helping kids to compose music, design backgrounds, create animations, and edit video in one of three different "studios." Price: \$58.99.

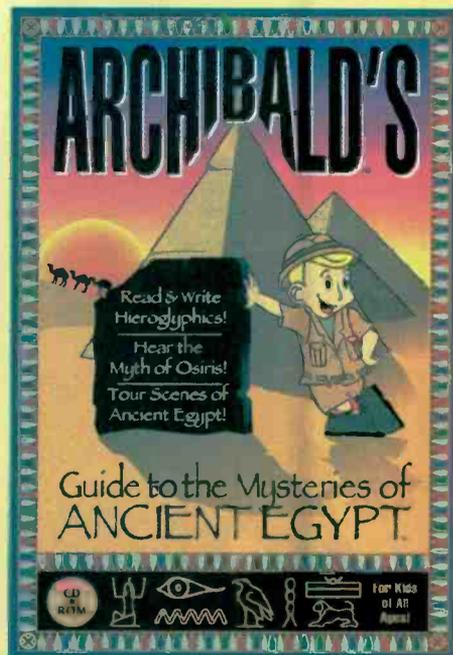


Remember the early electronic game, "Simon"? *Sega's PODS*, a futuristic version of that memorization toy, challenges kids to replicate the sound and light sequences that PODS creates. The electronic toy is activated not by touch, but by holding a hand over its infrared sensors at the right height. Players can also create their own pattern for friends to follow. Price: \$50 (additional sound cartridges, \$10 each).

## for the KIDS,



Send your kids on journey back in time, to Egypt in 2500 BC, with *Archibald's Guide to the Mysteries of Ancient Egypt* from *Swite International, Ltd.* The interactive CD-ROM lets kids tour the pyramids with Archibald, son of a British explorer. Along the way, in an adventure deep inside a pyramid, they can see how mummies are made, and—best of all—learn to read, write, and speak hieroglyphics, so they can create secret messages that you can't understand! Price: \$39.95.



If you'd rather not subject your kids to the hours of boring lessons and practice sessions that you went through, try giving them *Harmonic Vision's Music Ace* software for beginning music students. It includes fun lessons, challenging games, and a creative "Music Doodle Pad" for original composition. Maestro Max and his choir of singing notes use animation, graphics, and sound effects to teach fundamental music skills and theory. Price: \$59.95.

The *ComfyKeyboard* makes kid-computing more fun, with its large, colorful buttons and a working telephone built in. The keyboard and the included animated movie help young children reach higher levels of computer understanding through each session on the keyboard, using familiar shapes, colors, and visuals to invite young fingers to touch, poke, explore, and learn. Price: \$129.



# Your own TV station for less than \$100?

Recoton's engineering breakthrough transmits cable, TV, VCR and satellite programs throughout your home...without wires!

By Charles Anton

**T**oday television choices are virtually unlimited. With cable, satellite TV, videos and network programming to choose from, it's a full-time job just trying to keep up with everything. And it promises to get worse from here. Newly developed fiber optic technology will bring more than 500 TV channels to your home.

**Home broadcasting breakthrough.** The only problem with all this technology is the expense. Now, a newly developed wireless video broadcasting system gives you the power to utilize this technology, without the hassle and expense of wiring your entire home.

Recoton's research and development team brings you the next generation in wireless broadcasting.

The wireless video broadcaster enables you to transmit (re-broadcast) cable, TV, VCR or satellite programs to any other TV in your home, without wires!

**Wave of the future.** Never again will you have to drag your VCR from room to room, or have to buy more than one. With the wireless video system you can broadcast videos to any other TV in your home.

You won't have to worry about running cable wire all over the place either. Besides, who could afford to install cable in every room anyway? With the wireless video system, you won't have to. You can even watch one program on your main TV and watch a different program or video on the other. It's like having a personal broadcasting system in your own home—and it's legal in every state.

**Hi-tech home broadcast.** Recently, the Federal Communications Commission allocated a band of radio frequencies specifically for wireless, in-home product applications.

Recoton's research and development group took advantage of the 1989 FCC ruling by creating and introducing wireless home transmission equipment that could transmit pictures and sound in the prescribed frequency over distances of 150 feet or more.

**One transmitter, unlimited receivers.** One transmitter operates an unlimited number of receivers. That means one transmitter in the den can send signals to the TVs in the bedrooms, kitchen and wherever else. Put your favorite programs in the places you want them most.

**Even more choices.**

Since the system utilizes the latest 900 MHz frequency signals, no time-consuming or complicated wiring is required. The receiver can be moved from one TV to another as your needs change. Or the transmitter can broadcast to multiple receivers, so that you can watch the same program on many TVs simultaneously. The transmitter simply connects to the source TV; the receivers connect to the others.

**Easy-to-use.** With state-of-the-art resonator quality, both the transmitter and the receiver provide users with a small, easy-to-install product that does not require the adjustments that competitor's models do.

This latest version incorporating space-age styling with the latest miniaturized design circuitry, enables

the transmitter and receiver to be substantially smaller than previous models.

**Exclusive direct offer.** With this breakthrough in home video broadcasting technology, you can have the convenience of your

**Wireless Video Breakthrough... watch what you want, where you want**

- **Cable.** Broadcast cable channels to the other TVs in your home that aren't wired for cable... even premium channels.
- **Videos.** Transmit VCR signals to rooms that have no VCRs. Watch videos in any room of the house, even if someone's watching TV in the room with the VCR.
- **Satellite programs.** Watch satellite programs throughout your home without stringing cable everywhere.
- **Network programming.** If you have a house full of TVs but only one is hooked up to an antennae, you can broadcast the clear signal from that TV to all the others.
- **Live video.** Watch your home videos as you film them. Or turn your camcorder into a security camera.



**TV Tower**

**Size: 1059 feet**  
**Weight: 260 tons**  
**Cost: \$3.5 million**

**Home Video Broadcasting System**

**Size: 4.5 inches**  
**Weight: 3 pounds each**  
**Cost: \$99**

**TV broadcasting comes to the home.**

own personal wireless broadcasting system for a fraction of the cost of owning your own TV station. For a limited time, we are offering the Recoton wireless video broadcasting system direct-to-the-public for only \$99. Remember, one transmitter will operate an unlimited number of receivers, you can order additional receivers for other TVs for only \$59. So order now and put a personal broadcasting system in your home.

**Risk-free offer.** We are so confident that you will love the wireless video broadcaster that we back it up with our "No Questions Asked" 30 day money-back guarantee. If you are not completely satisfied for any reason, just return it within 30 days for a full refund. It also comes with a one year manufacturer's limited warranty.

**Video Broadcasting System.....\$99 \$9 S&H**  
*Includes one transmitter and one receiver.*

**Additional Receiver.....\$59 \$7 S&H**

To receive this special pricing, you must mention promotional code **172-PL1104**

For fastest service call toll-free 24 hours a day

**800-992-2966**



To order by mail send check or money order for the total amount including S&H (VA residents add 4.5% sales tax). Or charge it to your credit card by enclosing your account number and exp. date.

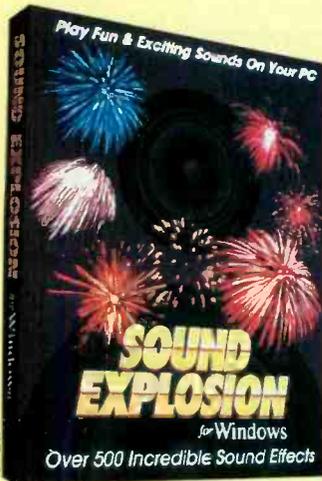
**COMTRAD INDUSTRIES**

2820 Waterford Lake Drive Suite 106  
 Midlothian, Virginia 23113

# for TEENS,



Make your teenagers the envy of all their friends with a portable, digital *MiniDisc* player or recorder from *Sony MiniDisc* promises audio quality virtually identical to CD's in a fraction of the size. The anti-shock features make them ideal for use on the go. Through March 31, 1995, the *Walkman* player comes with coupons redeemable for up to \$300 in prerecorded MD titles. Price: MZ-E2 (play-only) \$549.95; MZ-R2 (record/play) \$749.94.

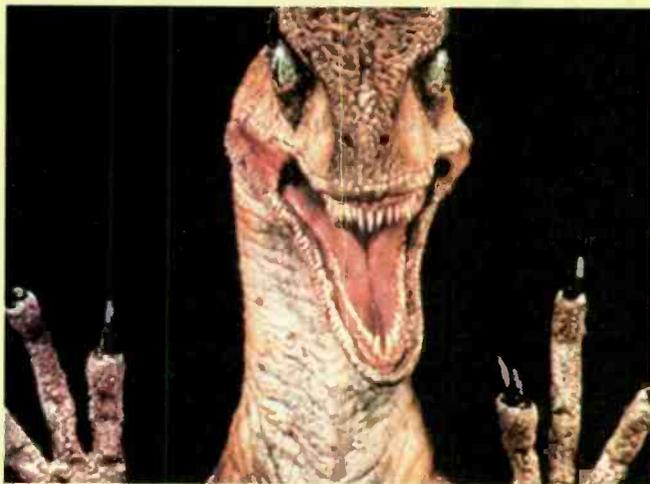


What kid wouldn't want to add rude sound effects to his computer? *Sound Explosion* from *Programmer's Warehouse* has over 500 sounds to choose from, including sounds from popular movies as well as explosions, horns, buzzers, animal sounds, human noises, splats, creaks, squeaks, and, well, you get the idea. *Sound Explosion* works under Microsoft Windows and adds 30 new events to the Windows sound accessory. Price: \$49.95.



Teens are not noted for their neatness. That's why a spill-resistant keyboard from *Identity Systems Technology, Inc.* could be a life (or homework) saver. Now those coffee or cola spills—and all those crumbs—will be stopped by a moisture-proof membrane underneath the keys. Price: \$39.95.

If they liked the movie, they'll love the game. *Jurassic Park Interactive* from *Universal Interactive Studios* plays off the film's plot and characters, and includes scenes and music from the movie. It can be played on many different levels, and is completely non-linear. It incorporates elements of strategy, as well as a driving game, shooting game, and maze game. The ultimate goal is to rescue the people on the island from the dinosaurs, and at the same time to unlock the sabotaged powerless grid. Price: about \$55.



For any teen who is tiring of the *Sega Genesis* or *Sega CD* videogame systems, the *Genesis 32X* upgrade promises to boost the power of those systems to bring arcade-quality game experiences to the home. The *Genesis 32X* has two 32-bit RISC (reduced instruction set computer) processors to bring fast processing speed and the ability to display more than 32,000 colors and three-dimensional graphics. Games for the new system will be priced at about \$70. Price: \$150.



Your teen might be driving a piece of junk, but that doesn't mean it has to sound like one. *Alpine's* family of detachable-face FM/AM cassette players are filled with such features as full-logic control and a "SmarTouch" powered mechanism. The *Model 7513*, shown here, has a 4-channel output with fader control. A healthy 25 watts of power is fed to each channel. It has CD Shuttle controls, so it's ready for the addition of an *Alpine* CD changer. Price: \$300.



Flight simulators take on a new level of realism with *CH Products' Virtual Pilot*, which works just like a real airplane yoke. Virtual Pilot attaches to a PC through the game port, and features complete aileron and elevator control, throttle, tactile fire buttons located under the thumbs, and trim controls. Although designed for flight simulators such as Microprose's "Fleet Defender F-14 Tom Cat," Virtual Pilot works with every game that uses a standard joystick port. Price: \$109.95.

If your teenager is having trouble keeping track of his busy schedule, he might welcome a multimedia personal information manager (PIM). The *Personal Daily PlanIt* series from Media Vision is available in three flavors, each of which contains still and video images on a theme. *PlanIt Earth* focuses on wildlife, *PlanIt Adrenaline* is for the fan of radical sports, and *PlanIt Paradise* is essentially "Swimwear Illustrated" on disk. Price: \$59.95 for CD-ROM version, or \$49.95 for a floppy-disk version with scaled-down features.

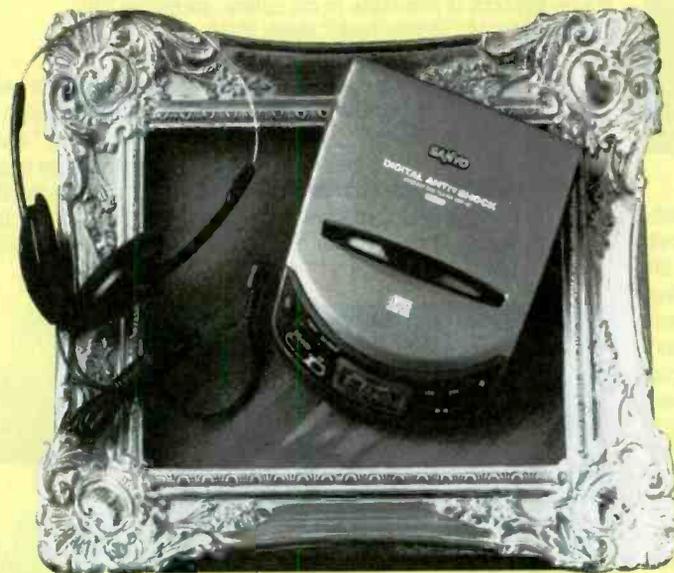


The *Key from Lonestar* is a musical instrument that can be played even by teens who flunked music class. The interactive controller is

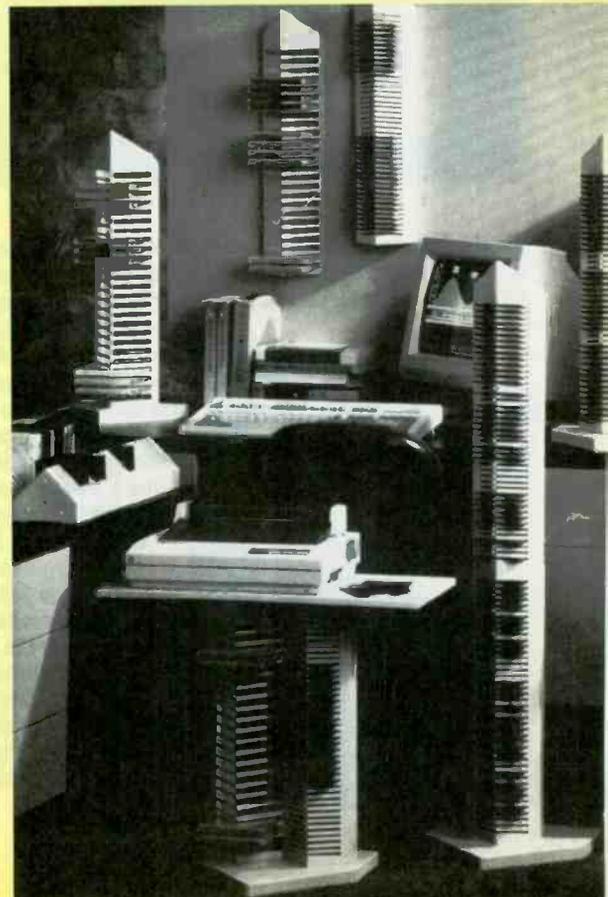


essentially a synthesizer that takes information from specially encoded sources such as a video tape. The player can modify the sounds, but can't play out of tune! The Key also conforms to General MIDI standard, and multiple units can be combined to form a "band." Price: \$400.

A teenager with a clean room? It doesn't happen very often, but good-looking CD storage systems from *Atlantic, Inc.* might at least encourage a teen to get his audio CD's and CD-ROM's off the floor and into the rack. They'll at least eliminate any excuses for not doing so! The towers and modules can be used individually, stacked upright, placed horizontally, or joined side by side. They can be free-standing or wall mounted, and are available to store 3½-inch diskettes as well. Prices: \$20 (wall mounted), \$25 (free standing with base).



Music on-the-go is essential for any teenager. *Sanyo's CDP-67* is a portable CD player with a twist. Built-in anti-shock technology promises to make it truly practical to listen to CD's while on the move. Along with an anti-shock butyl rubber damper mechanism, the player has a digital anti-shock memory that compensates for mistracking. The CDP-67 is also an inexpensive way to add a CD to a car. It comes equipped with a car cassette and power adapter kit. Price: \$199.99.



# and for MOM,



The *Canon Sure Shot A-1* offers automated point-and-shoot simplicity in a compact sports camera that is waterproof at depths down to 16.4 feet. The Sure Shot A-1 is a good choice for family ski trips, camping expeditions, boating, and beach outings. The camera's focus-free modes allow Mom to concentrate on picture composition and capturing the moment, as the family goes water skiing, canoeing, or splashes around the backyard pool. Price: \$310.



Modern moms need to keep organized, and *Casio's SF-4300B Business Organizing Scheduling System (B.O.S.S.)* can help. The digital diary and organizer has 32KB of memory and includes a schedule keeper to store appointment times and dates, a full month calendar display with special marks for viewing scheduled appointments at a glance, a daily alarm and a schedule alarm, and a telephone directory. Optional cables allow the SF-4300B to be connected to another B.O.S.S. or to a personal computer. Price: \$109.95.



Between managing a job and raising a family, today's busy moms are hard to track down. The *Memo Express* pager from *Motorola* can help them keep in touch with family members, friends, and co-workers. The alphanumeric pager features a one-line, 120-character, scrolling display. Messages are stamped with date, and time of day, and are saved even when the pager is turned off. The Memo Express is available in six colors, including "Bimini Blue" and "Totally Teal." Price: \$219.

Mom can sharpen her card-playing skills between bridge-club meetings with the *Pro Bridge 510* from *Saitek*. Built-in coaching features help players at all levels develop their skills. The device plays all major bridge systems (including standard American 4 and 5 card majors plus six other versions) and allows users to select from more than 30 pre-programmed bidding conventions. Ten skill levels provide a challenge for beginners, and club players alike. The Pro Bridge 510 includes cables for connection to Saitek's handheld model 310, to allow the two bridge computers or two players to play either as partners or opponents. Price: \$399.95.

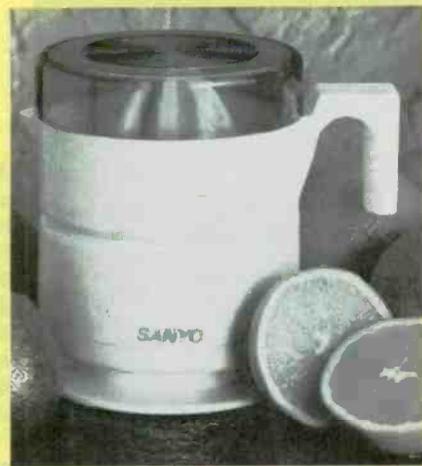


By masking the disturbing sounds of such household noises, such as stereos or snoring with the soothing sounds of a tropical rainfall, the pounding surf, or the steady "clickety-clack" of a train, *Radio Shack's Sleep Machine* might help Mom relax and fall asleep quickly and naturally. The home model comes with a pillow speaker for private listening. Price: home model, \$39.99; portable model, \$34.99.





If Mom, after a hard day, tends to fall asleep with the TV on, consider giving her one of *Gemini's* remote controls with built-in sleep timers. The *Q15* and *Q50* models allow the user to preset the sleep-timer function to turn off the TV after 60 minutes, whether or not the TV has its own built-in sleep timer. The slim *Q15* controls the basic functions of a TV or cable box, while the universal *Q50* controls both basic and special functions of any four TV's, VCR's, and cable boxes. For easy setup, the remote controls are pre-programmed with codes for most popular equipment. Just be sure to tell Mom not to fall asleep with the remote under the covers! Prices: N/A.



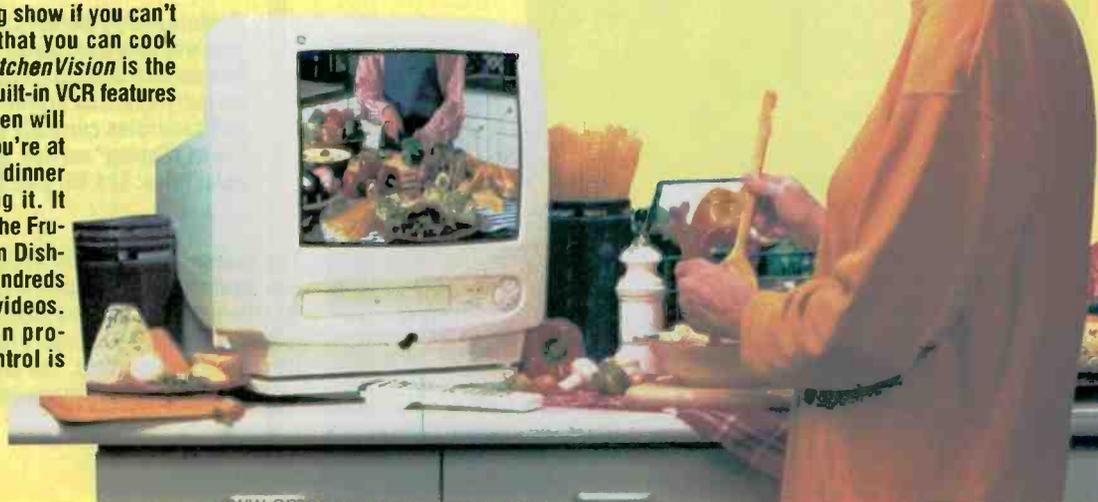
Health-conscious moms will appreciate fresh, fuss-free orange or grapefruit juice, with *Sanyo's SJ-200* electric citrus juicer. A built-in spout eliminates spills, and the unit breaks down into just two removable parts for easy cleaning. Price: \$14.95.

Help Mom spend less time in the kitchen with one of *Sharp's* new *Smart & Easy* sensor microwaves. An output power of 1000 watts, reduces the cooking time by up to 25% over less powerful microwaves. The time and power level needed to defrost foods perfectly are determined automatically. Memory Plus stores the most-often-used cooking times for fast recall, and a child lock prevents kids from using the microwave when adults are not present. Even culinarily-challenged family members will be able to reheat leftovers, bake potatoes, pop popcorn, and cook frozen dinners (each is accomplished at the touch of a button)—keeping Mom out of the kitchen completely! Prices: \$399.95–\$3439.95.



Mom can spend the dreary days of winter designing her summer garden, with the help of the *Better Homes & Gardens Complete Guide to Gardening CD-ROM* from *Multicom*. It contains the answer to virtually any question concerning America's favorite hobby. More than 600 plants, grouped by categories such as shrubs, bulbs, vegetables, and perennials, are illustrated by over 1500 color photographs. For beginners as well as experienced gardeners, the program covers pruning, composting, transplanting, and pest and disease control. Price: \$59.95.

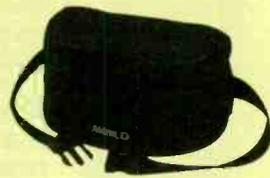
What good is taping a cooking show if you can't replay it in your kitchen so that you can cook along with the pros? *GE's KitchenVision* is the answer. The 13-inch TV with built-in VCR features a lazy-susan base so the screen will always be in view whether you're at the kitchen counter preparing dinner or at the kitchen table eating it. It comes with a free videotape: the *Frugal Gourmet's "Fancy Chicken Dishes,"* as well as a catalog of hundreds of cooking and entertaining videos. The VCR features on-screen programming, and a remote control is included. Price: \$499.



# for DAD,



Motorola's MicroTAC Elite personal cellular telephone would make a classy gift for any dad. Weighing only 3.9 ounces, the MicroTAC Elite is the world's lightest cellular phone. New lithium-ion batteries provide up to one hour of continuous talk time or up to ten hours of standby time. An internal rapid "smart" charger optimizes the required charge rate. An optional digital answering machine feature provides a up to 75 seconds of message storage time, and an optional headset jack allows hands-free use of the phone. A pager-like feature allows 10 numeric messages to be stored. Price: about \$800.



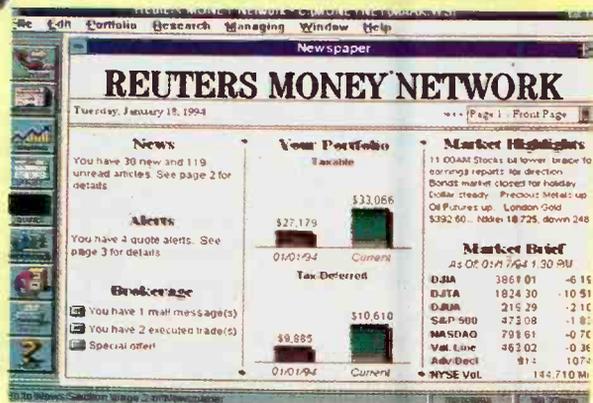
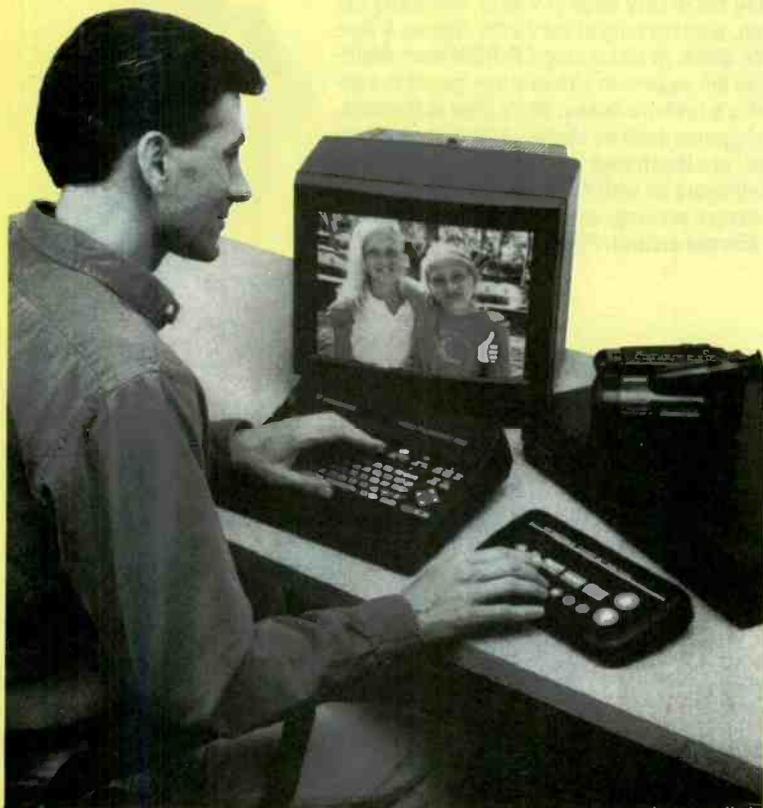
Does Dad always get stuck carrying more than his fair share of the gear—including the video camera—on family outings? *Ambico* can free his hands, with the *CamPack* combination backpack and video storage "fanny pack." Made of natural-fiber, water-resistant materials, the *CamPack* keeps extra clothing, maps, and other supplies dry in the large, upper compartment, and safely stores video gear and accessories in the padded, zip-off, lower compartment. Price: \$35.



When Dad goes off camping or hunting, he can bring along entertainment with *Casio's CD-TV80*, an AM/FM stereo cassette player/recorder with CD and built-in LCD color TV. The unit features a 2½-inch TV display, which doubles as a color monitor for CD functions. Video output and external antenna jacks are provided. Six D batteries power the unit in the field. Price: \$499.95.



When Dad goes off camping or hunting, he can bring along entertainment with *Casio's CD-TV80*, an AM/FM stereo cassette player/recorder with CD and built-in LCD color TV. The unit features a 2½-inch TV display, which doubles as a color monitor for CD functions. Video output and external antenna jacks are provided. Six D batteries power the unit in the field. Price: \$499.95.



*Reuters Money Network* for Windows from *Reality Technologies* will help Dad manage his personal investments. The online service offers personalized recommendations based on an individualized profile of risk tolerance, liquidity needs, and securities currently held. Stock quotes, a personalized "news clipping" service, and online discount trading are available. Price: \$24.95, plus \$9.95 per month.

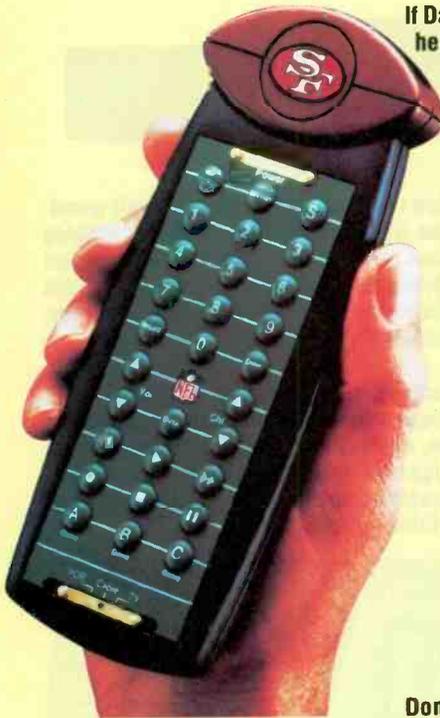
The *Videonics TitleMaker 2000* will let Dad turn his home videos into award-winning documentaries. The *TitleMaker 2000* has over 90 different type fonts and sizes for variety, and offers backgrounds, letters, outlines and borders that can be created with over a million colors and patterns. The full keyboard includes accented characters for over 16 languages and special characters. Price: \$599.



Help Dad become a safer driver by slowing down. *Uniden's* new laser/radar detectors will help make him aware of his speed with reminders that a radar trap might be just up the road. The LRD 900W-1 is a four-band laser/radar integrated detector with super wide-band KA detection. It features a rugged metal case. Price: \$249.95.



If Dad spends his free time on home-improvement projects, he'll love getting one of *Seiko Instruments'* hand-held electronic measurement devices for do-it-yourselfers. The *Home Contractor* line includes the *ProMeasure+HC1000*, a tapeless device that ultrasonically measures room dimensions, and the *ProLevel HC-200*, which has three ways to let Dad know if an object is level. Prices: less than \$50 each.



If Dad is a rabid football fan, he's sure to appreciate the *One For All Sports Clicker* line of remote controls from *Universal Electronics*. The football version comes with a sheet of different NFL team logos so that Dad can mount his favorite team's emblem on the remote. The remote is shaped like a football field; a football at the top of the remote transmits the infrared signals. The Sports Clicker can serve as a replacement remote for virtually any remote-controlled TV, VCR, cable box or CD player. Price: \$39.95.

Dad will never have to give in and ask for directions if his car is equipped with *Sony's GPS Mobile Navigation System*. The system, which uses software developed by *Etak, Inc.*, combines *Global Positioning System (GPS)* technology for moving maps that track the motorist's progress in real time with instantly accessible travel information about restaurants, hotels, and shopping. Both the maps and the information come on CD-ROM's and are displayed on a five-inch color LCD screen. The system comes in two versions: the installable *NVX-F15* and the transportable *GPX-M1*, which can be taken home for pre-trip route and activity planning. Prices: N/A.



Don't keep Dad in the dark! The *Hi-Gain 500* lantern will shed light on the darkest of subjects. *Diamond Light Industries, Inc.*, puts advanced optics to work in a flashlight. The patented lens casts up to 40% more of the available light from its four D-cell krypton bulb system than competitive products. The lantern is about 6 inches square and 2-1/2 inches thick. It features a convenient tilt bale that doubles as a handle. Price: \$24.95.

Help Dad stay fit by making his workouts fun, with the *Life Fitness Entertainment System* from *Life Fitness and Nintendo*. The system includes a *Lyfecycle* aerobic trainer that hooks up to a Super NES system (not included). Special software, such as a rough-and-tumble road race game called "Mountain Bike Rally," responds directly to the bike's resistance and the player's pedalling, speed, and steering. "Program Manager" software lets Dad track his progress over time. Price: \$700.

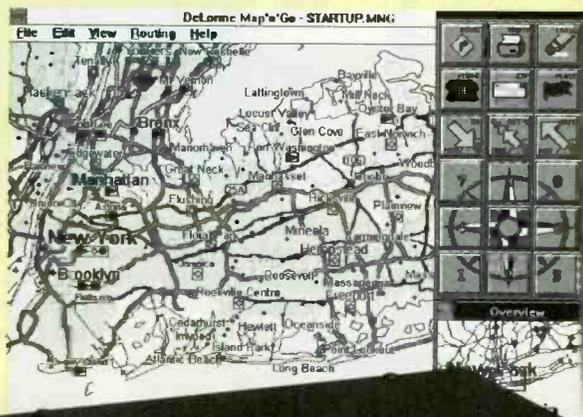


# for Grandparents



A veteran of World War II, might appreciate *NovaLogic's WoNPack*, submarine simulation software. Seventy challenging missions allows users to experience battles between German U-boats and U.S. destroyers. The historically accurate software is available in either CD-ROM or floppy-disk versions. Price: \$39.95.

Grandparents who love to travel will appreciate *Map'N'Go* travel-planning software from *DeLorme Mapping*. The CD-ROM contains a comprehensive map database combined with intelligent routing capability, and a database of more than 31,000 hotels, inns, campgrounds, restaurants, and points of interest throughout the U.S., Canada, Mexico, and the Caribbean. Price: \$49.



One complaint that is common for many older people is the difference in the volume levels of TV programs and commercials, or between scenes in movies. *Brookline Technologies' Volume Stabilizer* increases the volume of soft sounds and decreases the volume of loud commercials. A single front-panel control allows the user to adjust the level of volume stabilization. Price: \$129.50.



Let your grandparents keep track of changing weather conditions with the BA-212 home weather forecaster from *Oregon Scientific*. The unit features a four-line LCD that shows current conditions plus a forecast for the next 12 to 24 hours. An audible alarm warns of dangerous storms. Price: \$29.95.



Any grandparents who love to watch home videos of their grandchildren will appreciate the *GVR-DD1 VHS 8mm/VHS VCR* dubbing deck from *Goldstar*. It allows an 8mm camcorder tape to be copied easily onto a VHS tape. Available special effects include variable slow motion, still/freeze frame, frame advance, double speed play, and advanced editing functions. Price: \$899.95.

*Cobra's 35EM SOS Kit* contains an ultra-compact 40-channel CB radio, microphone, magnetic-mount antenna, emergency "Send Help" flag, jumper cables, and a carrying bag. It can be powered through a car's 12-volt cigarette lighter plug, or by AA batteries. The CB can provide enjoyable companionship on long road trips, and extra peace of mind. Price: \$79.95.



900 MHz breakthrough!

# New technology launches wireless speaker revolution...

Recoton develops breakthrough technology which transmits stereo sound through walls, ceilings and floors up to 150 feet.

By Charles Anton

If you had to name just one new product "the most innovative of the year," what would you choose? Well, at the recent *International Consumer Electronics Show*, critics gave Recoton's new wireless stereo speaker system the *Design and Engineering Award* for being the "most innovative and outstanding new product."

Recoton was able to introduce this whole new generation of powerful wireless speakers due to the advent of 900 MHz technology. This newly approved breakthrough enables Recoton's wireless speakers to rival the sound of expensive wired speakers.

**Recently approved technology.** In June of 1989, the *Federal Communications Commission* allocated a band of radio frequencies stretching from 902 to 928 MHz for wireless, in-home product applications. Recoton, one of the world's leading wireless speaker manufacturers, took advantage of the FCC ruling by creating and introducing a new speaker system that utilizes the recently approved frequency band to transmit clearer, stronger stereo signals throughout your home.



**Crisp sound throughout your home.** Just imagine being able to listen to your stereo, TV, VCR or CD player in any room of your home without having to run miles of speaker wire. Plus, you'll never have to worry about range because the new 900 MHz technology allows

### 150 foot range through walls!

Recoton gives you the freedom to listen to music wherever you want. Your music is no longer limited to the room your stereo is in. With the wireless headphones you can listen to your TV, stereo or CD player while you move freely between rooms, exercise or do other activities. And unlike infrared headphones, you don't have to be in a line-of-sight with the transmitter, giving you a full 150 foot range.

The headphones and speakers have their own built-in receiver, so no wires are needed between you and your stereo. One transmitter operates an unlimited number of speakers and headphones.



Recoton's transmitter sends music through walls to wireless speakers over a 75,000 square foot area.

stereo signals to travel over distances of 150 feet or more through walls, ceilings and floors without losing sound quality.

**One transmitter, unlimited receivers.** The powerful transmitter plugs into a headphone, audio-out or tape-out jack on your stereo or TV component, transmitting music wirelessly to your speakers or headphones. The speakers plug into an outlet. The one transmitter can broadcast to an unlimited number of stereo speakers and headphones. And since each speaker contains its own built in receiver/amplifier, there are no wires running from the stereo to the speakers.

### Full dynamic range.

The speaker, mounted in a bookshelf-sized acoustically constructed cabinet, provides a two-way bass reflex design for individual bass boost control. Full dynamic range is achieved by the use of a 2" tweeter and 4" woofer. Plus, automatic digital lock-in



Breakthrough wireless speaker design blankets your home with music.

tuning guarantees optimum reception and eliminates drift. The new technology provides static-free, interference-free sound in virtually any environment. These speakers are also self-amplified; they can't be blown out no matter what your stereo's wattage.

**Stereo or hi-fi, you decide.** These speakers have the option of either stereo or hi-fi sound. You can use two speakers, one set on right channel and the other on left, for full stereo separation. Or, if you just want an extra speaker in another room, set it on mono and listen to both channels on one speaker. Mono combines both left and right channels for hi-fi sound. This option lets you put a pair of speakers in the den and get full stereo separation or put one speaker in the kitchen and get complete hi-fi sound.



These wireless stereo headphones have a built-in receiver.

**Factory direct savings.** Our commitment to quality and factory direct pricing allows us to sell more wireless speakers than anyone! For this reason, you can get these speakers far below retail with our 30 day "Dare to Compare" money-back guarantee and full one year manufacturer's warranty. For a limited time, the Recoton transmitter is only \$69. It will operate an unlimited number of wireless speakers priced at \$89 and wireless headphones at \$59 each. Your order will be processed in 72 hours and shipped UPS.

**Recoton Transmitter** (you must have a transmitter to operate speakers and headphones).....\$69 \$7 S&H  
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For fastest service call toll-free 24 hours a day  
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### AWARD WINNING WIRELESS SPEAKER

Built-in receiver and amplifier:

The wireless speaker and headphones both contain a built-in receiver and amplifier. Signals are picked up and transmitted as far as 150 feet away through walls without the use of wires.



Volume Power Tuning Tuned ports  
 2" tweeter  
 4" woofer  
 Individual left, right & mono switch and Individual bass boost control (on back)

Size: 9"H x 6"W x 5.5"L  
 Signal-to-noise ratio: 60 dB  
 Channel Separation: 30 dB  
 Two-way bass reflex design  
 10 watts/channel RMS amps  
 Frequency Response: 50 Hz-15 KHz

**Don't take our word for it.** Try it yourself We're so sure you'll love the new award-winning Recoton wireless speaker system that we offer you the **Dare to Compare Speaker Challenge**. Compare Recoton's rich sound quality to that of any \$200 wired speaker. If you're not completely convinced that these wireless speakers offer the same outstanding sound quality as wired speakers, simply return them within 30 days for a full "No Questions Asked" refund.

Recoton's Design and Engineering Award



We've never met a family that could agree on what music to listen to. *Fisher's Studio 24* comes to the rescue by storing up to 24 CD's by user names or categories. Mom and Dad can have their own categories, and the kids can share a third. Each CD can be stored in a main category and a subcategory, so that if Dad likes some of the kids' music, he can program the Studio 24 to include those discs in his listening. The Studio 24 loads the discs vertically in a turntable arrangement, and protects the loaded discs from dust. It's about twice the height of a standard audio component. Price: \$499.95.



## for the Family

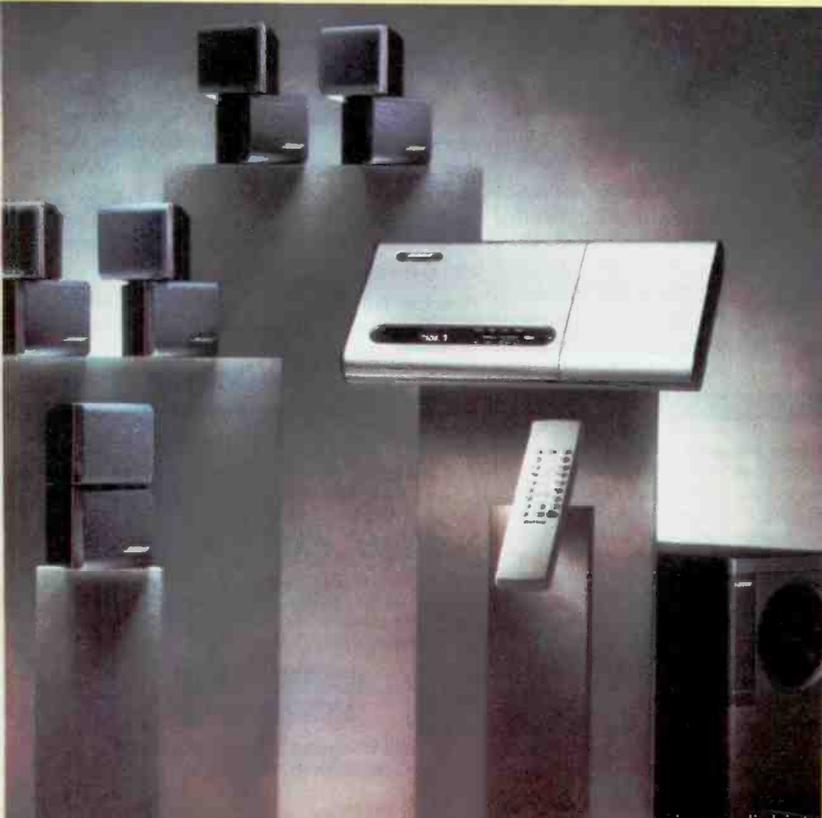
Capture the family on videotape with the *Sharp Viewcam VL-H400U*. This second-generation Viewcam lets viewers see everything they record on a four-inch color LCD screen, and provides an instant on-the-spot playback of videos. Because the camcorder doesn't have to be held up to the face, it allows videographers to be part of the action. With the ability to record with a 16:9 aspect ratio, the camcorder is ready for tomorrow. An optional TV-tuner pack is available to turn the camcorder into a travel TV. Price: \$2199.



Putting together a complete home-theater system can be a confusing task for many consumers, but *Quasar's HT1000* home-theater system makes it easy. The system combines a 60-watt-per-channel AM/FM Dolby Pro-Logic A/V receiver with front, center, and rear speakers, a 27- or 31-inch Quasar TV with Black Tint Tube for high-contrast, a VHS Hi-Fi VCR, and even an attractive cabinet with enough storage to expand the system. Price: \$2788 (with 27-inch TV) \$3399 (with 31-inch TV).

The *Bose Lifestyle 12* provides home-theater sound that can be heard but not seen. Five matched Acoustimass double-cube speaker arrays, each separately powered, provide uniform coverage for left, right, center, and surround channels. An Acoustimass bass module can be hidden from view. The control center is a small silver-toned component that houses a CD player, AM/FM tuner, and the electronics to control other program sources and multiple rooms of powered loudspeakers. The entire system is packaged in one box and is easily assembled. Price: \$2200.

From the kids' homework to Mom's bill payments to Dad's take-home work, the new *AST Advantage!* computers can do it all. Plus, installed AST Works software makes it all easy. The computer even acts as a full-time fully equipped receptionist that can screen calls, take messages, send, receive, and forward faxes. It becomes a family's message center. A host of productivity software is bundled with the computer, which also plays games, of course! Price: N/A.

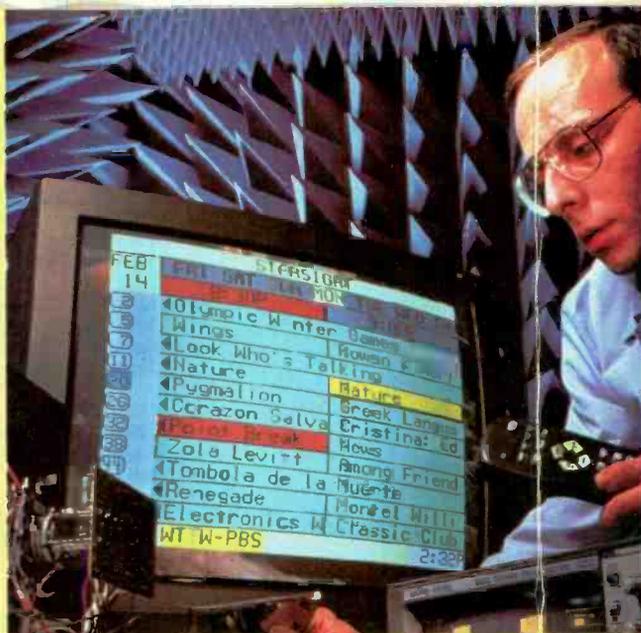


Eight new *Zenith* TV models are the first in the industry to offer an essential tool for a 500-channel TV universe: an interactive program guide. The StarSight Telecast guide can be customized to show you just what you're looking for—just sports, for example. Channel surfers will appreciate the system, too. Each time a new station is tuned, the guide displays the channel name, program, and the time remaining in the program—even if a commercial is on at the time. Price: Starting at \$799.



Your family can be the first on your block to have a new way to watch movies with the *Technics SC-VC10* Video CD player. The new format—which delivers up to 74 minutes of digital audio and full-motion digital video on a compact disc—is based on MPEG-1 (Moving Pictures Experts Group) technology. The SC-VC10 also plays standard audio CD's and graphic CD's (CD+G), and is equipped with a tuner, tape deck, remote control, and three-way speakers. Price: \$1199.95.

Families who still haven't figured out how to program their VCR's will appreciate the *Sony SLV-770HF*. The VCR is designed to receive a special signal broadcast by PBS member stations that promises to put an end to the flashing 12:00. The VCR could end up being the most accurate clock in the house! It also offers Hi-Fi stereo capability and MTS stereo TV reception. Price: \$599.



Sure to be one of the hottest gifts of the holiday season is the *RCA Digital Satellite System* or *DSS*. DSS promises to bring digital-quality audio and video to everyone in the continental U.S. The system's 18-inch satellite dish and set-top receiver offer a real alternative to cable TV. Popular cable channels are available, as are dozens of pay-per-view movies. Price: Starting at \$699. Program subscriptions from \$5.95 to \$34.95 per month.



You've been putting off buying that big-screen projection TV for the family because you thought you just didn't have a room big enough? Well, maybe. *Toshiba's* redesigned *TheaterView* line of 48- and 55-inch rear projection TV's will change your mind. They have such features as four-channels digital sound processing, Dolby Surround Sound, picture-in-picture, and more. The cabinets for 48-inch models are less than 20 inches deep, and the new 55-inch sets have a cabinet depth of only 22½ inches—about the same as many 27-inch direct-view TV sets! Prices: from \$3299.95 to 3799.95.



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# How to get surround sound without buying the theater...

Chase Technologies brings you an amazing new surround sound decoder that turns your stereo into a multi-channel home theater.

By Charles Anton

As much as I love renting videos, it's just not the same as seeing a movie in a theater. I remember the first time I saw *Jurassic Park*. I nearly jumped out of my seat when the dinosaurs roared. One of the reasons movies seem so real is because surround sound makes it seem like you're actually there when events are happening. Now there's an incredible new device that lets you use a stereo receiver to get that same surround sound in your home.

It takes more than four speakers to get surround sound; there needs to be a way of separating the signals. The new Chase Technologies HTS-1 decoder does just that, and in a revolutionary way that rivals the best Dolby Pro-Logic and THX systems.

**Wins over critics.** Gary Reber, editor and publisher of the most authoritative magazine on home theater systems, *Wide-screen Review*, stated, "...passive matrix decoders such as the new Chase HTS-1 work great as Dolby Surround™ extractors, and sound exceptionally natural when used for soundtracks and music."

**Passive circuit.** In 1972, legendary audio pioneer David Hafler invented a passive circuit to extract the "L minus R" difference

signals in stereo soundtracks. Because the circuit was patented, it was only available on expensive Hafler products. Now that the patent has expired, Chase can make this amazing decoding system available at a fraction of the cost of other systems!

## The secret of surround sound

Surround sound has become the rage of the 90's because it adds depth and realism to stereo sound, giving you the home theater experience. It makes you feel like you're actually at a concert or theater. To "fill a room" with surround sound, you need more than two channels. The HTS-1 provides four channels of sound from any two-channel stereo source.

**Free center channel.** By connecting your VCR or laserdisc player to your TV, you get sound from your TV speaker; this acts as the fifth or "center channel." Adjusting your TV's volume gives you as much or as little "center channel" localization as you desire, without extra speakers or amps. There are also no extra costs with the "fifth" channel. When used with the HTS-1, you'll have a true state-of-the-art five-channel system.



**Breakthrough.** The HTS-1 is able to decode the Dolby Surround™ signal in a videotape or laserdisc because the spatial and depth cues have been matrixed into the "L minus R" portion of the two-channel stereo soundtrack. By decoding passively, the HTS-1 avoids costly and noisy signal processing. Plus you don't need any additional amps! Just connect the HTS-1 to your existing stereo system, add two speakers for the rear, and you'll experience the magic of home theater at a fraction of the cost.

**Concert sound.** The HTS-1 also decodes the ambience found in all music recordings. This sense of space, or "concert hall acoustics," is present in all CDs and cassettes, especially live recordings. John Sunier, the leading authority on

surround sound and producer of *Audiophile Audition*, a nationally syndicated radio program for audio

enthusiasts, says, "...the new Chase HTS-1, when used to decode the hidden ambience in all musical recordings, definitely outperforms all the Dolby and THX processors (which could cost you up to \$3,000)... I am impressed!"

**Easy installation.** Hooking up the HTS-1 is easy. Simply connect the speaker outputs of your receiver or amp to the HTS-1, then connect speaker wire to the front and rear speakers. The rear channel speakers don't have to be big. In fact, we recommend the Chase ELF-1 in either black or white finish to match your decor. They can be mounted with enclosed color-matched mounting brackets or can be flush mounted on the wall. They are also water and weatherproof; they can be used indoors or out.



The ELF-1 rear channel speakers integrate perfectly with the HTS-1.

**Risk-free home trial.** Let's face it—the best way to evaluate surround sound is in your home, not in a showroom. That's why we're offering this risk-free home trial. We're so sure you'll be delighted with the quality of these products and the surround sound experience that we are giving you 30 days to try them for yourself. If they're not everything we say, return them for a complete "No Questions Asked" refund.

HTS-1 Home Theater Decoder..... \$79 \$9 S&H  
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## THE PASSIVE ADVANTAGE

**Passive.** Chase Technologies' passive home theater system eliminates signal processing, yielding better clarity and detail. The effects sound amazingly real.

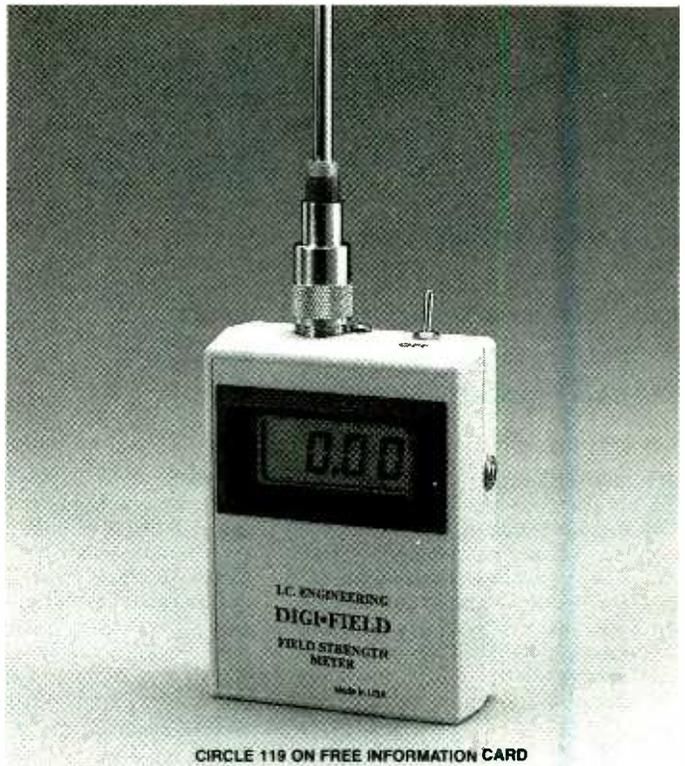
The HTS-1 decoder makes your movies come to life.



**Active.** All Dolby Pro-Logic decoders (even the built-in units) are active, meaning they decode and amplify the signal electronically. Noisy and expensive signal processing actually degrades the home theater experience. It's like putting a blanket over your speakers.



# IC ENGINEERING DIGI-FIELD FIELD-STRENGTH METER



*Monitor RF and microwave radiation levels with this inexpensive field-strength meter.*

In this modern day and age, we are all constantly exposed to radiation from many sources. Every day, we sit too close to television sets, work too long at computers, and stare into microwave ovens, without much concern for what that radiation might be doing to our health.

We must have at least some faith in the rules and regulations that govern legal radiation-emission levels on such everyday consumer items. However, it's quite possible that a TV set, computer monitor, or microwave oven is defective in some way, and that its radiation output could be a health concern.

Fortunately, there is an easy and inexpensive way to assess the amount of RF and/or microwave radiation in your home or workplace—the *Digi-Field* field-strength meter from I.C. Engineering (16350 Ventura Blvd., Suite 125, Encino, CA 91436, 818-345-1692). The Digi-Field comes in two basic models that sell for \$139.95 apiece. A deluxe model that combines the features of both sells for \$185.00.

**A Closer Look.** The two basic models differ only in their sensitivity and

intended use. "Model B" is sensitive down to 2 nanowatts and is ideal for testing low-level radiation sources such as computer monitors. For high-level sources, such as amateur-radio transmitters, "model A" is a better choice. Although only sensitive down to 150 nanowatts, it can handle power levels that would swamp model B. The deluxe "model C" is a switch-selectable unit that lets you choose between the two sensitivity levels.

An included rod antenna attaches to a jack on top of the unit and can be extended as needed to increase or decrease sensitivity; the unit can also be connected directly to cables and used as a relative signal-strength meter via that jack. The Digi-Field has a frequency response from DC to 12 gigahertz.

The hand-held unit is powered by a 9-volt battery. Its 3½-digit LCD reads from 0.00 to 19.99, providing a relative indication of radiation power levels. The display also includes a low-battery indicator. Charts included with the meter can be used to determine the dBm measurement associated with the LCD reading at frequencies

from 250 kilohertz to 1 gigahertz.

In addition to the readout, the Digi-Field produces a signal that is proportional to the level of the detected radiation. That signal is available at an output jack on the side of the meter.

**Some Applications.** Depending on distance and power levels, both basic models are useful for working with antennas, whether it be designing them, adjusting them, or experimenting with them, although model A is obviously better suited for close-range work with fairly high-power transmitters. Among other things, an antenna's radiation pattern is easy to observe with the Digi-Field.

Other applications for the Digi-Field include checking losses on TV coaxial cable and other transmission lines. At home, for instance, you could use the meter to see the effect that splitting your TV cable into multiple paths has on signal strength.

You probably have a microwave oven at home, but are you sure that the seal on the door is working and that you aren't being exposed to harmful microwaves? While checking a microwave oven at random with the

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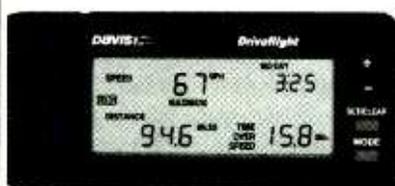


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**Sniffing.** We've been discussing applications for the Digi-Field where some kind of radiation is expected.

But what about sources that you don't expect? For example, have you ever had some kind of intermittent interference with your radio or TV? What causes it? The computer? The refrigerator? A neighbor's ham-radio equipment? The Digi-Field can be used to sniff out interference from any of those sources.

Are you afraid you're being bugged? The Digi-Field can calm your fears, as model B makes it a simple matter to track down any hidden RF transmitter.

**Some Hands-on Tests.** We had the opportunity to evaluate the model B meter, and found some interesting results. To begin with, the unit is not sensitive to 60-hertz AC, as we got no reading with the antenna touching a lit 60-watt light bulb. That is good, because otherwise readings would be thrown off from just about everything that plugs into a wall outlet.

With the antenna fully extended, the unit measured nothing from a TV set until it was about 2 feet from the screen. Then the reading quickly increased with decreasing distance until it overloaded (a reading higher than 19.99) at just about a foot from the screen.

Similar readings were obtained from certain computer monitors and, unfortunately, we often must sit less than 2 feet from those. At the office, it was interesting to see how varied the readings were from several different monitors—some supposedly "low-emission" models had higher readings than others that made no such claims. Another surprise was that some of those screen covers that are supposed to cut harmful emissions actually work! The radiation from a monitor was drastically reduced with the cover in place.

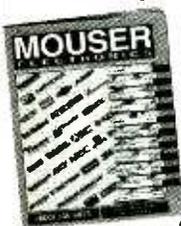
While there is some debate on whether low-level radiation is a health hazard, it is not a bad idea to at least know about the radiation levels that surround us all the time. Further, if you are a ham or otherwise work with antennas, transmission lines, and RF sources, the Digi-Field can be a useful addition to your arsenal of test equipment. If you want more information on the Digi-Field field-strength meter, contact I.C. Engineering directly, or circle no. 119 on the Free Information Card.

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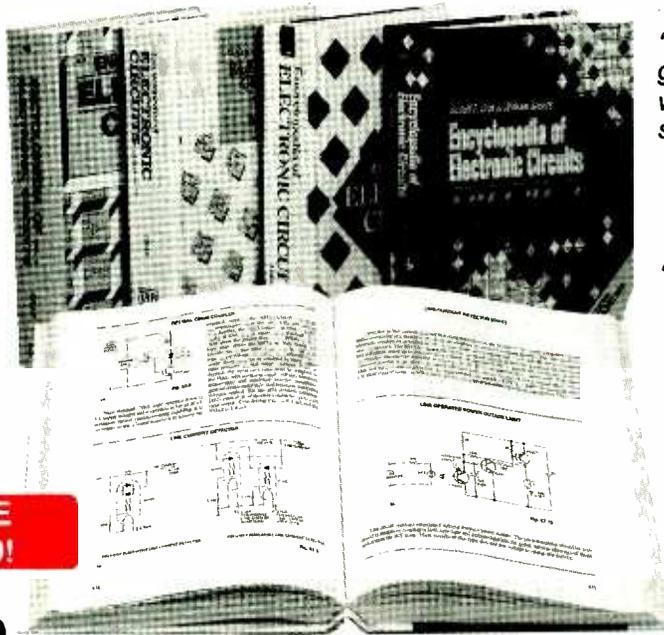
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December 1994, Popular Electronics 29

# THINK TANK

By John J. Yacono\*

## AV Circuits

**W**elcome back to the Tank. As promised, we'll explore more fundamental electronics this month. I'll also present audio and video circuits from readers.

Last month I explained how an acid battery works, and introduced the concept of current (the flow of electrons through metal) and conductors (metals used to direct current flow). Of course, wires are made of metal, so they act as "pipes" or conductors for electrons to flow through. They are usually coated

necting the blocks of metal together. The tendency to move between two points is measured in volts. The higher the voltage, the greater the tendency.

However, you don't need to have current flow to have voltage. To explain why, I'll use the time-honored water analogy for current flow. Imagine that water represents electrons, the flow of water is current, a series of pipes are like a wire, and a water pump is a battery. Let's say the pump has a network of pipes that connect its intake to its outlet, and the pipes and pump are full of water.

When you turn on the pump (battery), the water (electrons) will flow (like current) from the outlet of the pump (one block of the acid battery), through the pipes (wires), and back to the pump's inlet (the other half of the battery). That happens because the pump's action produces a surplus of water at one end of the pipe system—the pump's outlet—and a lack of water at the other end—the pump's inlet. A battery has a surplus of electrons at its "negative" end or "terminal," and a lack of electrons at its positive terminal. (As you saw last time, the chemical reactions inside the battery are responsible for that.)

Consider what would happen if the pipe got completely clogged, stopping the flow of water. Assuming our pump keeps working, pressure would build up at the pump's outlet, and drop at the pump's inlet. In other words, the water would still have the

tendency to move, the clog would just frustrate it. The tendency to move would be proportional to the difference in pressure between the inlet and outlet, but does not rely on the presence of flow.

That holds true for a battery. If there is no wire connecting its two terminals (no "pipe network"), there is still a surplus of electrons at the negative terminal, and too few electrons on the positive terminal, since the air between the terminals is an insulator (or "clog"). The difference in electron "pressure" in that situation is called "potential" because the electrons have at least the potential, or tendency, to move, whether there's a pathway or not. Potential is measured in volts.

So, now we've covered the concepts of current, voltage, positive and negative signs, and potential. One more key principle, resistance, remains. We'll cover that next month before proceeding with more profound stuff. Now let's get to those entertaining letters for this month.

### VIDEO-SIGNAL DETECTOR

If one is in need of a timer that is programmable, precise, and will provide long delays, almost any VCR can be used without any internal modification. All that is required is a circuit that will detect the presence of the video output signal when the recorder turns on. The simple circuit shown in Fig. 1 seems to work with any VCR that I have tried. The first diode (D1) clamps the

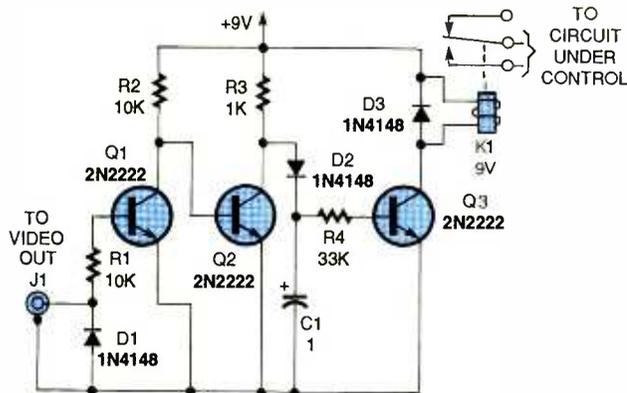


Fig. 1. If you need an extra-long turn-on delay (say to the tune of one or two weeks), try using this circuit and virtually any VCR.

with a non-metallic coating or sleeve called "insulation." Current can't flow through insulating materials, so insulation keeps wires from sharing current with one another should they touch. It also protects the metal from the elements.

I also alluded to the idea that, due to chemical reactions in the battery, the electrons had a tendency to flow through a wire con-

\*Technical Editor, Windows Magazine

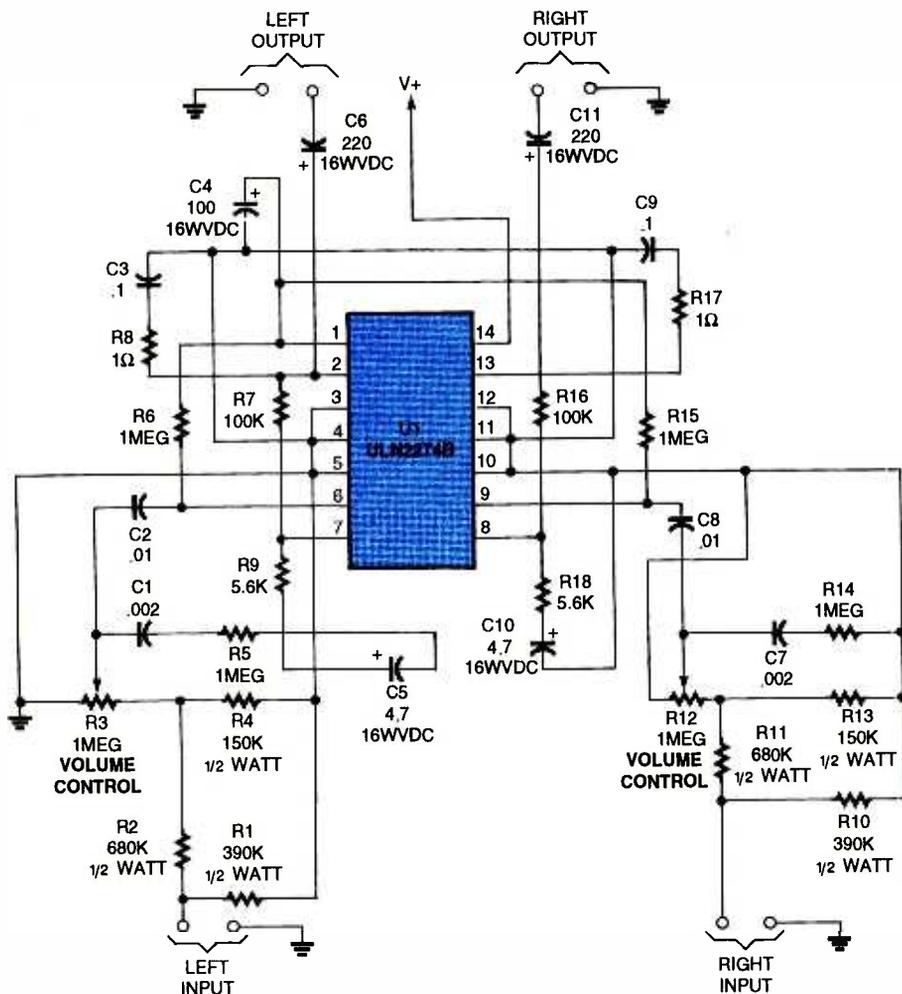


Fig. 2. You can make your Walkman do double duty as a small room stereo by adding this 2-watt amplifier.

negative video to ground. The rest of the circuit responds to the frame markers to charge up the capacitor and turn on the relay.

A tape isn't even required in most cases if the recorder is tuned to an active channel because the video-out signal appears as soon as the recorder is turned on. Therefore, the circuit's on time is not limited by tape length.

—Layton Warn, Sunnyvale, CA

*A word to the wise: this will not work if your VCR is set to simply pass video through.*

### WALKMAN AMP

I've been working on this amplifier (see Fig. 2) for my

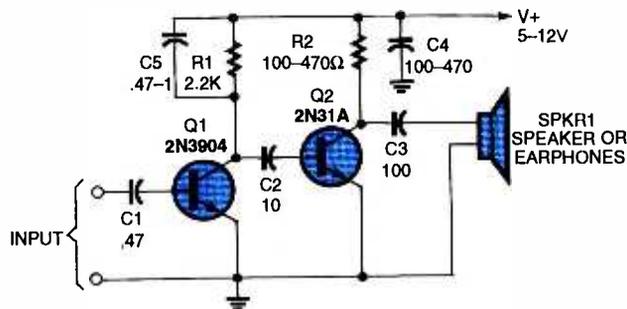


Fig. 3. If a down and dirty audio amp is what you need, try this miniature unit. Among other things, it can be used to boost the output of an earphone for the hearing impaired.

Walkman so when I come in from outside, I can plug-in and use my Walkman for room-size sound.

The amplifier is built around a ULN2274B, dual, audio power amp and provides a maximum of 2 watts of quality sound. Alternately, you could use an NTE804,

NTE990, SK9068, or an SK9012. Pins 3, 4, 5, 10, 11, and 12 are internally tied to ground. Since the amplifier is comprised of two identical subcircuits, only one subcircuit will be covered.

All resistors are 1/4-watt units except R1, R2, and R4 (and the corresponding re-

sistors in the other sub-circuit); they should be 1/2-watt units and are used in the circuit to prevent overdriving U1. Resistor R5 sets the tone and may be replaced with a variable unit; lower values of that resistor produce more bass. The bias is set by R6 and C4, and R7, R9, and C5 are feedback elements. For a more wholesome sound, R8 and C3 were used to roll off the high frequencies. Capacitor C6 is a DC-blocking capacitor. Experimenting with the power supply proved the circuit chip is content with anything from 6–26 VDC without distortion.

—Bobby Triplett, Raleigh, NC

*Very nice indeed. By the way Bobby, any plans to invert one half and bridge the inputs for twice the power output? Happy listening to everyone.*

### SIMPLE AMP

This month I would like to present you with an amplifier circuit (see Fig. 3) that's somewhat powerful and versatile. The circuit is a simple two-transistor, two-stage amplifier. The first transistor, Q1, serves as a simple medium-gain pre-amp that gets its signal from C1, which serves as a DC blocker. Transistor Q1 amplifies the signal and sends it to C2. That, in turn, couples it to Q2, the power-amplifier stage. That stage amplifies the signal further, and C3 couples it to the speaker. You may experience some distortion, but that can be reduced by experimenting with the value of C5, keeping it in the range shown. If that doesn't work, try other values and a regulated power supply.

—Bernardo Venerio,

Miami, FL

*One thing I like about this*  
(Continued on page 90)

# Countersurveillance

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You know that the Russians secretly installed countless microphones in the concrete work of the American Embassy building in Moscow. They converted

what was to be an embassy and private residence into the most sophisticated recording studio the world had ever known. The building had to be torn down in order to remove all the bugs.

## Stolen Information

The open taps from where the information pours out may be from FAX's, computer communications, telephone calls, and everyday business meetings and lunchtime encounters. Businessmen need counselling on how to eliminate this information drain. Basic telephone use coupled with the user's understanding that someone may be listening or recording vital data and information greatly reduces the opportunity for others to purloin meaningful information.

The professional discussions seen on the TV screen in your home reveals how to detect and disable wiretaps, midget radio-frequency transmitters, and other bugs, plus when to use disinformation to confuse the unwanted listener, and the technique of voice scrambling telephone communications. In fact, do you know how to look for a bug, where to look for a bug, and what to do when you find it?

Bugs of a very small size are easy to build and they can be placed quickly in a matter of seconds, in any object or room. Today you may have used a telephone handset that was bugged. It probably contained three bugs. One was a phony bug to fool you into believing you found a bug and secured the telephone. The second bug placates the investigator when he finds the real thing! And the third bug is found only by the professional, who continued to search just in case there were more bugs.

The professional is not without his tools. Special equipment has been designed so that the professional can sweep a room so that he can detect voice-activated (VOX) and remote-activated bugs. Some of this equipment can be operated by novices, others require a trained countersurveillance professional.

The professionals viewed on your television screen reveal information on the latest technological advances like laser-beam snoopers that are installed hundreds of feet away from the room they snoop on. The professionals disclose that computers yield information too easily.

This advertisement was not written by a countersurveillance professional, but by a beginner whose only experience came from viewing the video tape in the privacy of his home. After you review the video carefully and understand its contents, you have taken the first important step in either acquiring professional help with your surveillance problems, or you may very well consider a career as a countersurveillance professional.

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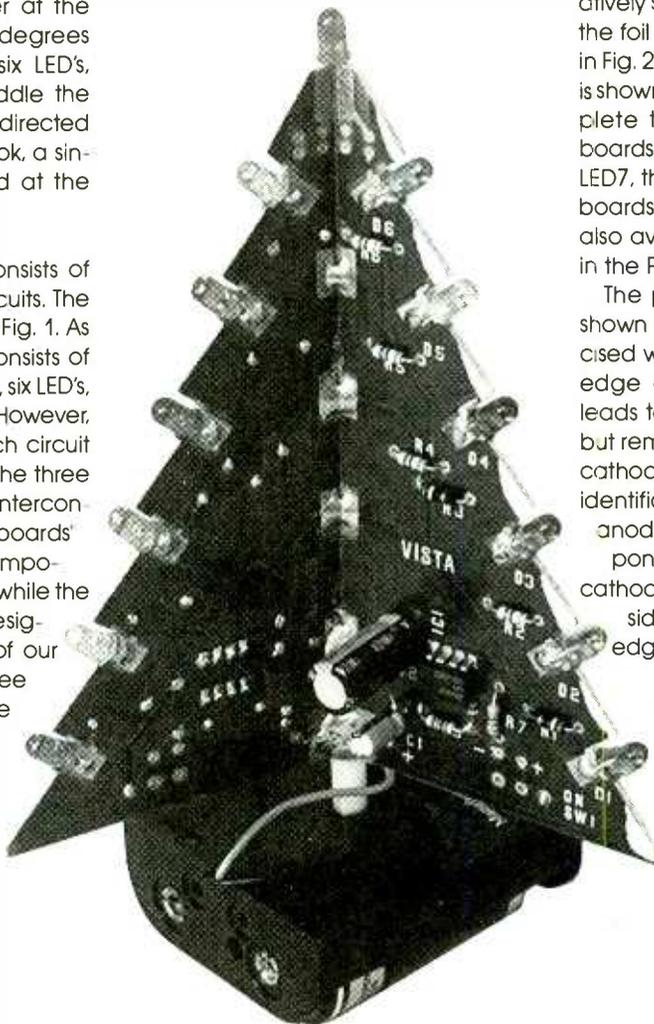
If you are looking for an unusual way to add some electronics fun to your Christmas, here's a project that you are sure to love. Called the *LED-Tric Christmas Tree*, it is a three-dimensional flashing Christmas-tree display that can help brighten up the holidays. To achieve its 3-D look, the tree is built using three identical boards connected together at the spine and spaced at 120 degrees apart. Each board sports six LED's, which are mounted to straddle the board edges so their light is directed outward. To complete the look, a single flashing LED is mounted at the tree's top

**How it Works.** The Tree consists of three essentially identical circuits. The basic schematic is shown in Fig. 1. As you can see, each circuit consists of an LM3909 LED flasher IC (U1), six LED's, and some support circuitry. However, note that the six LED's of each circuit are distributed equally over the three boards. That is done using interconnection pads located at the boards' spines. The pads on the component side are designated CP, while the pads on the foil side are designated SP. For the purposes of our discussion, the first of the three boards is identified as A, the second as B, and the third board as C.

Let's see how all of that works. The drive signal is taken from pin 8 of U1 on board A. It leaves that board via pad SP1 on board A and is fed to pad CP1 on board B, where it drives LED1 and LED4 on that board. That same drive signal then leaves board B at SP2 and goes on to connect with CP2 on board C, where it drives LED3 and LED6. Finally, the signal leaves board C via pad SP3 and is fed back to board A via CP3, where it drives LED2 and LED5. The result of all of that is to always move the drive signal one level higher as the signal rotates around the tree. To create a more random look, however, the value of the timing resistor, R8, is different on each board.

*Light up your holidays  
with this unusual and  
festive conversation piece*

BY RICHARD PANOSH



# Build The "LED-Tric" Christmas Tree

One independent blinking LED is placed at the very top of the Tree on board A. Power for that LED, LED7, is supplied by installing jumpers JU1 and JU2 on that board only. The power switch and battery also appear only on board A.

**Construction.** Building the Tree is relatively straightforward. The pattern for the foil side of the PC board is shown in Fig. 2; the component side's pattern is shown in Fig. 3. Remember, the complete tree requires three of these boards, and aside from S1, B1, and LED7, three sets of parts. If you prefer, boards, kits, and assembled units are also available from the source given in the Parts List.

The parts-placement diagram is shown in Fig. 4. Care should be exercised when soldering the LED's to the edge of the board. Cut both LED leads to about a quarter of an inch, but remember to leave the negative, cathode, lead a little shorter for easy identification. Make sure the positive, anode, lead is soldered to the component side of the board, and the cathode lead is soldered to the foil side so that the LED straddles the edge of the board.

Similarly, care should be exercised when mounting LED7. Again, its anode lead is soldered to the component side of board A, while the cathode is soldered to the foil side of that board. Be careful when selecting the unit used for LED7. Some blinking units require 5 volts or more of power for proper operation. The specified unit is rated to operate at 2.5 volts, and is extinguished at 2 volts.

Mounting the LED's on the board edge can get a little tricky. Fortunately, a technique used in assembling surface-mount components can be used here to good advantage. The technique involves the use of an epoxy such as Duro Depend II, available from most hardware stores. A drop of the part A epoxy is applied to the first surface to be joined, and a drop of part B epoxy is applied to



connections, these pads are used to give mechanical strength to the assembly.

The power switch (S1) should be mounted on PC board A at the appropriate location. On boards B and C, a feedthrough should be installed at the rightmost pad at the S1 location as indicated in Fig. 4. A second feedthrough, near C2, should be installed on all boards.

Two jumpers are also installed on board A. The first, JU1, installs on the foil

## PARTS LIST FOR THE LED-TRIC CHRISTMAS TREE

### SEMICONDUCTORS

U1—LM3909 LED flasher, integrated circuit

LED1—LED6—T-1¼ superbright LED, assorted colors

LED7—Flashing LED, Radio Shack 276-036C or equivalent

### RESISTORS

(All resistors are ¼-watt, 5% units)

R1—R6—39-ohms

R7—220 ohms

R8-a—1000-ohms, see text

R8-b—1200-ohms, see text

R8-c—1500-ohms, see text

### ADDITIONAL PARTS AND MATERIALS

C1—22µF, 16 WVDC, electrolytic capacitor

C2—1000µF, 16 WVDC, electrolytic capacitor

B1—3 volts, 2 alkaline C-cell batteries

S1—SPST slide switch, PC mount  
Printed-circuit board, battery holder (twin C-cell size, see text), 6-32 × ¾ screw, nylon spacer, 6-32 brass nut, wire, solder, etc.

**Note:** The following items are available from Vista, PO Box 1425, Bolingbrook, IL. 60440, (708) 378-5534. A set of three printed circuit boards is available as XMASBRD at \$18.00. A kit of all parts including etched, drilled, and plated-through silk-screened PC boards and 2 alkaline batteries are available as XMASKIT at \$35.50. A fully assembled tree is available as XMASASSEM at \$45.50. Please add \$5.00 for shipping and handling in the U.S. and Canada. Illinois residents please add 7.5% sales tax. Check, money order, and credit cards are accepted. For fast check verification, please provide street address (no P.O. box), telephone number, and drivers license number and state of issue.

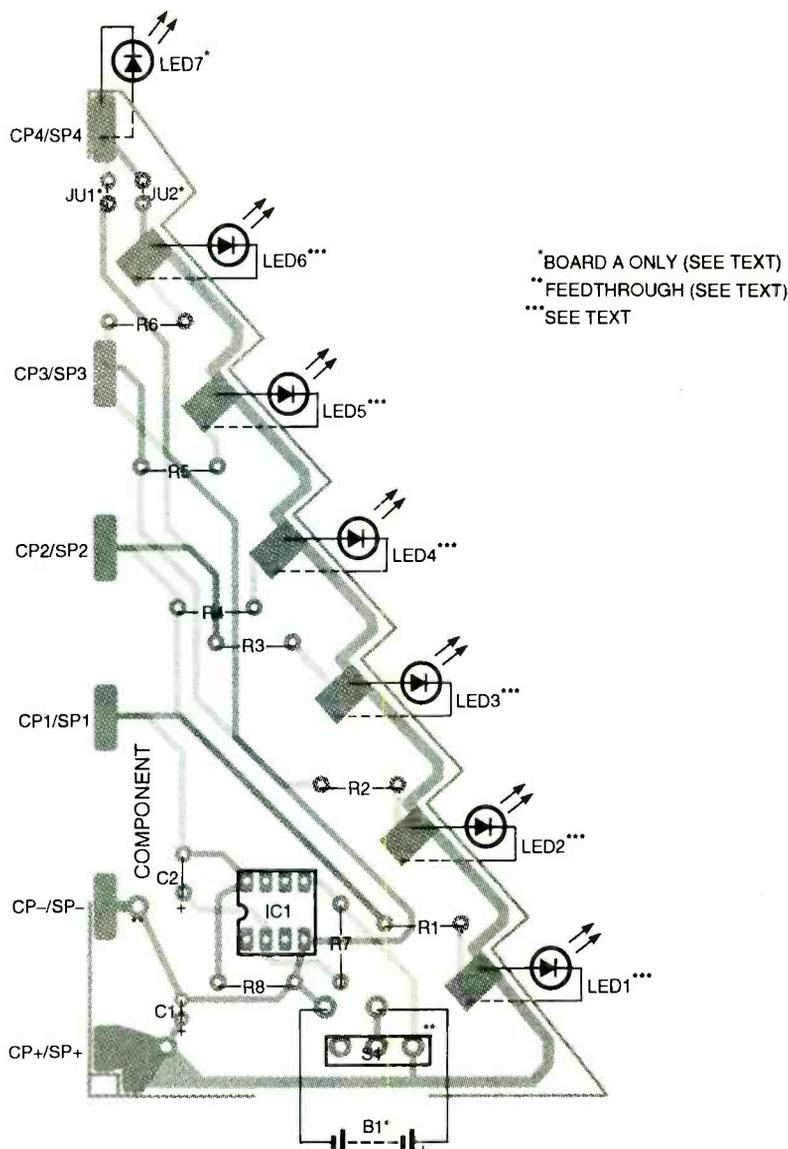


Fig. 4. Use this parts-placement diagram when building your unit. Note that some of the components mount on only one of the boards.

side of the board, while the second, JU2, installs on the component side. Those jumpers are used to get power to the blinking LED at the top of the tree.

The battery leads are connected to the appropriate positions on board A (BAT+ and BAT-). Incidentally, if you wish to omit the switch, the battery leads can be connected to the CP+/SP+ and CP-/SP- pads on board A. If you do that, however, the Tree will run continuously. On the positive side, the current draw of this project is so slight that a pair of alkaline C-cells can power it for about a month.

Speaking of the batteries, they and their holder make up the base of the Tree. The battery holder should be a twin plastic C-cell type with a mount-

ing hole located at the center; if yours does not have a hole, it will have to be drilled. The battery holder is mounted to the tree by means of that hole and a ¾-inch long, 6-32 machine screw. A half-inch long, unthreaded, nylon spacer is installed over the screw and the screw is fastened to the tree base by means of a large 6-32 brass nut that is soldered in the notch at the bottom of the tree spine. The length of the screw can be trimmed to fit, or, alternately, one or two washers can be installed as spacers.

That's all there is to it. The circuit is simple enough that it should work the first time power is applied. Once it is completed, your LED-Tric Christmas Tree is sure to brighten up your holidays.

*Today, LCD's are practically everywhere, but it took hard work and good fortune to turn an interesting chemical effect into a useful and practical device.*

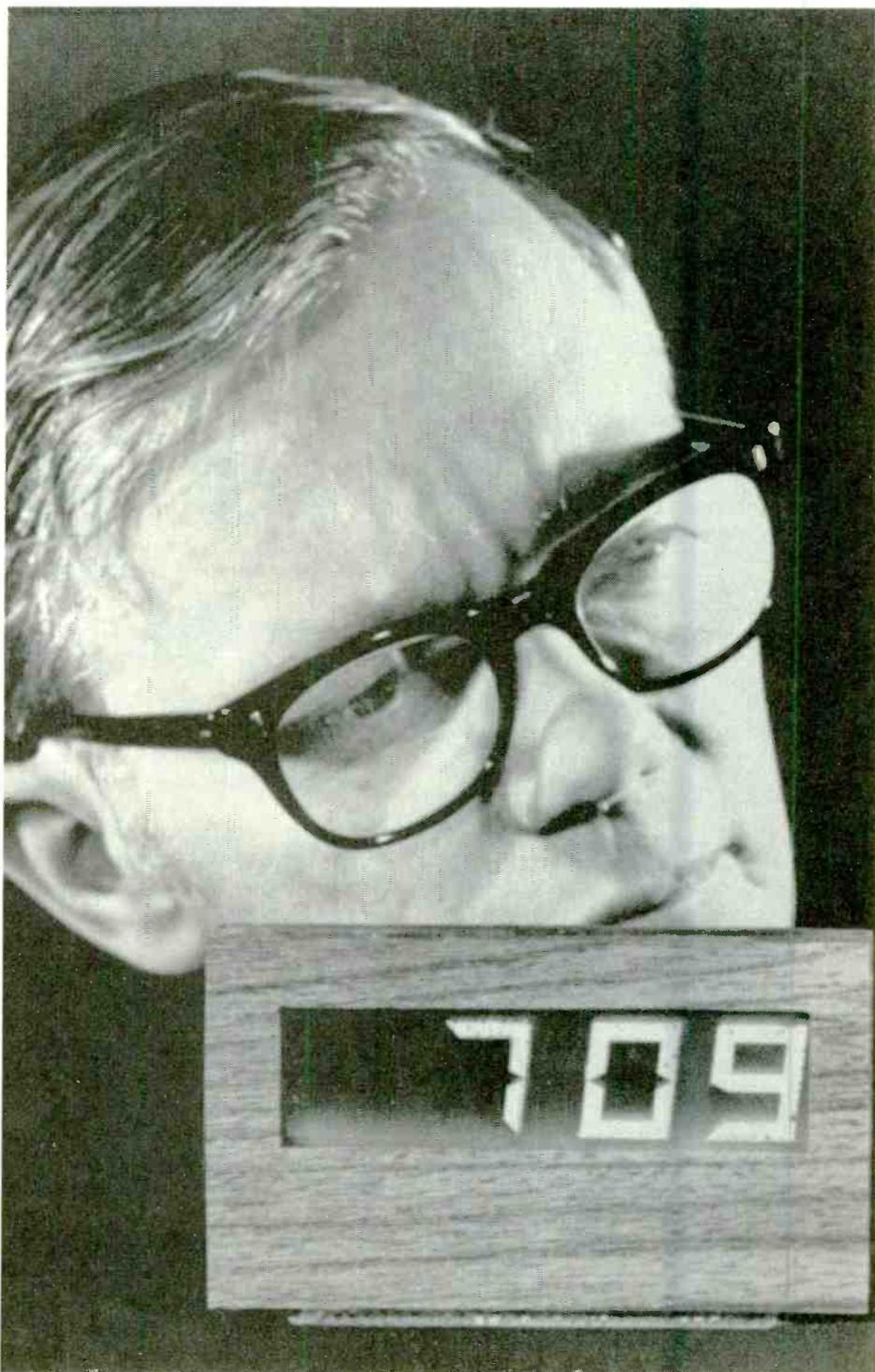
# George H. Heilmeyer

**“A** DC voltage of several volts was applied and we watched the cell change color from red to colorless as a function of the applied [electric] field.” That comment, made by George Heilmeyer in a personal account published in 1976, factually describes a scientific event that occurred 12 years earlier. The words alone, however, cannot fully describe the sense of professional excitement he and a group of other young researchers at the RCA Laboratories had experienced at that time. It was quickly becoming apparent to them, in the autumn of 1964, that a totally new and highly versatile type of electronic display, one that used liquid crystals, was an attainable goal.

What the researchers were observing, however, was only a laboratory demonstration; many problems still had to be overcome. For example, the material with which they were working had to be heated well above room temperature to be in the liquid-crystal state. Nonetheless, the young scientists knew that they had made a breakthrough of gigantic proportions.

**An Engineer Turns Chemist.** What he called the “dirty world” (by semiconductor standards) of organic chemistry was unknown territory. In 1961 to a 25-year-old RCA electrical engineer named George Heilmeyer. He had done some state-of-the-art research in solid-state microwave devices, and that seemed like the logical and “safe” area for him to continue his work. But Heilmeyer wanted scientific excitement, not safety. He took the advice of a colleague who urged him to “do something different,” and ventured into the uncharted world of organic semiconductors.

Heilmeyer's new research went well, and he made numerous important



# and the LCD

BY  
JAMES P. RYBAK

discoveries. However, it soon became apparent that organic semiconductors were not going to lead to organic transistors that could compete with the inorganic variety. In Heilmeyer's own words—"Now it was time to do something useful."

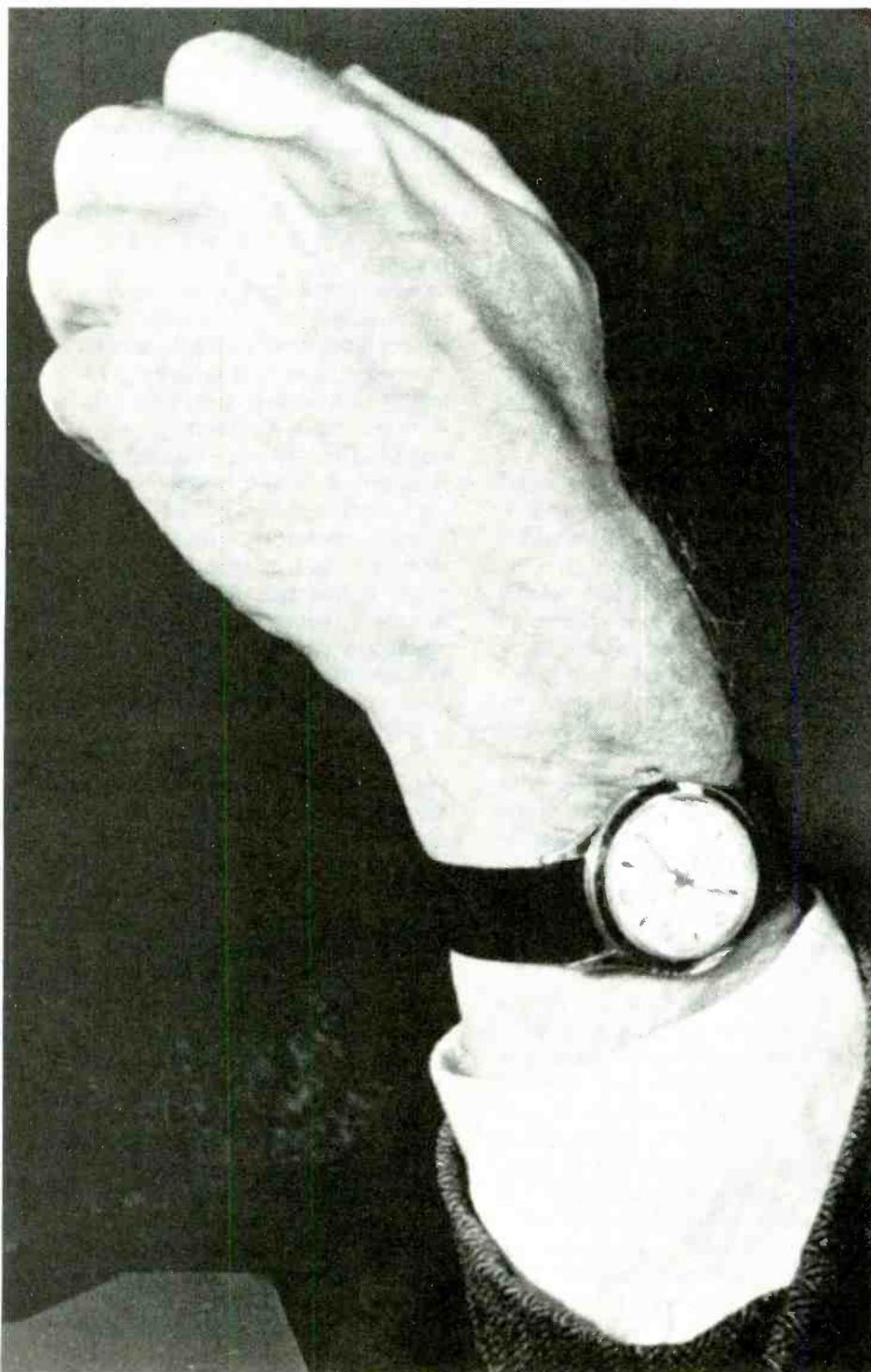
Organic chemistry continued to hold a fascination for Heilmeyer. Lasers were brand new at that time, and means for modulating their intense, coherent beams were being sought. Use of the Pockels effect was being investigated as a possible means of achieving that modulation.

In the Pockels effect, a material's index of refraction is changed by applying an external electric field to that material. The net effect is that by applying and modulating an electric field to a crystal that exhibits the Pockels effect, you can modulate a beam of light, including laser light, passing through the material.

Unfortunately, the only crystals then known to exhibit the Pockels effect either required voltages in the kilovolt range or were extremely difficult to grow. The goal, then, was to find or create a material that was both easy to produce and capable of modulating laser beams using just moderate signal voltages. George Heilmeyer wanted a piece of that action.

Heilmeyer began to give serious thought to the possibility of using externally applied electric fields to control the local internal electric fields of certain crystalline materials, thereby altering the molecular order of the crystals. If successful, that could produce an enhancement of the Pockels effect and allow laser beams to be modulated using relatively small sig-

*This was the first demonstration of a clock using a liquid-crystal for display. (Photo courtesy of the David Sarnoff Research Center.)*



nal voltages. Heilmeyer was particularly interested in the experiments that a colleague named Richard Williams had conducted concerning the orientation of liquid-crystal molecules in external electric fields.

**“Liquid” Crystals?** The term “liquid crystal” sounds almost like an oxymoron. After all, one typically thinks of crystals as being solids consisting of molecules that are rigidly bonded together in a precisely structured and repetitive geometric pattern. Those rigid bonds in crystals are due to forces of attraction that exist between neighboring molecules.

In contrast to solids, the molecules in liquids have no ordered arrangement and are free to move about almost randomly. Those molecules experience only comparatively weak forces of attraction from other nearby molecules. That difference in bonding forces with neighboring molecules explains why a solid maintains its own shape while a liquid takes the shape of the container into which it is placed.

Virtually everyone has observed that a solid can be changed into a liquid by adding enough external energy (usually in the form of heat) to raise the temperature of the substance to its melting point. At that temperature, enough energy has been added to begin breaking some of the rigid bonds that have been holding the molecules together. The initial, visible result is that, as the melting point is reached, a small amount of the solid is converted into liquid.

As more heat is added, the rigid bonding forces between additional molecules are broken and more of the solid is converted into liquid. The temperature of the mixture of solid and liquid remains constant as melting progresses, despite the fact that additional heat is being added. When enough heat has been applied, melting is completed and the substance has changed completely from its solid phase to the liquid phase. Adding still more heat now increases the temperature of the liquid, but causes no fundamental changes in its nature until the boiling temperature is reached.

However, there are a few special organic materials that have somewhat different characteristics when

going from the solid phase to the liquid phase. When in the solid phase, those special substances are identical with other crystalline or amorphous solids. However, while ordinary organic substances produce a clear liquid when melted, the melting of one of those special substances produces a liquid that is very cloudy. Interestingly, if the temperature is increased further, a point is reached where the liquid suddenly does become clear.

Those special organic materials, therefore, possess two distinct liquid phases. The phase in which the liquid is clear is the normal liquid state that ordinary substances possess. The phase in which the liquid is cloudy, however, is unique. It is called the “liquid crystal” phase. The molecules in that liquid-crystal phase are able to move about freely, but do not have the completely random orientation that occurs in the normal liquid phase. The molecules in the liquid-crystal phase tend to remain oriented in a particular direction, somewhat as they did in the solid phase.

The word “tend” is very important in the above sentence. The orientation of the molecules in a liquid crystal is not nearly as well defined as in the solid phase. The molecules actually spend only a relatively small amount of time pointed in the preferred orientation. Nonetheless, that phenomenon does not occur in the normal liquid phase and gives rise to some important properties. The liquid-crystal phase can be thought of as a phase of matter that is truly distinct from the normal liquid phase. Approximately one organic compound in two hundred has a liquid crystal phase when melted. A few substances have more than one liquid crystal phase.

The liquid crystals discussed so far have involved only pure substances, where temperature changes are the sole cause of changes to and from the liquid-crystal phase. Those are called “thermotropic” liquid crystals. In addition, another class of liquid crystals exists for mixtures of certain substances. In those, the change to and from the liquid crystal phase depends on the relative concentrations of the substances as well as on the temperature. “Lyotropic” is the name given to those liquid crystals. While

lyotropic liquid crystals have many interesting features and applications, only thermotropic liquid crystals are of interest in the present discussion.

**A Little History.** Credit for the discovery of liquid crystals is usually given to the late nineteenth-century Austrian botanist, Friedrich Reinitzer. He was investigating the function of cholesterol in plants in 1888, when he noticed that an organic substance related to cholesterol appeared to have two melting points. Reinitzer observed that the substance melted into a cloudy liquid at 145.5° Celsius, and that further heating caused the liquid to become clear at a temperature of 178.5°C. Reinitzer wondered if he might be observing a phase of matter other than the normal liquid and solid phases.

Several other researchers had earlier observed the same effect with various substances, but had assumed they were observing something related to the process of crystallization. Reinitzer, however, seems to have been the first to have suggested the possibility of certain substances having two distinct liquid phases.

Three general classes of thermotropic liquid crystals have been found. In “nematic” (from the Greek word for “thread”) liquid crystals, the molecules tend to be aligned parallel to each other throughout the material and appear thread-like when viewed under a microscope.

The molecules in “smectic” (from the Greek word for “soap”) liquid crystals are also aligned parallel to one another throughout the material, and are arranged in layers as well. A layer of molecules generally can slide over neighboring layers relatively easily. Not surprisingly, given the name, an ordinary soap-and-water mixture can produce a lyotropic liquid crystal. The “gooey” substance often found at the bottom of a soap dish is an example of that type of liquid crystal.

In “cholesteric” liquid crystals (so called because they were originally associated with cholesterol), the molecules again tend to be aligned parallel to each other in layers. The direction of the alignment of the molecules, however, changes in uniformly discrete increments from one layer to the next, much as the direction of the second hand on a quartz clock

changes in uniformly discrete increments. Cholesteric liquid crystals are the type Reinetzer observed. However, not all the cholesteric liquid crystals involve substances related to cholesterol. Consequently, the name "cholesteric" is somewhat misleading.

Research interest in liquid crystals had peaked and waned at intervals over the years. In the 1960's, interest in those unusual organic compounds again was reviving among chemists, with particular attention being paid by most researchers to cholesteric liquid crystals. Heilmeier, however, had different ideas.

### Nematics Interest Heilmeier.

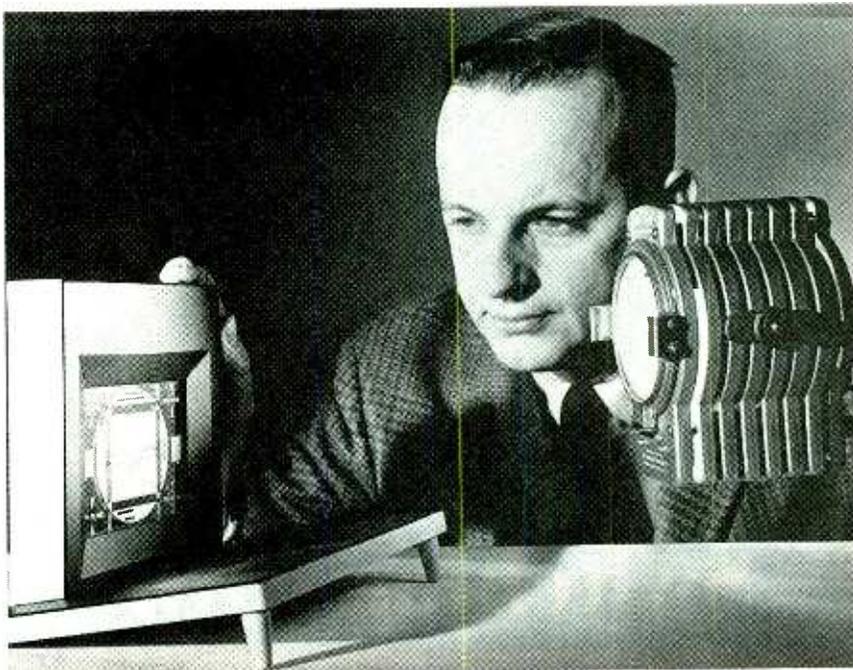
Unlike some of his colleagues, Heilmeier had a great interest in nematic liquid crystals. He suspected that a moderate, externally applied electric field could possibly cause the molecular order of that type of liquid crystal to be altered. Heilmeier hoped that an altering of the molecular order might significantly enhance the crystal's Pockels effect.

Heilmeier's initial experiment was designed to see if moderate external electric fields could be used to cause a change in the preferred orientation of the liquid-crystal molecules. A small amount of a strong organic dye was combined with butoxy-benzonic acid, a compound that has a nematic liquid-crystal phase. Heilmeier reasoned that the dye would make visible any rotation of the liquid-crystal molecules.

A dye is a substance that affects light of only a certain wavelength (color). The result is that the light transmitted through or reflected by the dye appears to be colored. Many dye molecules are elongated in shape, and some work better as a dye if the incident light is polarized in the direction of the long axis of the molecule. That is the type of dye used by Heilmeier and his colleagues.

When dye molecules that are elongated in shape are mixed with a liquid crystal, the dye molecules tend to align themselves in the same direction as the liquid-crystal molecules. Heilmeier reasoned that if an external electric field is successful in causing the liquid-crystal molecules to rotate, the dye molecules should also rotate.

### An Experiment is Devised.



Here's George Heilmeier examining an image created using an array of early liquid-crystal displays. (Photo courtesy of the David Sarnoff Research Center.)

Heilmeier and his research colleagues placed a small amount of the liquid-crystal and dye mixture between two glass microscope slides separated by less than one mil (.001-inch) with Teflon spacers. Extremely thin, transparent layers of tin oxide had been deposited on the inner surfaces of each of the glass slides to serve as electrodes. Those electrodes would be used for generating the external electrical field. The cell was placed under a microscope equipped with a heating stage. Heat-

ing the mixture was necessary to produce the desired liquid-crystal phase. No substance known at that time had a liquid-crystal phase at room temperature.

A polarizing filter was then oriented so that the polarization of the light that fell on the cell was along the long axis of the liquid crystal and dye molecules when no external electric field was applied. That caused the dye to appear red in color.

A low DC voltage was then applied to the tin-oxide electrodes on the cell to create a moderate external electric field in the direction transverse to that of the light polarization. Just as Heilmeier had hoped, the liquid-crystal molecules now rotated in response to the electric field. The dye molecules also rotated to maintain their alignment with the liquid-crystal molecules.

The polarization of the incident light was kept constant and, as a result of the molecular rotation, was now perpendicular to the long axis of the dye molecules. Under those conditions, the dye had little effect on the polarized light and appeared virtually colorless. The changing of the dye from red to colorless confirmed to Heilmeier that the external electric field was indeed causing the liquid-crystal molecules to rotate.

(Continued on page 92)

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# Switching with PIN Diodes

*These interesting little components allow switching of RF, IF, and audio frequencies without routing the signals themselves all over the cabinet.*

BY JOSEPH J. CARR, K4IPV

**M**ost modern amateur transceivers use "relayless" switching to snap back and forth between receiving and transmitting. In many cases, that switching is done with PIN diodes. Similarly, IF filters or front-end bandpass filters are selected through front-panel switches that handle direct current. How? Again, PIN diodes.

The PN-junction diode (in Fig. 1A) is obviously different from the PIN diode (shown in Fig. 1B). Pin diodes have an insulating region between the P and N-type material. So they are multi-region semiconductor devices despite having only two electrodes. The "I-region" is not really a true semiconductor insulator, but rather is a very lightly

doped N-type region. It is called an "intrinsic" region because it has very few charge carriers to support the flow of an electrical current.

When forward bias is applied to the PIN diode, charge carriers are injected into the I-region from N and P regions, but in the lightly-doped intrinsic region, the charge carriers don't immediately recombine (as in PN-junction diodes). There is always a delay period for recombination. Because of the delay, there is always a small but finite number of carriers in the I-region that are uncombined. As a result, the resistivity of the I-region is very low.

One application that results from the delay of signals passing across the intrinsic region is that the PIN diode can be used as an RF phase shifter. That's because RF signals can pass through the PIN device, and in fact under some circumstances see it as merely a parallel-plate capacitor. In some microwave antennas, phase shifting is accomplished by the use of one or more PIN diodes in series with the signal line. Although there are other RF phase shifters usable at those frequencies, the PIN diode remains somewhat popular. Other uses include electronic switching for RF sig-

nals, RF delay-line implementation, and amplitude modulation.

Figure 2 shows some of the package styles used for small-signal PIN diodes. The NTE-553 or ECG-553 PIN diode will dissipate 200 mW, and uses the standard cylindrical package style in Fig. 2A. The NTE-555 and ECG-555 device, on the other hand, uses the UHF flat package style (Fig. 2B) and can dissipate 400 mW. I used these diodes for the experiments performed to write this article because they are service-shop replacement

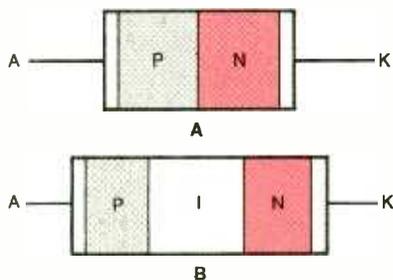


Fig. 1 A standard PN-diode junction (A) lacks the insulating layer found in a PIN diode (B).

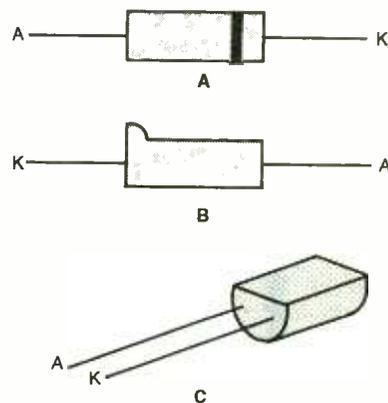


Fig. 2 The case of a PIN diode can make it look like a small-signal transistor (A), a flat component (B), or a normal diode (C).

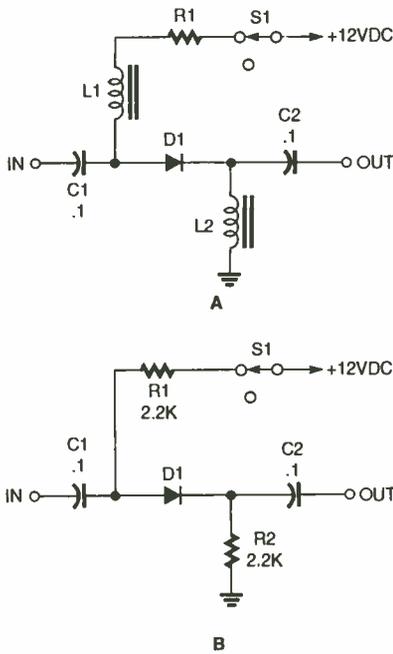


Fig. 3. A shows a standard series PIN-diode switching circuit using RF chokes to present a high impedance to RF signals. B contains a resistor version used in some of my experiments.

devices, and both ECG and NTE are widely distributed in local parts stores. An alternative that might be harder to come by is the MPN3404, which uses the TO-92 plastic package style shown in Fig. 2C.

**PIN-Diodes as Switches.** PIN diodes can be used as switches in either series or parallel modes. Figure 3 shows two series switch circuits. In the circuit of Fig. 3A, the PIN diode (D1) is placed in series with the signal line. When switch S1 is open, the diode is unbiased so the circuit is open by virtue of the very high series resistance, but when S1 is closed, the diode is forward biased and the signal path is now a low resistance (thus providing the switching action). The ratio of off/

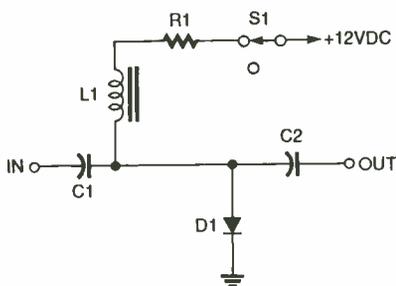


Fig. 4. This shunt PIN-diode switching circuit directs signals to ground when D1 is forward biased.

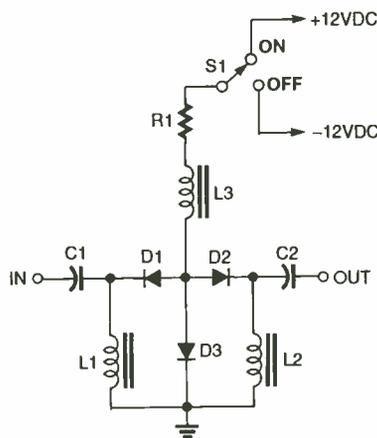
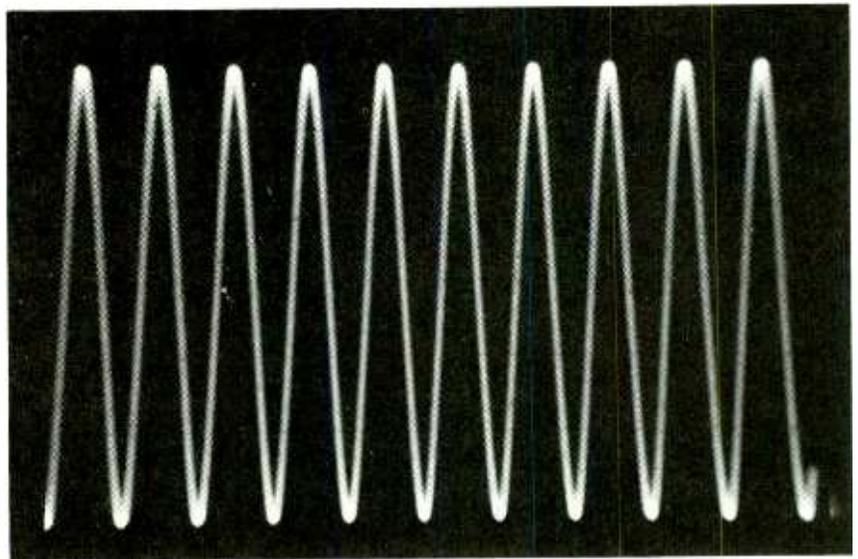


Fig. 5 A combination of series and shunt switching, like that shown here, results in superior isolation between the input and output when in the off condition.

on resistances provides a measure of the circuit's isolation. A pair of RF chokes (L1 and L2) are used to provide a high impedance to RF signals, while

offering low DC resistance. The value of the chokes should be set to yield appropriate impedances at the frequencies of interest.

Figure 3B is similar to Fig. 3A except that the RF chokes are replaced by resistors. I performed a test on that circuit, which contained an NTE-555 hot-carrier PIN diode, using a 455-kHz IF input signal and an oscilloscope set to show only a few cycles of the circuit's output. The oscilloscope trace in Photo A shows the on condition where 12 VDC was connected through switch S1 to the PIN diode's current-limiting resistor (R1). The output signal was 1200 mV peak-to-peak. The trace in Photo B shows the output with the switch off (i.e., 12 VDC disconnected), but with the oscilloscope set to the same level. It appears to be a straight line. Increasing the sensitivity of the oscilloscope showed a level of only 12 mV getting through. That means the



With the PIN-diode circuit in Fig. 3B is in the on condition, the IF signal at the output looks like this.

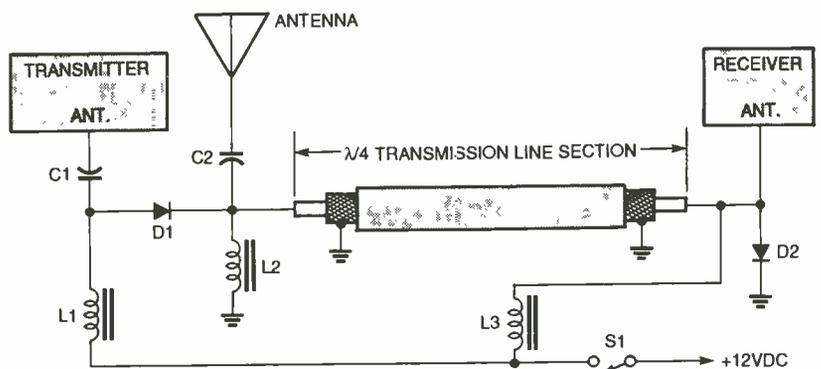


Fig. 6 This is a transceiver's transmit/receive switch that uses PIN-diode instead of a relay.

simple circuit provided a 100:1 on/off ratio, which is 40 dB of isolation.

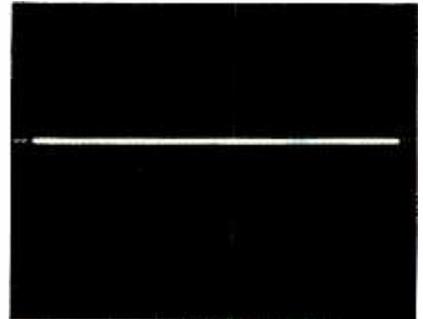
The photo that appears at the beginning of this article is actually the output of that switch when a square wave is used to drive the PIN diode control voltage line, rather than S1. That situation is analogous to a CW-keying waveform. The photo represents one on/off cycle. Note that with

the resistor and capacitor values used, there is a pronounced switching transient present.

Figure 4 shows the circuit for a shunt PIN-diode switch. In the circuit, the diode is placed across the signal line, rather than in series with it. When the diode is turned off, the resistance across the signal path is high, so signals pass through unimpeded, but

when the diode is turned on (i.e., when S1 is closed) a near short circuit is placed across the line. So that type of circuit is turned off when the diode is forward biased. That is in contrast to the series switch in which a forward-biased diode is used to turn the circuit on.

A combination series/shunt circuit is shown in Fig. 5. There, D1 and D2 are



The Fig. 3B circuit in the off condition provides 40 dB of isolation from input to output, resulting in the weak output waveform shown here.

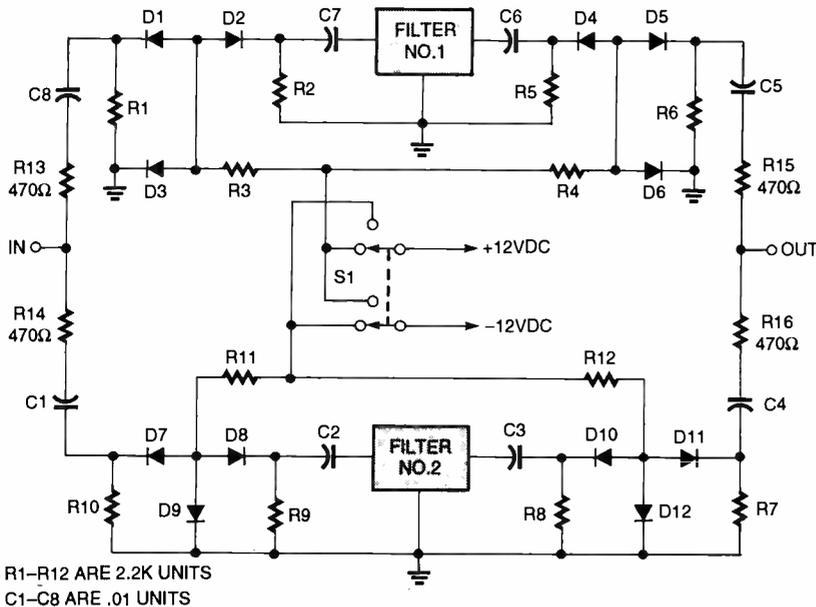


Fig. 7 Selecting IF bandpass filters via series/shunt PIN-diode switching can be accomplished with this circuit.

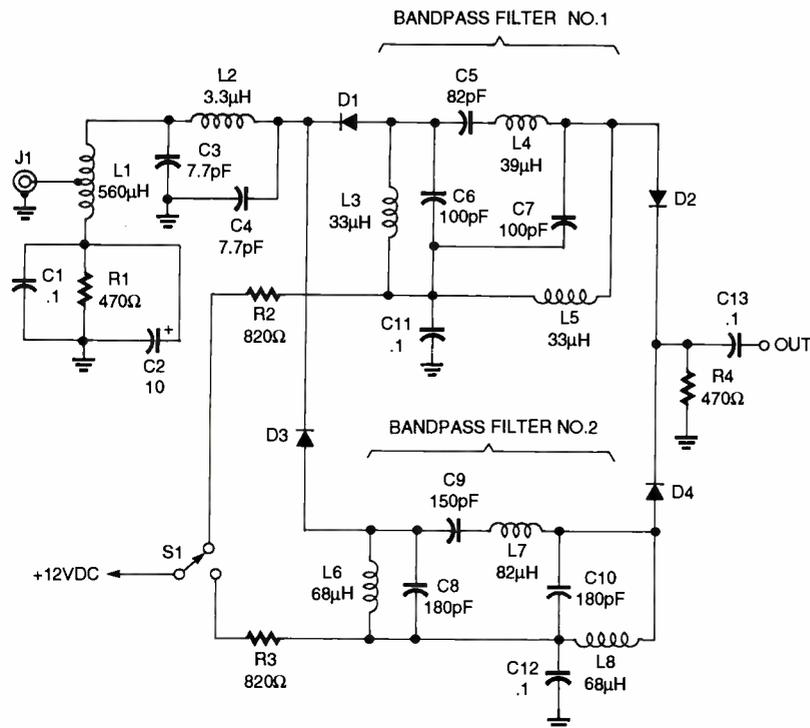


Fig. 8 Receiver front-end selection can be accomplished by using PIN diode switches as shown.

placed in series with the signal line, while D3 is in parallel with the line. Diodes D1 and D2 will turn on (close) if a positive potential is applied, while D3 turns on (opens or stops shunting) when a negative potential is applied.

When switch S1 is in the on position, a positive potential is applied to the junction of the three diodes. As a result, D1 and D2 are forward biased and thus take on a low resistance. At the same time, D3 is hard reverse biased, and therefore has a very high resistance. So signals are passed from input to output essentially unimpeded.

However, when S1 is in the off position the applied potential is negative, so D1 and D2 are reverse biased (and take on a high series resistance), while D3 is forward biased (and takes on a low series resistance). That tremendously attenuates the signal before it reaches the output.

**Switch Applications.** When used as switches, PIN diodes can be used to switch attenuators, filters, and amplifiers in and out of circuits. To avoid routing RF/IF signals to front-panel controls in radio equipment, it has become standard practice to use PIN diodes.

In the application shown in Fig. 6, a

(Continued on page 88)

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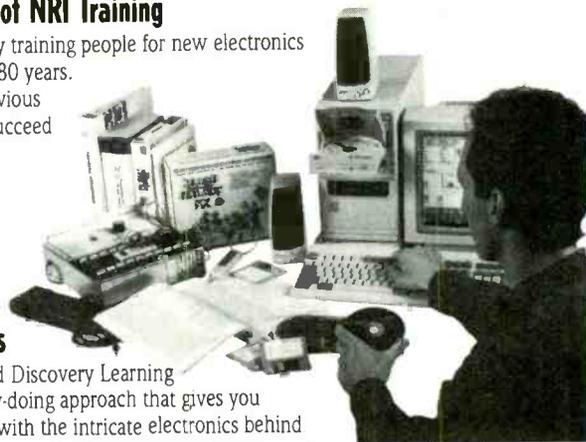
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**P**oker is a game of skill with an element of chance. Dice is a game of chance with (some say) an element of skill. Combine the two and you get a game of chance, skill, fun, and excitement. That's the idea behind *Z-Dice*, a challenging \$30 construction project that everyone can enjoy.

Before we go on, let me head off any confusion: Yes, you can use *Z-Dice* with Milton Bradley's classic *Yahtzee* game, and yes, the name *Z-Dice* was inspired by *Yahtzee*. However, the author has no affiliation with Milton Bradley, and is sure that Milton Bradley has never heard of him or *Z-Dice*.

**How it Works.** *Z-Dice* uses five clusters of seven LED's to represent the marks or "pips" on five dice. Buttons below each of the LED dice let the player mark a die to be rolled on the next throw. Marked dice show up as dimmed LED's. Pressing the button to the right of the display rolls the marked dice. If the player changes his or her mind about rolling a particular die before pressing the roll button, he or she can unmark it by pressing its button a second time.

BY SCOTT EDWARDS

If no dice are marked at the time the player presses the roll button, then all of the dice are marked to be rolled. A second press starts them rolling, animating the LED's of the marked dice for a second or so before displaying the results of the roll. *Z-Dice* doesn't count rolls or keep score, so it's still up to the players to make sure that nobody cheats!

Figure 1 is a schematic diagram of *Z-Dice*. Those of you who have built simple two-dice games from a batch of logic gates may be a little surprised at the circuit's low parts count. The reason is that the logic of this circuit is programmed into U2, the PIC 16C55 microcontroller. Use of that IC reduces the parts count, and the cost of the circuit, by quite a bit.

Microcontrollers are close relatives of the microprocessors found in PC's. Internally, they perform many of the same functions, such as math and logic. Externally, however, microcontrollers and microprocessors are very different. A microprocessor has connections for memory and input/output (I/O) devices. Related groups

of connections are known as buses. Microprocessors generally have buses for address, data and control, and built-in commands for orchestrating their operation.

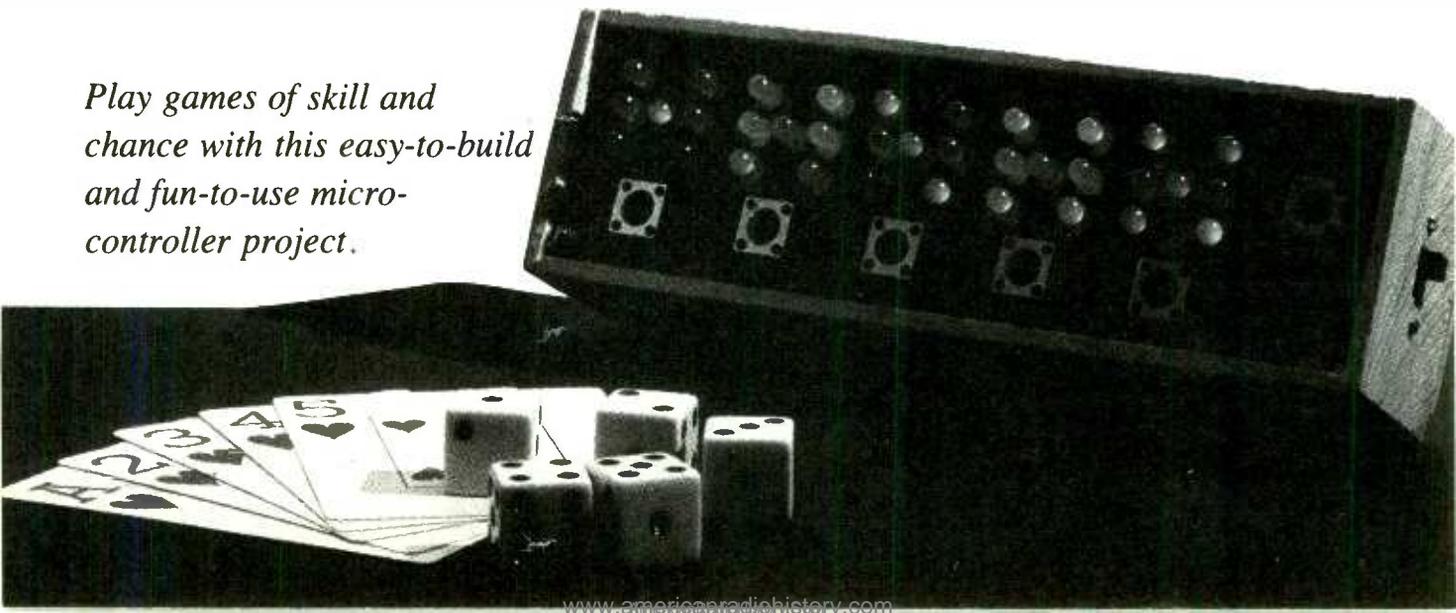
A microcontroller also has external connections, but uses them directly for I/O. It has no buses for convenient connection of external memory or other devices, and no built-in commands for bus operation.

From that description, it's easy to think of a microcontroller as something less than a microprocessor. For general-purpose computing, that is true. But in the case of stand-alone devices that just need a little bit of intelligence, microcontrollers make sense. Microprocessors not only allow the connection of external memory, they need it in order to function. Microcontrollers don't. They have a single program permanently stored in internal read-only memory (ROM) or erasable/programmable ROM (EPROM). To carry out their program, they have a limited amount of internal random-access memory (RAM).

The PIC 16C55 microcontroller used in this project has EPROM storage for a 512-instruction program, 32 bytes of

# BUILD THE "Z-DICE"

*Play games of skill and chance with this easy-to-build and fun-to-use microcontroller project.*



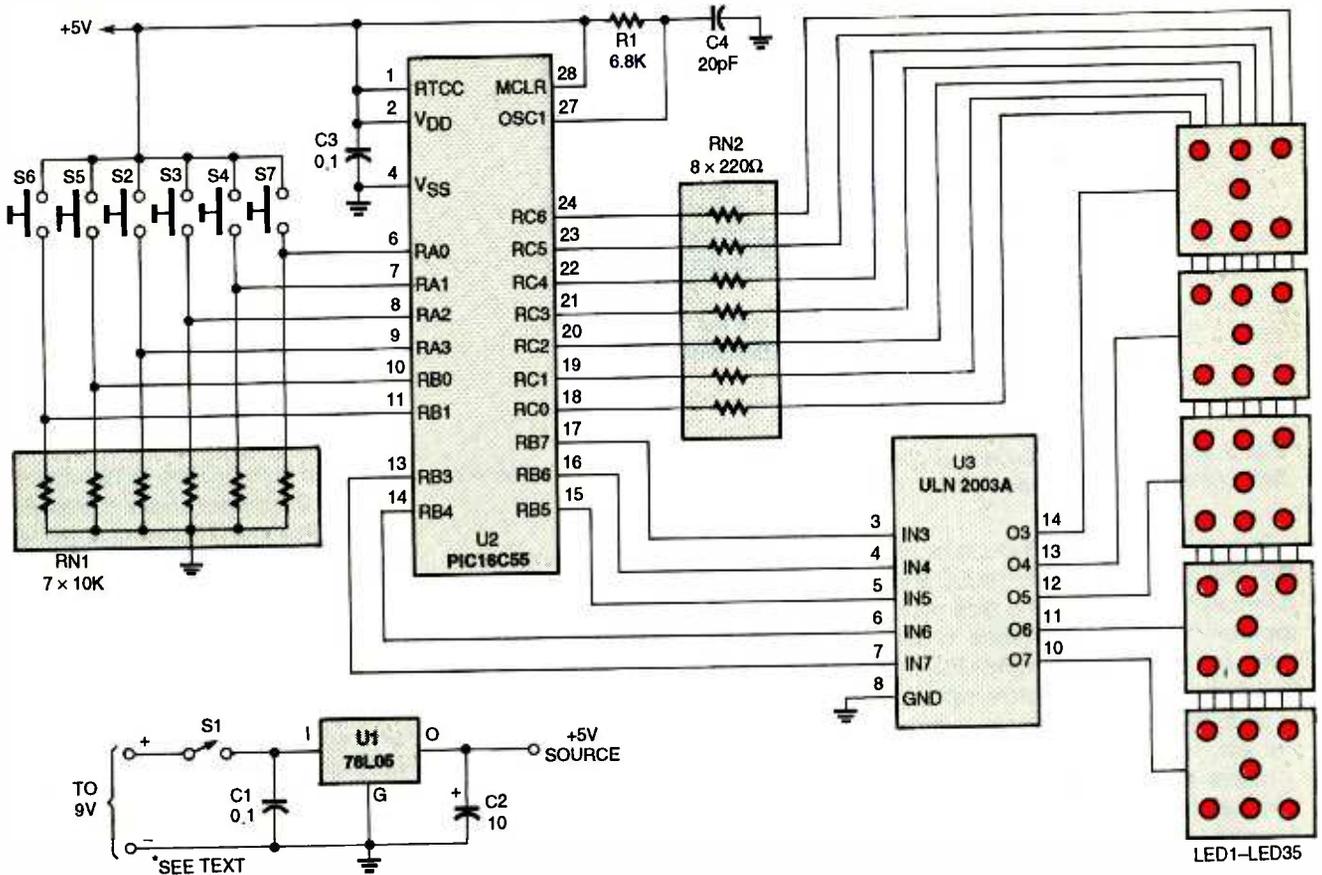


Fig. 1. The use of a microcontroller (U2) keeps the parts count, and the cost, of this 5-die LED display relatively low.

RAM, and 20 I/O lines. Z-Dice uses the I/O lines to light the seven LED's that make up each of the dice, to select which of the dice to light at a given time, and to check the states of switches S2 through S7. Let's look at those functions in more detail, starting with the LED display.

It takes seven LED's to display all of the patterns of pips required for the six sides of a die. For five dice, that's 35 LED's. The PIC doesn't have enough I/O lines to control 35 LED's at once, so Z-Dice uses a technique called multiplexing.

Take a look at the LED wiring detail, shown in Fig. 2. The LED's are connected so that all of the cathodes (-) for a given die are connected together. The anodes of the LED's that make up the different dice are tied together according to their positions on the face of the dice. If you grounded all of the cathode connections, and connected the line marked RC0 to +5 volts (through a current-limiting resistor, of course), all of the upper-left LED's of the five dice would light. But what if only the first die's com-

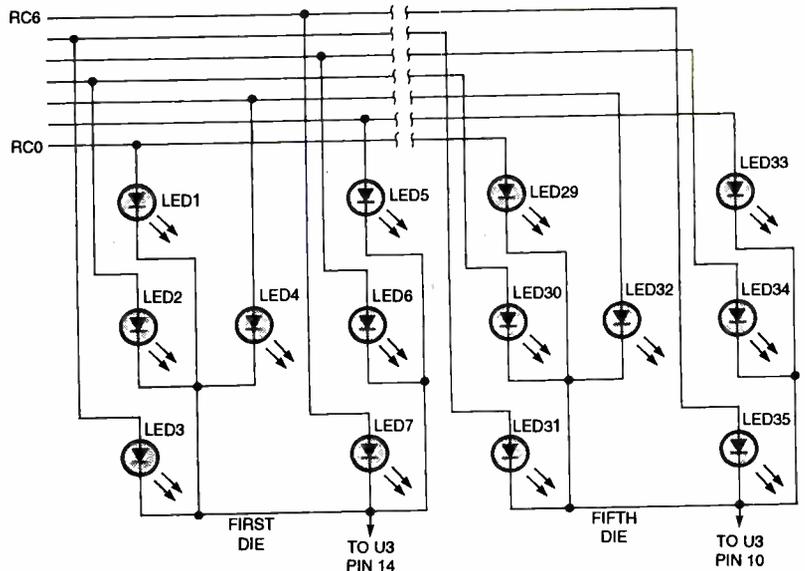


Fig. 2. This diagram shows the wiring details of the dice display. For space and simplicity, only the first and last dice are shown.

mon-cathode connection were grounded? Then, only the upper-left LED of the first die would be lit.

That's how the PIC controls the LED's. It establishes the pattern of LED's by switching on the appropriate pins

(RC0 through RC6). Then it selects which die should display the pattern by switching on one of the RB3 through RB7 pins. U3, a ULN 2003A Darlington-transistor array, grounds the corresponding die-select pin.

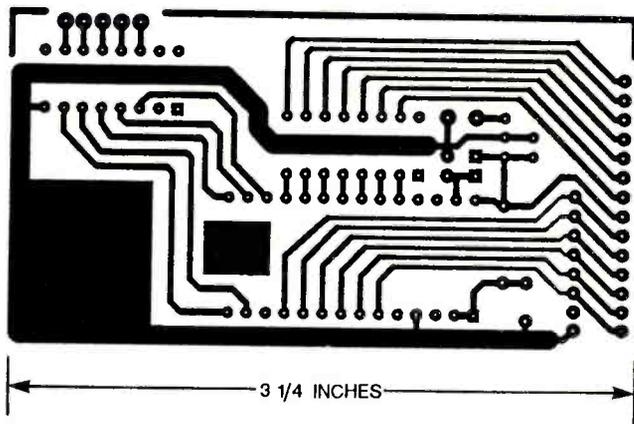


Fig. 3. Here's a full-size foil pattern for the controller board. This board contains the bulk of the project's circuitry.

To make it appear as though all of the dice are constantly lit, the PIC sequences through all of the dice very rapidly. Your eyes' persistence of vision—the property that makes television appear as a solid picture instead of a rapidly moving bright spot—does the rest.

Notice that the PIC drives the LED anodes directly, but uses U3 to switch the cathodes. That's because each of the anode pins must drive only one LED at a time, but the cathode connections must handle current from up to six LED's at once. The current through each LED is equal to the power supply voltage - (LED voltage drop + U3 voltage drop), divided by the series resistance. That works out to  $(5 - (2 + 1.5))/220 = 6.8$  milliamperes (mA). When a die displays a six, the total current is almost 41 mA. That exceeds the PIC's I/O pins' sink capability of 25 mA. However, U3 is rated to sink up to 500 mA, so it can easily handle the required current.

Apart from lighting the LED's, the PIC's other external function is to

check the state of the pushbutton switches. When a switch is open, the corresponding pin of the PIC is grounded through a 10k resistor that is part of RN1, a 1x7 resistor network. The PIC sees that as a logic 0. When you push one of the switches, you connect the corresponding pin to +5 volts. The PIC sees that as a logic 1.

The PIC's internal program has two basic jobs. It displays the current values of the dice, and it checks the switches. Depending on which switch is pressed, it must determine whether to mark a particular die, mark all of the dice (when the roll button is pressed with no dice marked), or roll. Unless you are a PIC programmer, these internal details are of no more interest than the internal construction of any other IC. If you are interested in programming PIC's, and have the needed equipment and knowledge to do so, the source code is available on this magazine's BBS (516-293-2283, 8N1). Pre-programmed PIC's are available from the source given in the Parts List.

**Construction.** The Z-Dice prototype was built using two single-sided printed circuit boards. The foil pattern for the controller board is shown in Fig. 3, while the pattern for the display board is shown in Fig. 4. The parts-placement diagrams for the boards are shown in Figs. 5 and 6, respectively. Once the separate boards are built and checked out, final assembly is just a matter of plugging the display board into the controller board. The resulting assembly is compact and modular, should you ever want to take your game apart to show off your construction or modify its operation.

While the order of assembly for the two boards is not important, a few tips will make the job go more smoothly. Let's start with the display board (Fig. 6). Before you solder components to the display board, consider whether you want to paint the component side of the board. I assembled my prototype, and then decided that the LED's would look better against a flat-black background. Painting around the 35 LED's and 6 switches seemed like a hopeless job, so I cut flat-black cardboard as a mask. If I had painted the board beforehand, I would have saved myself considerable work.

The display board requires eight jumper wires. Each of those wires is identical in length: 0.3 inches. For the neatest possible job, I swiped some formed jumper wires from my prototyping kit. In most kits, those are the orange wires. I mounted them on the foil side of the board, and soldered carefully to avoid melting away too much of the insulation. Because those wires are machine formed and stripped to exactly 0.3 inches, they mount flat against the board without risk of shorting other traces.

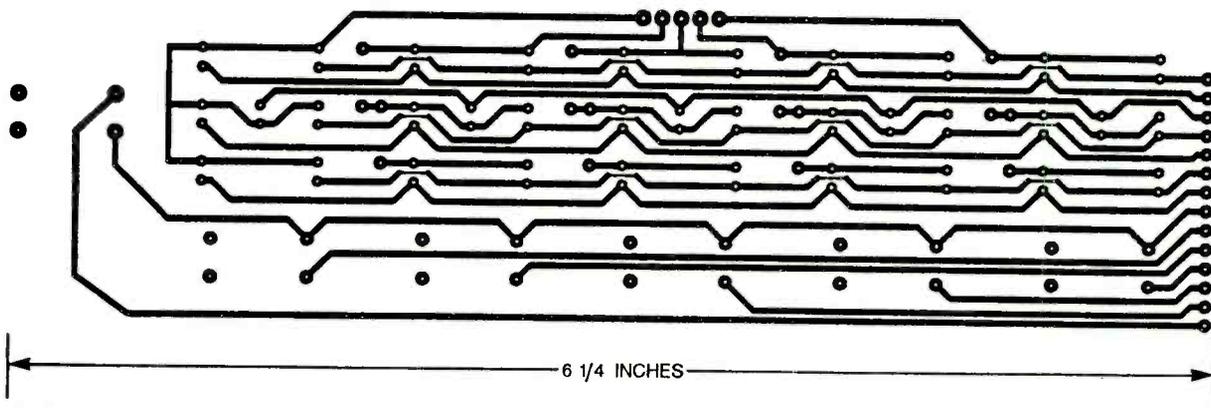
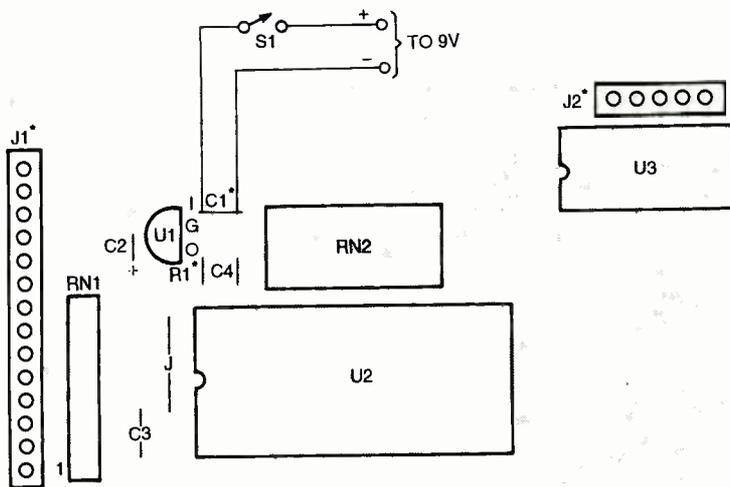


Fig. 4. Here's the foil pattern for the display board. The board is shown here full size.



\*SEE TEXT

Fig. 5. Use this parts-placement diagram when building the project's controller board. Watch the orientation of RN1, but RN2 can mount in either direction.

Note the orientation of the LED's. Most of the LED's mount with their anodes toward the bottom of the board; however, the LED at the center of each die (the "snake eye") mounts anode-up. On most LED's, the anode is the longer lead, and the cathode is marked by a flat spot on the base of the LED's body. For the best appearance, make sure that you mount each LED with its base flat against the circuit board. Crooked LED's will make crooked-looking dice.

I suggest that you alternate LED colors from one die to the next. That creates a visual dividing line that makes it much easier to distinguish a die from its neighbors. On the prototype they alternated green-yellow-green-yellow-green. Since each die requires seven LED's, that's 14 yellow and 21 green LED's.

The specified switches should snap into their mounting holes with a gentle push. If they resist, the mounting holes may be a little too small. Enlarge them slightly with a small drill bit or hobby knife.

Connectors PL1 and PL2 are rows of square header stakes that protrude from the foil side of the LED board. The easiest way to make those plugs is to use extra-long header stakes, like those specified in the parts list (however, you can make substitutions if you have others on hand that you want to use). If you choose to use the specified headers (which are available from Digi-Key—701 Brooks Avenue South, P.O. Box 677, Thief River Falls, MN

56701-0677; Tel. 800-344-4539), insert them through the holes in the board so that the longer end sticks out of the foil side and the plastic retaining block is on the component side of the board. Solder the longer stakes lightly to the foil at their bases. Next, pry off the plastic retaining block. Now, one at a time, reheat the light solder connection at the base of each stake and use a pair of needle-nose pliers to pull the stakes through the board, leaving as little as possible protruding from the component side. Once you have done that with all of the stakes, support them from the LED side of the board, and solder them more securely to the foil.

That is a better procedure than pulling the stakes out of their plastic block and mounting them one at a time, because it is more likely to produce straight, even results. Now you can see why it is worth the trouble of searching for longer header stakes. The procedure is similar, but instead of pulling the stakes through the board, you simply cut off the excess.

Next, let's turn to the controller board. Follow Fig. 5 and you shouldn't have any problems. Note that resistor R1 mounts on its end. Also, pay attention to the orientation of resistor-network RN1. Make sure that the pin-1 end (marked on the body of its case) points toward the bottom of the board, as shown. The other resistor network, RN2, also has its pins numbered and marked, but it is symmetrical and may be mounted either

## PARTS LIST FOR THE Z-DICE

### SEMICONDUCTORS

- U1—78L05 5-volt, 100-mA voltage regulator, integrated circuit
- U2—PIC16C55 microcontroller, integrated circuit (see text)
- U3—ULN 2003A Darlington-transistor array, integrated circuit
- LED1-LED35—T1¼ green and yellow diffused LED's (see text)

### RESISTORS

- R1—6800-ohm, ¼-watt, 5%
- RN1—7 × 10,000-ohm fused resistor network, SIP package (Digi-Key 750-81-R10K-ND or equivalent, see text)
- RN2—8 × 220-ohm isolated resistor network, DIP package (Digi-Key 761-3-R220-ND or equivalent, see text)

### CAPACITORS

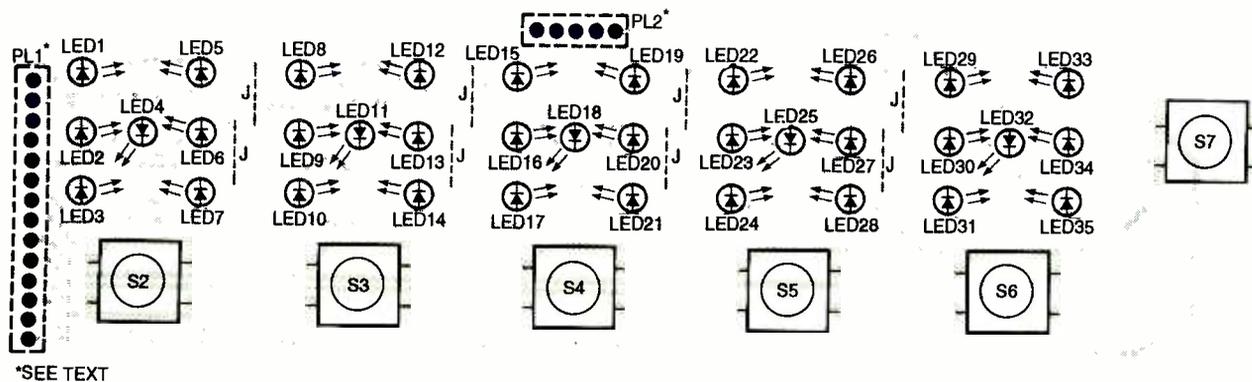
- C1, C3—0.1µF, ceramic disc
- C2—10-µF, 16 WVDC, tantalum
- C4—20-pF, ceramic disc

### ADDITIONAL PARTS AND MATERIALS

- S1—SPST switch, slide or toggle
- S2-S7—SPST, normally-open, momentary-contact pushbutton (Digi-Key P8034S-ND or similar)
- PL1, PL2—straight male header pins on snappable strips, 0.1-inch spacing. (Digi-Key S1252-36-ND or similar)
- J1, J2—Molex pins on keeper strips (All Electronics MP-100 or similar)
- PC board, batteries (6 AA cells or 9-volt transistor battery), battery holders or clip, solder, wire, etc.
- Note:** A programmed PIC16C55 microcontroller (U2) is available for \$13 postpaid from Scott Edwards, 964 Cactus Wren Lane, Sierra Vista, AZ 85635. Check or money order only, please. Tools for programming PIC microcontrollers are available from Parallax Inc., 3805 Atherton Road, Rocklin, CA; phone 1-916-624-8333.

way. In fact, you may substitute seven ¼-watt, 220-ohm resistors for RN2. The network is just easier to mount and makes for a neater assembly.

To connect the power leads to the board, first solder them to the leads of capacitor C1, close to the body of the unit. Then mount C1 to the board. Make sure that the polarity is correct; the ground lead should be closest to RN2.



\*SEE TEXT

Fig. 6. Here's the parts-placement diagram for the display board. For a more dramatic display, you may want to paint the component side black before mounting the parts.

Header sockets J1 and J2 are strips of Molex spring clips (available from All Electronics—P.O. Box 567, Van Nuys, CA 91408; Tel. 800-826-5432). Those come attached to "keeper" strips. Cut the keeper strip to get the desired number of pins, then insert and solder the clips in place as a unit. Remove the keeper strip only after the clips are installed. If you remove it beforehand, the tiny, loose clips will be a pain to install.

Once the clips are soldered to the board and free of their keepers, slip a small section of 1/8-inch heat-shrink tubing over every second clip. Shrink the tubing using a heat gun, hair drier, or paint-stripping gun on the lowest setting. Now install heat-shrink over the remaining clips and shrink it. The tubing generally will not fit if you try to install it all at once, but goes on relatively easily if you do half at a time. The tubing serves to prevent short circuits between adjacent clips, and also keeps the clips from losing their shapes after repeated use.

Before you install U2, check the power-supply section for proper operation. Connect 7.5- to 9-volts DC to the power leads, and measure the voltage between pins 2 (+ supply) and 4 (ground) of U2's socket. You should measure 4.9 to 5.1 volts. If the voltage you measure is outside that range, double-check your previous assembly work for bad solder joints and improperly installed components. Do not install U2 until the supply voltage is correct. Supply voltages in excess of 5.5 volts or short circuits elsewhere on the board will damage U2.

When you are sure that the power

supply is working properly, disconnect the battery and install U2. You may now plug the display board into the sockets on the controller board. Plug PL1 into J1 first, making sure that all of the pins line up with the clips. If necessary, bend the pins or clips slightly to bring them into alignment. Once PL1 is seated in J1, mate PL2 with J2. Your Z-Dice unit is ready for checkout.

### Checkout and Final Assembly.

Connect power to the assembled Z-Dice controller board. The LED's on the display board should light in the pattern of a large straight: 1, 2, 3, 4, 5. If some of the LED's light, but the dice patterns are incomplete, one or more pins of J1/PL1 are not making correct contact. If one or more of the dice are not lit, then the problem is with J2/PL2. Remove power and separate the boards. Inspect the header pins and clips to ensure that none are bent or broken. Correct any problems you find, reassemble the boards, and try again.

Once you have the LED's working properly, you're ready to throw the dice. Press S7, the button on the far right of the board, twice. All five dice will roll. Next, select individual dice to roll by pressing S2 through S6. When you're ready, press S7 to roll your selections. That's all there is to it.

When you are satisfied that the unit is working correctly, turn it off and separate the boards. Use a spray defluxer to remove solder flux from the boards. Cover J1, J2, PL1, and PL2 with masking tape, and spray the foil sides of the circuit boards with clear lacquer to protect them from corrosion. When the lacquer is dry, you're ready to

mount your Z-Dice circuit boards in an enclosure.

The author's prototype was housed in a simple box built out of crate wood. Narrow strips of wood were cut into pieces matching the length and width of the display board. Grooves were cut along the length of the longer pieces, about 1/4-inch from one edge. The two long pieces and one short piece were then hot-glued into a U shape. The display board was then slid into the grooves, and the rest of the box was assembled around it. The appropriate holes for switch S1 were cut into one of the end panels of the box, and the switch was soldered into the circuit between the controller board and the battery.

Of course, you may mount your project any way you like. Just be sure to provide adequate support for the display board. Some players might be heavy-handed they they use the pushbuttons.

The choice of battery is also a matter of taste. Z-Dice draws an average of 30 mA, depending on the value of the dice displayed. Higher numbers mean more LED's lit and therefore more current. While a standard 9-volt battery will provide sufficient current to run Z-Dice, two 3-cell AA holders connected in series were used in the prototype.

You may use your completed Z-Dice with any game that uses ordinary dice. As the name suggests, I am especially fond of Yahtzee. Beware, though: Just because you built the dice doesn't mean that you can control them. I lose as many games as I ever did! However, I don't seem to mind as much!

# THE HIGH-TECH WAR ON CRIME



*Here is how technology is helping to put  
the bad guys behind bars.*

BY BILL SIURU

**N**oel Fitzpatrick, a British tourist, mistakenly wandered into an area of Washington, DC plagued by drug-dealing and prostitution. The tourist was found dead the next morning from a bullet wound in his chest. If the fatal shot was heard, it was not reported. Without a report, the murderer remained at large, and free to shoot other unsuspecting victims. Also, the tourist was left in an alley to bleed to death when prompt medical attention would have probably saved his life.

SECURES (System for Effective Control of Urban Environment Safety) could have saved Mr. Fitzpatrick's life, and helped many of the other American victims of gunfire injured at the rate of one every two minutes. The SECURES concept—proposed by Alliant Technologies, Inc.—would allow local law-enforcement agencies to respond immediately to gunfire, thereby dramatically increasing the probability of arresting a suspect. Likewise, EMS trauma units could get to the victim within the first "Golden Hour."

As shown in Fig. 1, SECURES consists of a dense grid of Pole Units (PU) located at each intersection of a city block. Each PU would contain a low-cost acoustic sensor (basically a microphone), an analysis module, and a communications transceiver. When a burst of high-intensity acoustic energy is detected, the high-speed digital signal processing hardware and software within the analysis module are used to determine if the sound has the characteristics of a gunshot, or if it comes from another source.

If it is determined that the sound is a gunshot, the communications transceiver in the PU, which contains a digital modem and a VHF radio, transmits a gunfire-incident report to a central command center or base station via an intermediate local transceiver node. That report is transmitted as a digital-communications packet that includes a unique identification code associated with the location of the PU in the grid, and any other information necessary for gunshot verification and localization. The time lag between the gunshot event and the report will be less than a second. Computers at the base station would use time-differencing techniques to pinpoint the location of the gunfire to within a city block. Then necessary police and EMS personnel could be dispatched. Alliant estimates that SECURES could reduce police and EMS response times by as much as 85%.

SECURES is not the only technique proposed for locating the source of gunfire. U.S. Geological Survey geophysicists have shown that sensors used for locating the epicenter of earthquakes can also be used to locate the source of gunshots. The scientists used five simple sensors, each consisting of an inexpensive microphone, amplifier, and radio transmitter installed in a small plastic box. One sensor was placed in a central location, while the other four were placed in remote locations. Each battery-powered sensor radioed data back to a central site where the signals were monitored.

Whenever the sensors detected a sudden increase in noise, a computer recorded the arrival time of the acoustic energy at each sensor. A computer program called Hypo-

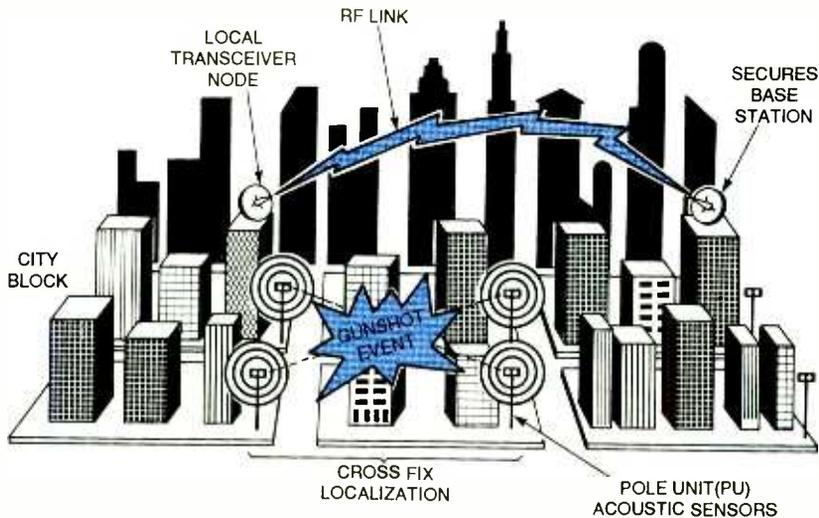


Fig. 1. Pole units (PU's) pick up gunshot sounds and relay the information to a base station. Computers at the base station pinpoint the shot's location and forward the information to law-enforcement agencies and EMS trauma units.

Shot compared the arrival times at the sensors to triangulate the location of the sound source. While the geophysicists did not solve any crimes, they did demonstrate that the technique would work.

**One Gun, Many Crimes.** In the spring of 1992, a Baltimore woman was wounded by a .40 caliber bullet. A couple of months later, another man was shot a few blocks away. In the next two months, two more people were shot in the same neighborhood. It appeared that the incidents were unrelated, and each time the perpetrator escaped. However, the Baltimore Police were participating in a pilot FBI program called Drugfire that allowed them to connect these incidents. From recovered casings at each crime scene they concluded that the same handgun was used. A break in the case came a few months later when they arrested a suspect on a concealed-weapons charge. The recovered Glock pistol was test-fired to obtain a casing, and the computer database was searched for another match. It matched the other rounds and the case was solved.

Solving serial and drug- and gang-related crimes often involves linking the weapon used in several crimes. That requires forensic identification by experienced firearms examiners. Up to now, examiners have used the ballistic-comparison microscope introduced in 1925. Comparisons to determine if the same firearm was

used in multiple crimes require side-by-side microscopic examination of marks on bullets and cartridges. While that technique works well and results are routinely accepted in the courtroom, it was too time-consuming to handle the exploding number of firearm-related crimes. A more efficient forensic identification technique was needed to keep pace with the problem.

Like fingerprints, individual firearms leave their own characteristic microscopic "signatures" on ammunition. No two guns leave the same impressions. Linking firearms used in multiple crimes requires measuring, analyzing, sorting, cataloging, and comparing a huge number of those signatures. Those are perfect jobs for computers and digital image-processing technology.

Drugfire is a computerized database that forensic labs can use to maintain and search Open Case Fired Ammunition Files (OCFAF) with greatly increased effectiveness. That database was developed by the FBI for about \$1 million. The technique starts by storing high-definition, digital "snapshots" of the markings on spent bullets or casings as they appear through the microscope in the Drugfire database.

Many of those images can then be called up for rapid comparison. The Drugfire database's format allows the review of 25 images on the computer screen at one time. That includes the suspect round located under the microscope, plus 24 more images in the

database. The number of 24-image files in the database can be many pages deep, so a virtually unlimited number of candidates can be compared.

The Drugfire database uses search techniques to narrow down the possible candidates from hundreds or even thousands to a few prime "suspects." That is done by specifying characteristics like the caliber of the round, impressions left by the rifling, direction of the rifling twist, and the width of the lands and grooves. The spent cartridge can be characterized by parameters such as the shape of firing-pin impressions, position of the extractor/ejector marks, and breech face marks. For example, are the markings parallel or circular? The database and search techniques were developed using feedback from firearms examiners who pointed out what was important, as well as what was not.

Another feature of Drugfire is its sophisticated digital image-processing techniques. For example, "edge enhancement" greatly improves the clarity of the image through increased contrast and sharpness. With a simple click of a mouse, rounds can be flipped for mirror image comparisons or two images can be merged for better side-by-side comparisons.

Using Drugfire, firearms examiners can quickly manipulate the database to compare the images produced from different microscopic examinations. That means Drugfire can perform remote side-by-side comparisons of fired ammunition specimens in near real-time using the images in the database, rather than mounting and examining the actual fired rounds under the same microscope. The same database can be used by several labs, allowing comparisons to be made without having to physically transfer the evidence. All that is needed is a telephone link between the labs. That represents a major breakthrough since the chance of the evidence being misplaced, lost, or damaged is eliminated. So is the need for the cumbersome chain of custodial paperwork needed to insure the results will remain admissible as evidence in the courtroom.

To make Drugfire more accessible to laboratories, it can be used by re-

gional computerized firearms-evidence clearinghouses. That will allow linking of regionally clustered forensic laboratories so they can share information on firearms.

Drugfire will significantly change the role of firearms examiners. Instead of just confirming matches of weapons used in crimes, they can actually solve crimes by finding matches on the computer screen. However, the age-old comparison microscope and the examiner's expertise is still needed for the final confirmation of evidence needed for court testimony.

Drugfire has been in operation since the summer of 1992, uniting six forensic laboratories in the Washington/ Baltimore metropolitan area. Law-enforcement agencies in Los Angeles and surrounding communities are now using the system. Florida is investing \$350,000 for a system to connect the seven crime labs operated by the Florida Department of Law Enforcement and three county-run crime labs in South Florida.

**An Honest Lie Detector.** For decades, scientists and mathematicians at the Johns Hopkins University Applied Physics Laboratory (APL) in Laurel, Maryland did complex analyses on submarine-launched missiles for the military. Today, APL's years of experience and vast expertise have been applied to solve a civilian problem. The result is Polyscore—computer software that can score polygraph tests automatically and with greatly increased reliability and confidence.

The Polyscore computer program, from Axitron Systems, Inc., uses a highly sophisticated mathematical algorithm to analyze physiological signals recorded during the polygraph examination. The software makes the complex, statistical comparisons that sometimes cannot be made by human examiners. After the test, Polyscore displays the results: deception, no deception or that the test was inconclusive. The program also presents a probability value that indicates the confidence of the results. Inconclusive results only occur about 5% of the time.

According to Dr. Dale E. Olsen, a co-developer of the software, "The program's scoring rules deliver consistent, objective results time after time. That allows the software to easily identify

the physiological reactions of people who are telling the truth and of people attempting deception."

To develop Polyscore's scoring algorithm, 539 cases were used. After subtracting a relatively low 6% in inconclusive findings, POLYSCORE scored all but two of the remaining cases correctly. And how was that "correct" scoring determined? In 162 of the test cases, actual confessions, either by the subject or someone else, were used to identify which subjects attempted deception. The remaining were judged by an independent team using traditional scoring methods. Their results matched the POLYSCORE findings. Furthermore, twenty cases identified as inconclusive by the original human examiners were scored either deceptive or non-deceptive by Polyscore. Eventually, it was determined that Polyscore correctly scored each of them.

User-friendly, Polyscore has also been designed to assist the examiner in analyzing the polygraphs. For instance, the program removes long-term trends in the data so the graphs can be displayed without breaks, or pen adjustments, in the channels. Also, with Polyscore, the examiner can zoom in and see the details of a cardio pattern or other patterns. Or the user can zoom out and display an entire chart on the screen at once

(see Fig. 2). Polyscore can also provide a visual display of question probabilities. That option is especially useful for demonstrations.

Polyscore has been tested and is currently used by law enforcement agencies in Vermont, South Carolina, Georgia, Florida, and Alabama.

**The Law Sees in the Dark.** A particularly brutal crime was committed, and from the modus operandi, local law-enforcement officers immediately suspected a particular individual. When confronted by the police, the suspect claimed he was at home at the time of the crime. However, the police scanned the suspect's car with the IR Thermal Imaging Camera they brought with them. The scanner showed it was still warm. Confronted with that simple evidence, the suspect broke down and eventually confessed.

Thermal imaging (TI) is another technology being transferred from the military. Indeed, the Germans used it on their potent *Konigstiger* tanks in World War II. Thermal imaging offers even more capability than night-vision equipment based on image intensification (II), which is already used widely in law-enforcement work. Unlike II, which needs some light source, for instance moonlight, TI needs none. Thermal imaging

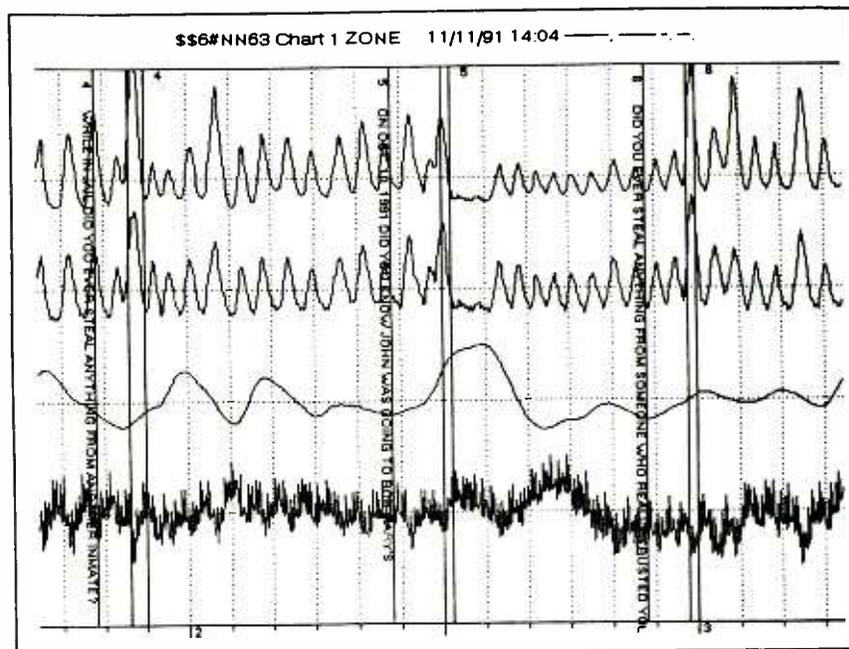


Fig. 2. Here's a sample of the output from the Polyscore computerized polygraph scoring system. The system can sometimes outperform even expert polygraph examiners.

is effective even when it is too dark for image intensifiers because it uses the natural heat generated by all objects. A sensitive TI "camera" can convert the heat image of vegetation, people, machinery, etc. into a visible image on a screen.

Unlike image intensification, TI can also be used effectively in broad daylight to find people or things hidden behind natural vegetation. Thermal imaging can not only see through the night, but also through fog, mist, or smoke. It is especially useful in penetrating almost any type of camouflage. Thermal imaging takes advantage of infrared "light" passively, so only the user knows when it is in operation, not the suspect.

Thermal imaging systems measure the thermal energy of an object against its background. By distinguishing minute variations in thermal radiation, the system is able to electronically display a thermal picture that can be viewed by the operator. The pictures are digitized and portrayed by differences in color. In principle, a TI camera operates much like a TV camera, except in the infrared rather than the visible bandwidths. Usually, the TI camera is tied in with a computer where special software can be used to present, store, and analyze the digitized pictures. Personal computers and laptops can be used with the latest commercial TI equipment. Their storage capability is especially attractive when gathering evidence.

While every object emits thermal energy, much of the energy is ab-



*Thermal imagers, like this Mitsubishi IR-M 300, are valuable additions to the police's surveillance capabilities.*

sorbed by the atmosphere. There are two IR-wavelength bands where absorption is minimum. Those are in the 3- to 5-micrometer and 8- to 14-micrometer bands. Fortunately, those are the wavelengths where high-temperature sources like engine exhaust and low-temperature sources like humans emit heat energy. Most commercial TI systems work in the 3- to 5-micrometer range, although some newer ones operate at 8- to 12-micrometers with better response.

In order for a TI device to detect minute differences in thermal energy, it must be kept at a very precise, very low, and constant temperature. That means the TI device must be cooled, usually using a Stirling cycle cooler or refrigerator. Cooling must be accurately controlled. That adds up in terms of weight, complexity and cost.

Thermal imaging can detect everything from a suspect hiding in the bushes to detecting which cars in a parking lot have been run recently. It can also be used to spot the very high heat sources associated with the growing or manufacturing of illegal drugs. Police are already using forward-looking, infrared systems aboard light aircraft and helicopters to better observe suspected drug operations. Any countermeasures to conceal heat generation are virtually ineffective and criminals rarely even realize their vulnerability.

On the ground, thermal imagers are used for all types of observation of suspected criminals or just for security surveillance. The better TI devices can pick up emitted energy from people or events even outside the direct field of view. Police forces are also buying transportable imagers that can be used from helicopters without the added expense of gimbaling, as well as for normal street observations.

As with any detection technique, thermal imaging brings some legal questions with respect to the Constitution's Fourth-Amendment protection against unreasonable search and seizure. That question has already been tested in the courts, specifically by a U.S. District Court in Pennsylvania.

The court ruled that people do not retain privacy interest in the heat that is emitted from their homes. Furthermore, since TI does not use any active beams to penetrate the dwelling, it is like using a dog to detect drugs by sniffing, for example, luggage at an airport. That is a universally used, and legally accepted, detection technique.

However, it is expected that TI-obtained evidence will be challenged in the future as the technology gains wider acceptance. From that litigation will come more legal clarification. In its favor is the fact that TI is less intrusive than a dog because it does not disclose specific information. ■

#### For More Information

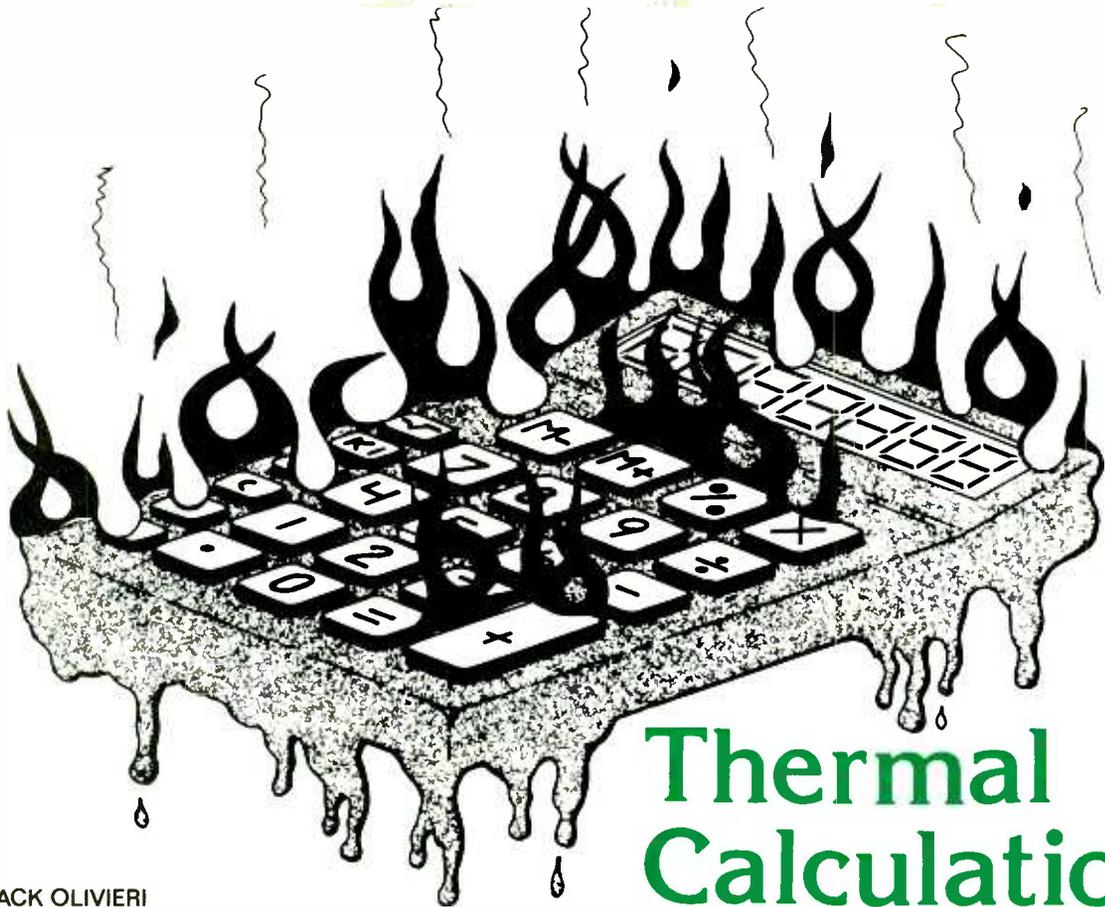
Alliant Technologies, Inc.  
7225 Northland  
Minneapolis, MN 55428-1516

Federal Bureau Of Investigation  
Laboratory  
9th and Pennsylvania Avenue, N.W.  
Washington, DC 20536

Johns Hopkins University  
Applied Physics Laboratory  
Johns Hopkins Road  
Laurel, MD 20707

Axitron Systems, Inc.  
P.O. Box 42380  
Houston, TX 77042

Mitsubishi Systems and Peripherals  
Division  
5665 Plaza Drive  
Cypress, CA 90630



# Thermal Calculations

BY JACK OLIVIERI

*Learn how to do the math that will keep your projects from a fatal and messy meltdown.*

**W**hen designing electronic circuits, hobbyists often overlook heat as a design concern. Since significant time, money, and effort can be expended designing and building a circuit, it makes sense to do it correctly up front. The following article illustrates some of the basic concepts for performing heat calculations and the rules to follow when designing and building heat-producing electronic circuits. These hints should help your circuits to work reliably for a long time.

**Power Dissipation.** The basis for all heat calculations is power dissipation. Power is simply the amount of energy flow measured over a given time period. If more energy goes into a component than comes out as useful work, the balance of the energy must be taken into account. For this discussion, we will assume that all of the unaccounted for energy takes the form of heat.

To start our analysis, let's consider a hypothetical resistor (see Fig. 1). The power dissipated is simply the voltage across the resistor multiplied by the

current through the resistor. Alternatively, any variation of Joule's Law can be used to calculate power using resistance, voltage, or current.

In general, the power rating of resistors are specified at a maximum rated temperature. For example, ¼-watt resistors will dissipate their maximum wattage at 70°C. However, it is customary to be conservative when designing circuits, so you should derate a resistor by 50%. Therefore, you should not try to dissipate more than ⅛ watt through such a resistor in 70°C surroundings. At higher ambient temperatures, the power dissipation must be even less. That will ensure that the part is not stressed to the point where its life is shortened.

Temperature ratings of capacitors should be considered also. Even though most of the heat experienced by a capacitor is externally generated, in some cases the heat can be internally generated. Since capacitors are frequency-dependent impedances, they can dissipate enough power to raise their internal temperature. Therefore, derate their voltage and temperature as well.

**Transistors.** Semiconductors dissipate power in much the same way—the dissipation equals the voltage across the device multiplied by the current through it—but they usually require more consideration.

Let us consider the 600-milliwatt transistor in Fig. 2. The transistor has 1.0 amp flowing through it. The voltage drop can be looked up in a data book; for use as a switch,  $V_{ce(sat)}$  is the correct voltage parameter. Alternatively, the voltage drop can be measured directly. It is 0.6 volt in this case, so the power dissipated is 0.6 watts. On the face of it, it looks like there should be no problem, because the transistor is rated at 0.6 watts and we have not exceeded that rating of the device.

However, the temperature of the device's junction must be considered, so we need to look up some information. For example, we should check the maximum rated junction temperature (the temperature at which the reliability of the device is compromised). This parameter is important because we would like to stay well under that value for a conservative

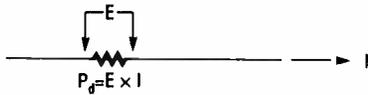


Fig. 1. The power dissipated by a resistor is equal to its voltage drop times the current it handles.

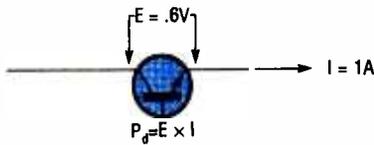


Fig. 2. The power dissipated by a transistor can be calculated using the same technique applied to a resistor; the dissipation is equal to the voltage drop times the current.

design. We also need to know theta-JC, the thermal resistance between the semiconductor junction and the case of the device, which is based on the device's construction. It is expressed as the temperature rise per watt of power dissipated ( $^{\circ}\text{C}/\text{watt}$ ). The last parameter of interest is theta-JA, the thermal resistance between the junction and the ambient air, which is based on construction (such as whether a heatsink is used) and is also measured in  $^{\circ}\text{C}/\text{watt}$ . For simplicity we'll assume no heat sink is used, other than the case of the device.

For the transistor shown, the maximum rated junction temperature is  $150^{\circ}\text{C}$ , theta-JC is  $62.5^{\circ}\text{C}/\text{watt}$ , and theta-JA is  $208^{\circ}\text{C}/\text{watt}$ . Looking at the special diagram in Fig. 3, notice that the thermal resistance is depicted as a resistor. As we determined, there is 0.60 watt being dissipated in the device, so the junction temperature rise will equal the power dissipated multiplied by theta-JA or:

$$0.6 \times 208 = 124.8 \text{ }^{\circ}\text{C} \text{ above ambient temperature}$$

If the air surrounding the diode inside the circuit's cabinet is  $20^{\circ}\text{C}$  higher than the outside air, which we'll assume is at  $40^{\circ}\text{C}$ , then the junction temperature is:

$$124.8 + 20 + 40 = 184^{\circ}\text{C}$$

far above the maximum  $150^{\circ}\text{C}$ .

What went wrong? If we had read more closely, we would have seen the rating specifies a power dissipation of 0.6 watt at  $25^{\circ}\text{C}$  only, our ambient temperature was effectively  $60^{\circ}\text{C}$  ( $20 + 40$ )! Notice that theta-JC was not

needed in this calculation, since no heat sink was considered.

**With a Heatsink.** Now we would like to know the junction temperature of the transistor if a heat sink is used. First

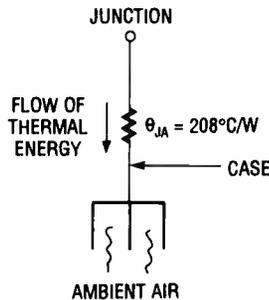


Fig. 3. Much as a resistor value is the voltage drop across it divided by the current flow, a thermal resistance is the temperature drop across it divided by the heat flow through it.

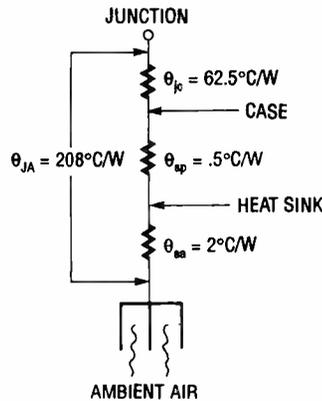


Fig. 4. The thermal resistance of each junction must be taken into account to determine the maximum temperature experienced by a device.

we need to know the thermal resistance of the heat sink, called "theta-SA" (the sink-to-ambient theta). The thermal resistance of any heat-sink compound or silicone washer should also be considered. For illustration, our heat sink will be a  $2^{\circ}\text{C}/\text{watt}$  unit and a  $0.5^{\circ}\text{C}/\text{watt}$  silicone washer will be used between the transistor and the heat sink. Figure 4 shows the thermal diagram. The total theta is:

$$62.5 + 0.5 + 2 = 65^{\circ}\text{C}/\text{watt}$$

Multiplying by the power dissipation to find the total temperature rise:

$$65 \times 0.6 \text{ watts} = 39^{\circ}\text{C}$$

Using the same ambient temperature ( $60^{\circ}\text{C}$ ) results in a junction temperature of only  $99^{\circ}\text{C}$  (the sum of 60 and 39), which is well within the safety limit. Notice that the sum of thermal resistances shown on the right in Fig. 4 does not equal the resistance on the left. That is because the heat sink ( $2^{\circ}\text{C}/\text{watt}$ ) is much better thermally than the case alone and shunts the heat to ambient air better.

There are several instances where it may be difficult to determine the various thermal resistances from data books. For example, if a transistor has no way to be coupled to a heat sink (perhaps because it's in a plastic TO-92 case), theta-JC is typically not provided. Therefore all calculations must be made simply with theta-JA. Also, some books state the numbers in different ways. Sometimes the information is presented this way:

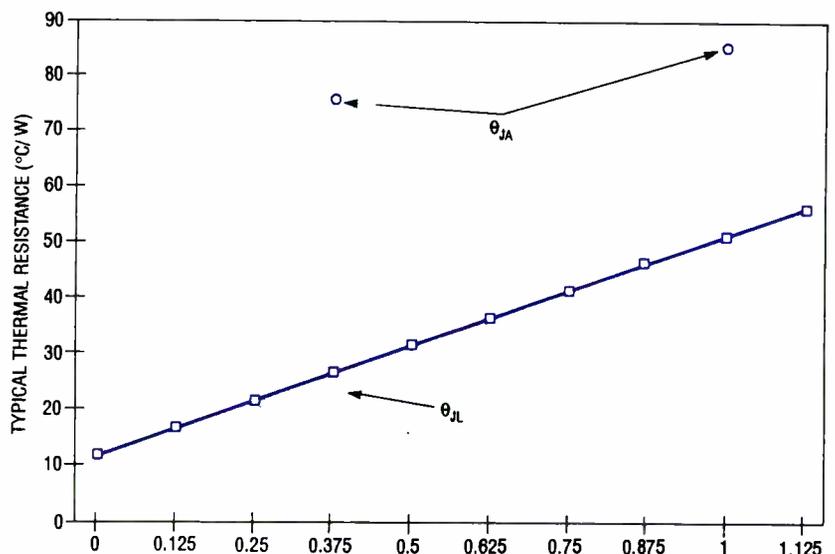


Fig. 5. If a component is cooled by its leads, it stands to reason that its theta value depends on the lead lengths.

Collector-Emitter Voltage: 25 VDC  
 Collector-Base Voltage: 50 VDC  
 Emitter-Base Voltage: 5 VDC  
 Collector Current: 1 Amp DC  
 Total Device Dissipation at 25°C: 0.6 watt  
 Derate above 25°C: 4.8 mW/°C  
 Total Device Dissipation at 25°C: 2.0 watt  
 Derate 16 mW/°C above 25°C  
 Operating and storage junction temperature range: 65 to 150°C

The data indicates that if the environment surrounding the transistor is kept at 25°C, the device will dissipate 0.6 watts safely without a heat sink and the junction temperature will not rise above 150°C. For every degree above the ambient temperature, the 600-mW rating must be reduced by 4.8 mW. Another way of saying that is for every 0.208°C (the inverse of 4.8) increase in the ambient temperature, 1 mW must be subtracted from the 25°C rating of 600 mW. Multiplying that by 1000 mW gives us the theta-JA, which is 208°C/watt.

Similarly, if we hold the case temperature at 25°C (using a perfect heat sink), we can dissipate 2 watts. But above that, (inverting and multiplying again), we come up with a theta-JC of 62.5°C/watt.

**Diodes.** Diode heat calculations can be slightly different also. There may be no theta-JA given if the diode is a stud-mounted type meant to be mounted on a heat sink. If it is a simple axial-lead type, the main way to dissipate heat is usually through the leads. Therefore lead length and mounting can be critical. In general, the shorter the lead length, the cooler the junction

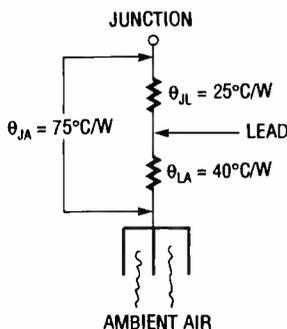


Fig. 6. Here we show the thermal diagram of a lead-cooled device. Note that the device-to-lead junction has its own theta value.

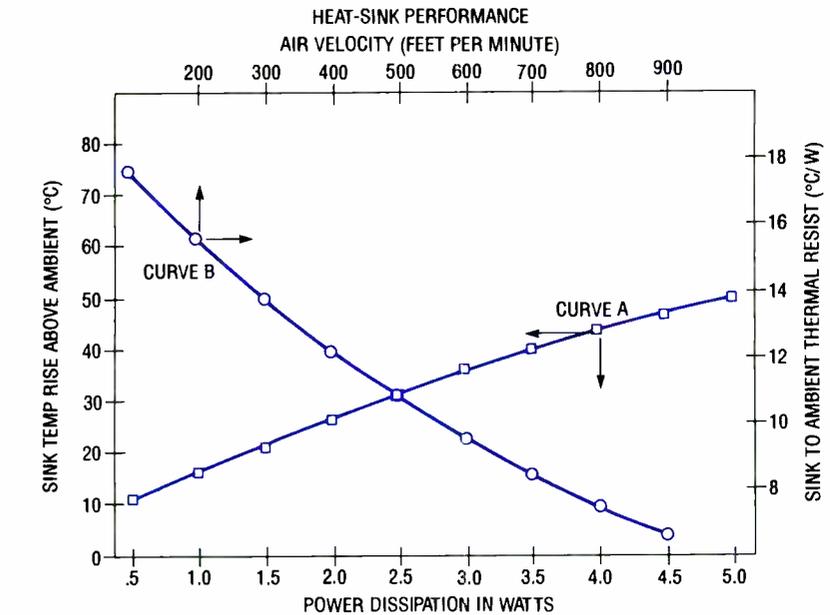


Fig. 7. The data sheets for heat sinks contain families of curves that help designers determine the appropriate theta values for both convection and forced-air cooling.

TABLE 1—PACKAGES AND THEIR THETA VALUES

PACKAGE	NUMBER OF PINS	$\theta_{JA}$	$\theta_{JC}$
Ceramic DIP	8-14	110	30
	16	100	30
	18	93	27
	20	90	25
	22	75	27
	24	60	26
	28	57	27
Plastic DIP	8-14	89-125	41-45
	16	86-120	39-45
	18	108	40
	20	74-100	32-37
	22	78	35
	24	59-75	30-34
	28	52-65	27-35
DO-5	—	—	5
TO-3	—	—	10
TO-5	—	—	70
TO-66	—	—	10
TO-92	—	150-200	70-100
TO-220	—	—	5

tion will stay. Also, usually one lead is listed (e.g., the cathode) as the primary thermal conduction path. Instead of theta-JC, the factor theta-JL (for junction-to-lead) is used. A typical curve for theta-JL is shown in Fig. 5. The thermal resistance varies over a range of 12 to 60°C/watt depending on the lead length. Also shown on the chart is theta-JA for 3/8-inch leads (75°C/watt) and for 1-inch leads

(85°C/watt). As an example, a 1N4001 diode dissipating 0.5 watt, with 3/8-inch leads mounted on a terminal strip, would have the thermal sketch shown in Fig 6. Theta-LA (lead-to-ambient) can be difficult to find in some books, but typical values are 30-40°C/watt.

**Integrated Circuits.** The math for  
 (Continued on page 88)

**A**lmost all **Popular Electronics** readers probably have fond memories of toys containing battery-powered motors. Technically known as permanent-magnet (PM) DC motors—and commonly available in sizes ranging from micro units (that pull only about 0.5 watts) to compact motors (that pull 200 watts)—they can be powered from 3- to 12-volt DC sources. Such motors are used in applications ranging from powered toothbrushes to trolling motors, and a whole lot more.

However, as convenient and reliable as they are, they all lack one important feature; speed control. Due to the low impedance of the devices and the fact that they are usually powered from batteries, they are difficult to run as variable-speed devices—all conventional methods of voltage control are grossly inefficient at high-current levels due to semiconductor gain and saturation limitations. But the *Low-Voltage Power Controller* described in this article is designed to overcome the problems associated with conventional DC controllers. It can be used with 12-volt permanent magnet DC motors as long as they draw less than 16 amps.

What's more, the unit can be used with 12-volt incandescent lamps; campers and other portable-spotlight users should really appreciate that capability. The Power Controller can be used to set lamps and spotlights at the optimum light-intensity levels. The Power Controller allows you to run at 35% of normal power levels when high-intensity illumination is not required; of course, the light intensity can be increased when the situation requires it.

Also, powering lamps and motors from the Power Controller allows them to run for much longer periods while consuming the same amount of battery charge. Further, since the starting current is eliminated or attenuated, lamps and motors operated using the Power Controller could have a measurably longer life. The Power Controller can also be used for automotive applications; for instance as a variable-speed wiper control for your car, a dimmer for the car's interior lighting, or a variable-speed air-blower control.

Not long ago, a controller of this type would have been prohibitively expensive. However, due to the ad-



## Build A Low-Voltage Power Controller

*Use it as a dimmer control  
for low-power lamps or as  
a speed control for small  
DC motors.*

BY FAZAL A. REHMAN

vent of power MOSFET's (which can drive a 200-watt load from a 12-volt battery source), the Controller can be built for under \$35. The efficiency of the circuit is almost 95%. That level of efficiency is possible because of the power MOSFET's combined with pulse-width modulation and other power-saving techniques throughout the entire circuit. The same circuit based on bipolar transistors would

have produced losses as high as 33% with a 200-watt load.

**How It Works.** Efficient power handling demands that the transistor passing the most power be very efficient, after all, that transistor might be responsible for up to 90% of the total controller loss. Now, power transistors (bipolar or MOSFET) lose the least amount of power when they are off. The second-least loss occurs when they are turned on hard (saturated). They are the least efficient when they are half on. That mandates that the Controller be operated so that the power transistor is either fully on or fully off—thereby making the average power output a ratio of the duty cycle.

The circuit has a duty-cycle generator that will give an output varying from fully off to fully on and pulses of any duty cycle in between the two extremes. For example, let's suppose that load circuit connected to the Controller requires 50% of the available power. The circuit generates power pulses that are on 50% of the time and off 50% of the time (called a 50% duty cycle). That method of operation is called the PWM (pulse width modulation).

The circuit can be fed from any DC supply source of between 10 and 15 volts. As shown in Fig. 1, U1-a (half of an LM556 dual oscillator/timer) and U2-a (one quarter of an LM339 quad comparator) combine to form a voltage-to-pulse-width converter. The first half of the dual oscillator/timer (U1-a) is configured as an astable oscillator, generating a continuously oscillating ramp voltage. Op-amp U2-a (one quarter of the quad comparator) compares the voltage at its non-inverting input (pin 5)—which is connected to pins 2 and 6 of U1-a—to the voltage at its inverting input (pin 4). The op-amp will give a low output if R1's wiper voltage is higher than the instantaneous voltage present at pins 2 and 6 of U1-a. The output of U2-a at pin 2 will have an on/off ratio that is proportional to the voltage at R1's wiper.

Since the output of U2-a does not have enough power-handling capacity to drive the MOSFET, its output is fed to U1-b, which is used to buffer the signal. The low-impedance, pulsed output of U1-b at pin 9 is fed to the gate of MOSFET Q1, driving it hard on

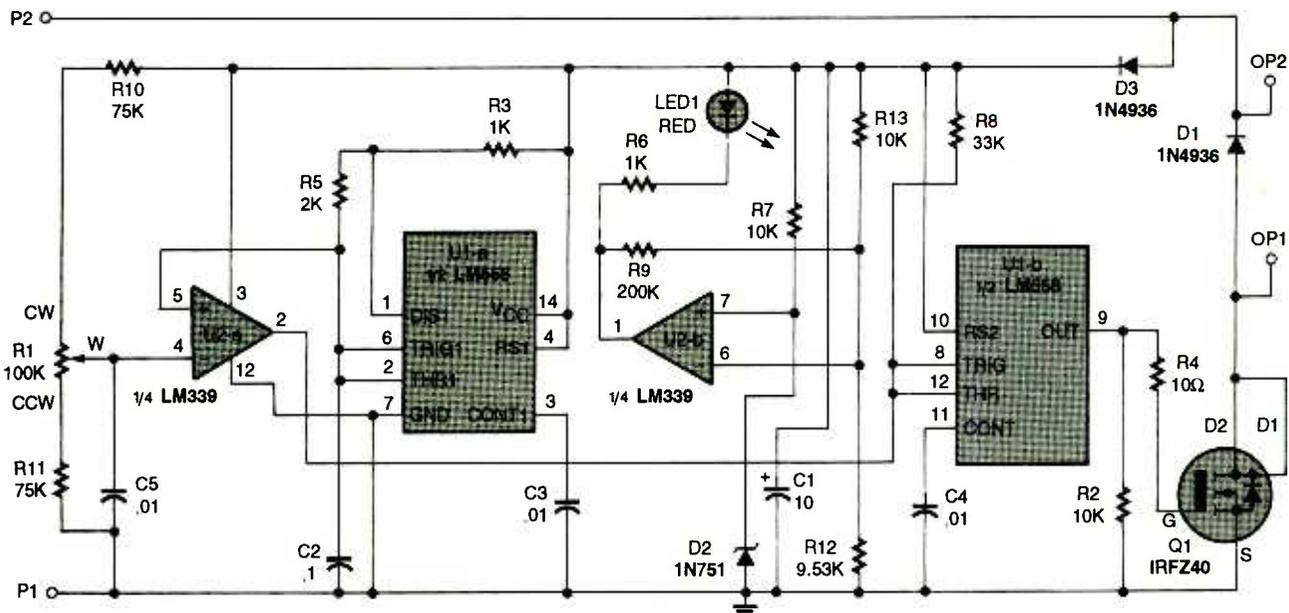


Fig. 1. The Low-Voltage Power Controller—which is comprised of an LM556 dual oscillator/timer (U1), an LM339 quad comparator (U2), and 1 to 4 IRFZ40 power MOSFET's (only one of which, Q1, is shown)—can be fed from any DC supply source of between 10 and 15 volts.

or off (which results in a fast turn-on/turn-off time). The circuit also has a power-input detector, built around U2-b and LED1. If the input power is OK, LED1 will normally be lit, but if the input voltage drops below a certain point, the LED will shut off.

Diode D1 is used to suppress the reverse voltage spikes generated by inductive loads during turn off; without that diode, the MOSFET might be destroyed. If the circuit will not be used to drive inductive loads (motors), D1 can be eliminated.

The best frequency of operation for the range of motors and lamps that can be used with this circuit would be around 3500 Hz, which is the frequency the circuit is set up for. **Note:** This kind of switching has some limitations, hence this controller can be used only with incandescent lamps and permanent-magnet DC motors.

**Construction.** The author's prototype of the DC Power Controller was built on a pair of small printed-circuit boards; which we'll refer to as the "main" and "driver" boards. Templates for both boards are shown in Fig. 2. The main board (which is shown in Fig. 2A) contains the bulk of the circuitry and measures about 2 $\frac{3}{16}$  by 2 $\frac{1}{4}$  inches. The driver board (see Fig. 2B), which measures 1 $\frac{13}{16}$  by 2 $\frac{1}{4}$  inches, is designed to accommodate up to

four parallel-connected MOSFET's, along with gate resistors. Note that only one MOSFET/gate-resistor circuit is shown in Fig. 1 (Q1/R4); any additional MOSFET/gate-resistor circuits are identical. It is recommended that one MOSFET be used for every 4 amps of load current to be drawn; for maximum efficiency, all four MOSFET's can be installed.

Parts-placement diagrams for the main (Fig. 2A) and driver (Fig. 2B) boards are shown in Figs. 3 and 4,

respectively. Referring to the main board, R1 can be a board-mounted trimmer potentiometer or a panel-mounted unit. If R1 is to be a panel-mounted unit, solder three wires to the appropriate PC pads of the main board. When assembling either board, be sure that the IC's and all other polarized components are properly oriented.

Begin assembly by installing the passive components (resistors, capacitors, and jumper connections)

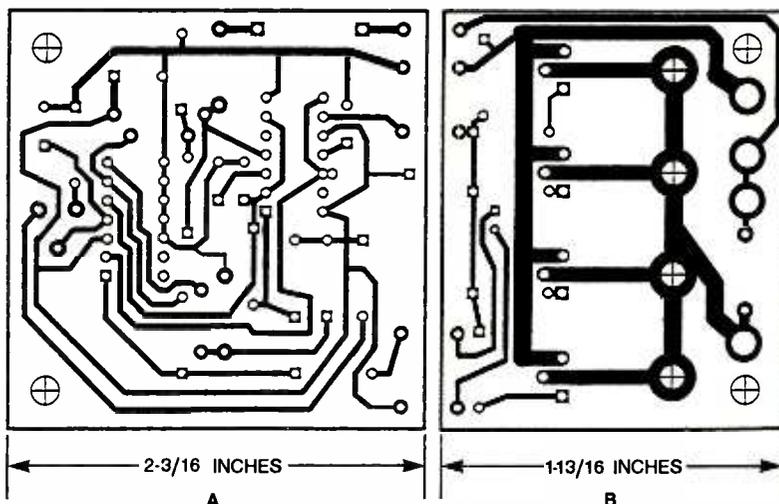


Fig. 2. The author's prototype was built on a pair of small printed-circuit boards, referred to as the "main" and "driver" boards. Templates for both boards are here, with the main board appearing in A, and the driver board appearing in B.

## PARTS LIST FOR THE LOW-VOLTAGE POWER CONTROLLER

### SEMICONDUCTORS

U1—LM556 dual oscillator/timer, integrated circuit  
 U2—LM339 quad comparator, integrated circuit  
 Q1—IRFZ40, IRFZ42, or similar power MOSFET  
 D1, D3—1N4936, Schottky diode  
 D2—5.1-1N751 volt, 250-mW, Zener diode  
 LED1—Red light-emitting diode

### RESISTORS

(All fixed resistors are 1/4-watt, 1% metal-film units, unless otherwise noted.)

R1—100,000-ohm, 1/2-watt, carbon, linear potentiometer  
 R2, R7, R13—10,000-ohm  
 R3, R6—1000-ohm  
 R4—10 ohm  
 R5—2000-ohm  
 R8—33,000-ohm  
 R9—200,000-ohm  
 R10, R11—75,000-ohm  
 R12—9530-ohm

### CAPACITORS

C1—10- $\mu$ F, 25-WVDC, electrolytic  
 C2—0.1- $\mu$ F, ceramic-disc  
 C3, C4—0.01- $\mu$ F, integrated circuit

### ADDITIONAL PARTS AND MATERIALS

Printed-circuit materials, enclosure, spacers, silicone tape, silicone grease, input and output connectors (see text), wire, solder, hardware, etc.

**Note:** The following parts are available from TW Engineering, P.O. Box 2995, Garden Grove, CA 92642-2995; Tel./FAX: 714-533-2908. A set of etched printed-circuit boards only, for \$10.00; a complete kit of parts for the printed-circuit board for \$30.00. Please add \$3.00 for shipping and handling. California residents please add appropriate sales tax.

first, followed by the semiconductors—diodes, LED, IC's, and finally, the MOSFET(s). The MOSFET's should be outfitted with heat sinks if the circuit is to handle more than 50 watts of power. Note: In the author's prototype, the MOSFET's were installed on the solder side of the board.

In the author's prototype, the enclosure lid is used as a heat sink. That

(Continued on page 91)

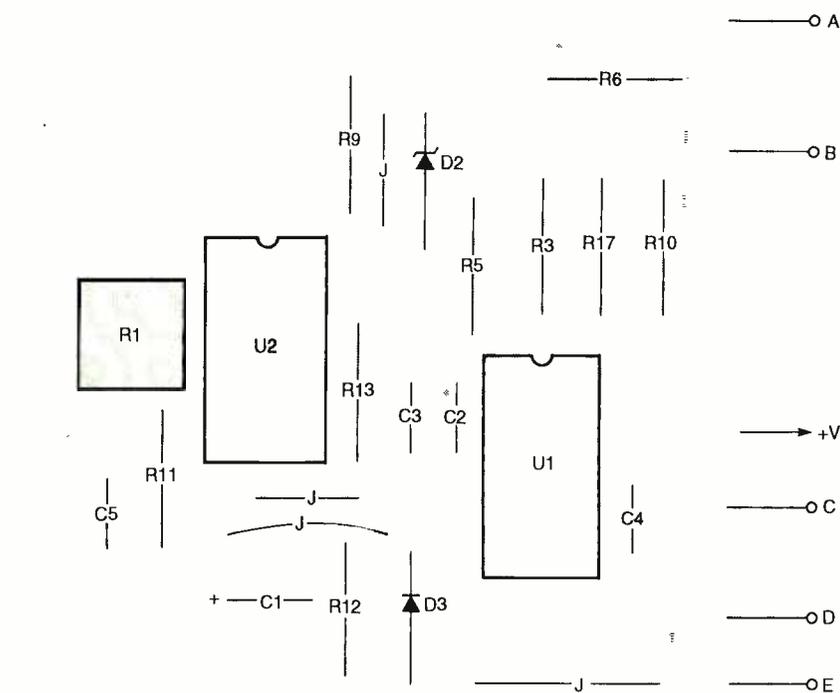
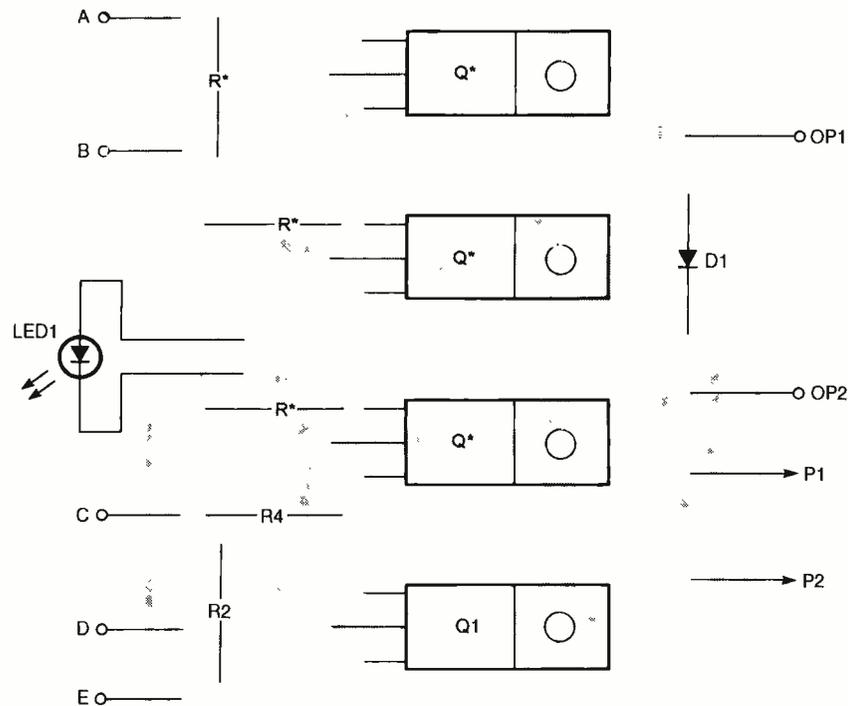


Fig. 3. Potentiometer R1 can be a board-mounted trimmer potentiometer or a panel-mounted unit. If R1 is to be a panel-mounted unit, solder three wires to the appropriate PC pads of the main board and connect their other ends to R1. You'll also need to attach five wires to the appropriate points on the main printed-circuit board to make the inter-board connections.



\*SEE TEXT

Fig. 4. The driver board (as shown here) is designed to accommodate up to four parallel-connected MOSFET's, along with their associated gate resistors.



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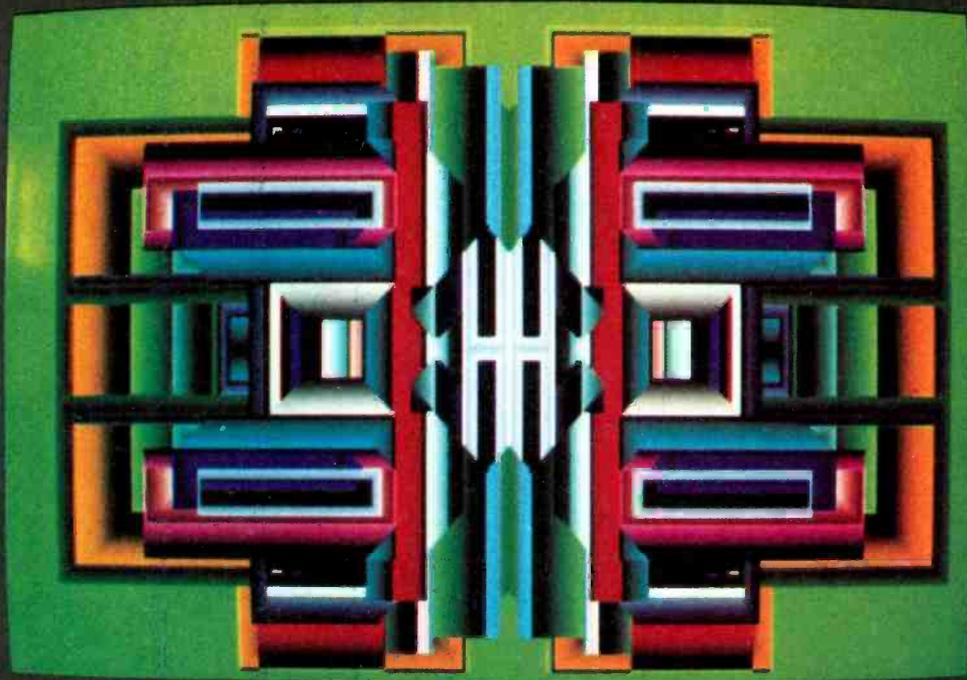
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# Screen Shots and Project Photography Made Easy

*We present two simple but effective and inexpensive techniques for producing excellent photos of your projects and program screens.*

BY FRED BLECHMAN

If you'd like to take good color pictures of your computer screens and electronic projects without expensive equipment, without elaborate lighting setups, and without fancy calculations—especially if you know little or nothing about photography—then this article is for you.

Why take pictures of your computer screens or electronic projects? Certainly, if you intend to show others your software displays or handiwork, "a picture is worth a thousand words"—especially a color picture. The photos can be used for lectures, club meetings, club publications, magazine articles, books, technical papers, illustrations for documentation or manuals, or just for the gratification of making a permanent record of your latest successful program or project.

I make no claim to being a camera expert, but I've had good success using the techniques I'll describe. I've taken over 3000 photos for illustrating hundreds of magazine articles, based on lots of trial (and error!). My methods are relatively simple, inexpensive, and effective. Photo experts may shriek in horror at my rule-of-thumb approach, but it works!

**Non-Technical Photo Primer.** Before loading your camera, you should know a few basic facts. To get a good picture, you need the proper film exposure, which is the result of the combination of film speed, lens opening, shutter speed, and focus. You may also need a special filter for color correction when using artificial light. While developing and printing

techniques can correct for some errors, the closer you are to the proper exposure in the first place, the more likely you'll have a good picture.

Color film speed these days is commonly rated at speeds of ISO/ASA 100, 200 and 400, among other speeds. This article will assume the use of an ISO 100 speed color film.

Lens openings (commonly called *f*-stops) are typically marked on an adjustable ring around the camera lens, from the largest opening (around *f*1.4) to the smallest (around *f*22). The light gathering ability of the lens doubles with each "full" *f*-stop; 1.4, 2, 2.8, 4, 5.6, 8, 11, 16, and 22 are each "full stops." In other words, to double the light, open the lens one more *f*-stop. Many lens-opening adjustment rings have 1/2 stops between full stops. For our pur-

poses, we'll only be using  $f11$  and  $f16$  lens openings.

Shutter speeds are adjustable over a broad range—usually from  $\frac{1}{1000}$ -second to 1- or 2-seconds. Doubling the exposure time doubles the light captured by the lens. Your camera must also have a "B" setting for time exposures if you intend to take photos other than computer screens. We'll be using one-second exposures for screen shots, and exposures running to 50 seconds or more for tabletop project photos.

Proper focus depends on two things—the center of focus and the depth of field. The center of focus is the focus at the center of the picture. The depth of field is the range (closer and further) within the picture field that remains in focus, and is related to the lens opening. The smaller the lens opening, the greater the depth-of-field range.

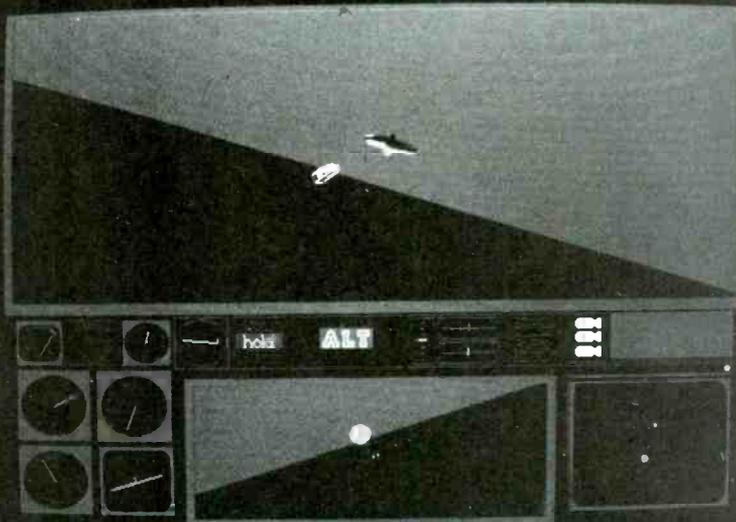
**The Camera.** Your camera doesn't have to be exotic, but it should have a few features found on most cameras above the the simple fixed-focus snapshot variety.

For one thing, anything less than a 35mm (millimeter) single-lens-reflex (SLR) camera will yield poor results most of the time. With an SLR camera, your viewfinder is literally through the camera lens, so you can center the screen or project, make sure the corners are not cut off, and make sure it's in proper focus.

You must be able to adjust the focus and exposure settings manually. An automatic camera is not suitable unless it can be operated manually. The camera must have a tripod socket and a cable release socket to trigger the shutter. A "bulb" or "time" exposure setting must be provided.

"Wow," you may respond, "that sounds expensive!" Well, if you check with camera stores and camera exchanges (look in the yellow pages of your phone book), you'll find that these non-automatic SLR cameras, which originally sold for hundreds of dollars, are now available for about \$125, and less if found through classified newspaper ads from private parties.

Remember, you are looking for a pretty "plain-vanilla" SLR camera. Make sure the shutter works, and that you can set the exposure to as



Here a Corncob-3D missile heads toward flying saucer. The lower part of screen shows the rear view and radar display.



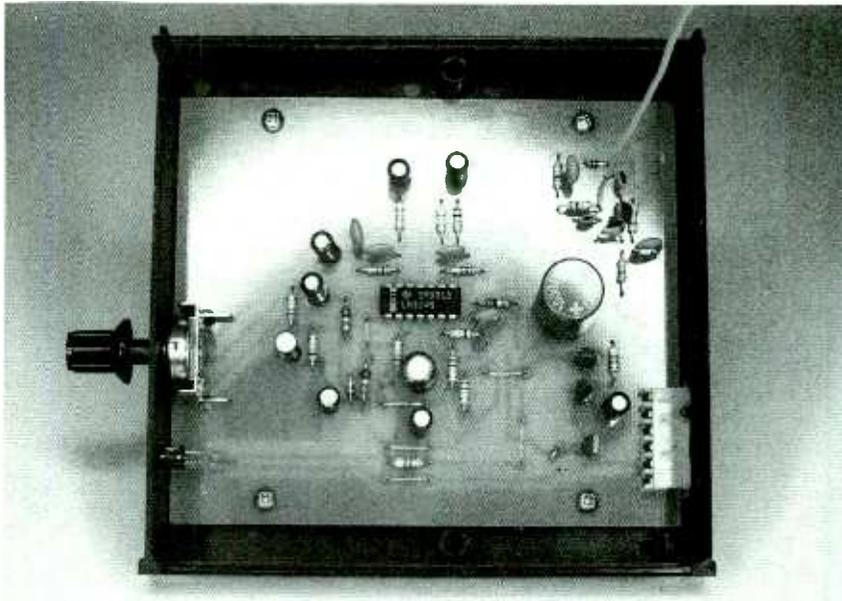
Here's a Ramsey Electronics Motion Detector assembled into the bottom of its optional case. Note the lack of lighting reflections and the good focus through out.

long as 1 second, plus you'll need a "B" setting for longer time exposures. The lens should close down to at least  $f16$ ; some will go to  $f22$ .

What else will you need? You must have a tripod to hold the camera steady, and a manual cable release to hold the shutter open during long time exposures. Your light source (more on this later) can be a standard 60-watt incandescent light bulb screwed into a lamp socket with a line cord and switch. An inexpensive retractable steel rule or yardstick, a

white 28- x 44-inch art board (which you can purchase from an art-supply or stationary store for about \$3), and a pencil and paper complete your equipment list. If you intend to take photos closer than about a foot, you might need some closeup lenses, but this is only necessary if you'll be photographing small parts or closeups of parts in equipment.

**Film, Lighting and Lens Opening.** What film should you use? There are all kinds, but you are best off to settle



This is what happens if you're not careful about reflections. The 60-watt light bulb reflected from the circuit board as it painted out the shadows.

EXPOSURE RECORD									
ROLL#		FILM TYPE		SPEED		DATE			
CAMERA FILM #	ACTUAL NEGATIVE #	DESCRIPTION	f STOP	DISTANCE (INCHES)	EXPOSURE TIME (SEC)	EXTRA LENS?	LIGHTING	TIMER (Y/N)	REMARKS
1		SCREEN #1	11	22	1	—	—	Y	LUMEN-CTX MONTR
2		SCREEN#2	11	22	1	—	—	Y	" " "
3		CIRCUIT BRD	16	16	40	80A	60 W	N	SPEED CONTROL
4		CABINET-FNT	16	20	50	80A	60 W	N	" " "
5									

Fig. 1. Preparing an exposure record is the best way to ensure you'll get all your future shots just right. It'll keep you from having to frame every shot.

on one type and stick with it. Color films, especially, vary. I use Fujicolor Super HG 100 color print film for consistent results. If you change the type of film, or film speed, you'll never be quite sure of the results—until you see them.

What about lighting? To photograph a computer screen, use no outside lighting! In fact, any outside lighting will probably result in screen reflections, and will also allow the monitor bezel to show; you're only interested in the display screen itself.

For project tabletop lighting, use the 60-watt household light bulb in a

dark room, and take a l-o-n-g time exposure. The bulb is waved from side-to-side during the exposure to "paint out" the shadows. The result is usually a very well highlighted picture with lots of contrast and depth, and a pleasant gradual darkening of the background.

Photo purists will have a fit reading this, but—trust me—standard 60-watt bulbs are bright enough. If you used stronger lights you wouldn't have sufficient time to "paint" away the shadows, and the shorter exposure time would be more critical.

For project photos, always use the

smallest lens opening (f/16 or higher) to get the clearest pictures. The exposure time then depends on the lighting, light attenuation of any filter used, and the film speed. I've worked all that out for you.

You may wonder why earlier I mentioned the use of a pencil and paper. To assess your results, you need to keep a record of all the settings for each picture you take. I simply make a table (see Fig. 1) showing the f-setting, distance to object, exposure time, lighting used, etc., for each exposure. Jot down the information just before you take each picture, and later refer to this record to see which settings gave you the best pictures. It's worth experimenting with one roll of film this way, just so you'll know what to do for future pictures.

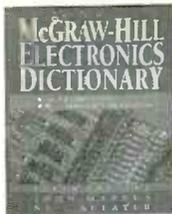
**Screen Session.** Taking pictures of your computer screen turns out to be extremely simple compared to tabletop project photos. First of all, get the picture you want on your screen, and "freeze" it. This is usually done with a "pause" command of some sort within the computer program, or by using a PAUSE key on the computer keyboard. In any case, you won't be able to get a good photo using my method unless you can freeze the screen for a few seconds. The screen colors and brightness should be the way you normally view them.

Set up the camera on the tripod so the front of the lens is centered about 22-inches from the screen. This should allow a typical 14-inch monitor screen to be well within the camera viewfinder. If you use the Fuji film I've suggested, you will not need any filter for the camera.

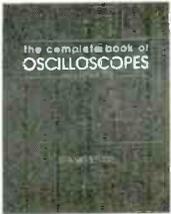
Write in the settings you'll use on your exposure record. Set the camera shutter speed to 1 second and the lens opening to f11. Use a cable release so the camera does not shake when you trigger the shutter. Aim and focus using the viewfinder, press the cable release, and that's all there is to it! The simple parameters are: film speed 100; f11; one-second exposure at 22-inches; no filter.

Now, to play it safe (since your monitor might be brighter or dimmer than mine) take two more photos, varying the lens opening ½-stop either side of f11. This is known as "brack-

(Continued on page 89)



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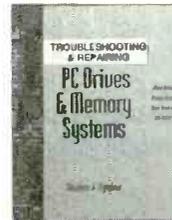
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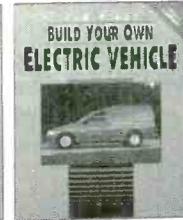
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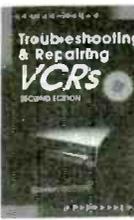
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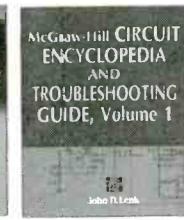
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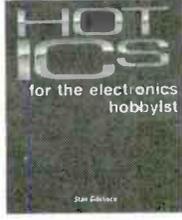
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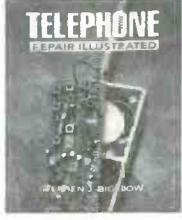
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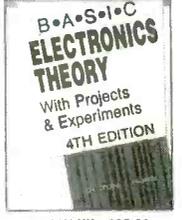
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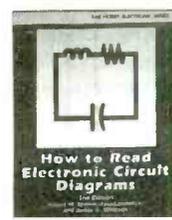
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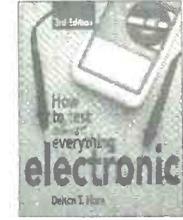
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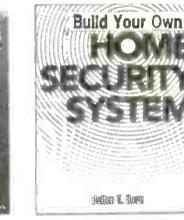
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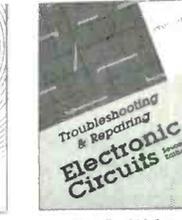
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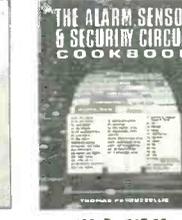
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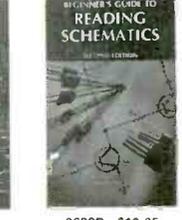
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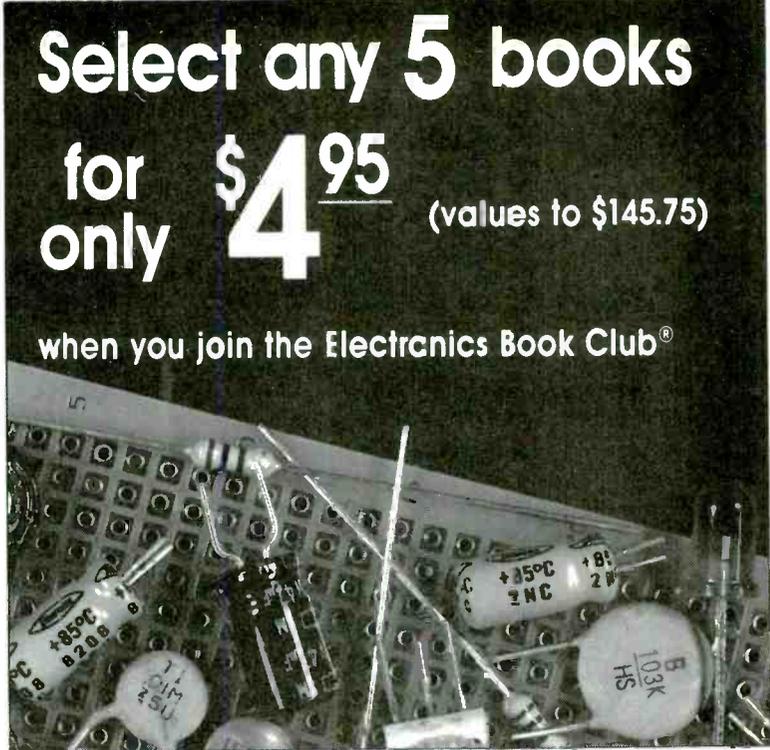
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# ANTIQUÉ RADIO

By Marc Ellis

## Firing Up the Tel-Ohmike TO-4

Last month, I introduced you to the *Sprague Tel-Ohmike TO-4* capacitor analyzer and resistance bridge, our current restoration project. We opened up the case, found no signs of tampering or charred parts, and checked the power transformer—which got a clean bill of health.

Among the minor problems that we discovered were a pushed-in viewing glass on the working-voltage/leakage-current meter,

roughly moistened Brillo pad.

### SOME FINAL FIXES

One of the first things I did at the beginning of this month's session was to replace the line cord. The old one was still intact and usable, but the plastic zip-cord wire felt stiff enough to crack if bent or stressed. And the bakelite plug didn't inspire confidence either. I expect this piece of test equipment to have a permanent home on my workbench, so I equipped it with a sturdy tubular line cord having a heavy molded-on plug.

I also installed the new pair of electrolytic filter capacitors that I ordered after last month's session. The originals were 12- $\mu\text{F}$ , 450-volt units installed in series (each paralleled by a 470K resistor to even out the voltage drop) to make a 900-volt capacitor capable of standing up to the high voltages (up to 600 or so) that could be delivered by the power supply.

If I'd been able to find an easy way to get hold of 600-volt or better electrolytics, I would have replaced the two original 12- $\mu\text{F}$  capacitors, and their series resistors, with a single capacitor rated at 6  $\mu\text{F}$  (the value of two 12- $\mu\text{F}$  capacitors wired in series), or more. However, the only electrolytics I could get my hands on quickly were 450-volt units. So I replaced the two original 12- $\mu\text{F}$  capacitors with a pair of the closest standard size (22  $\mu\text{F}$ )—keeping the same wiring scheme that had been used before.

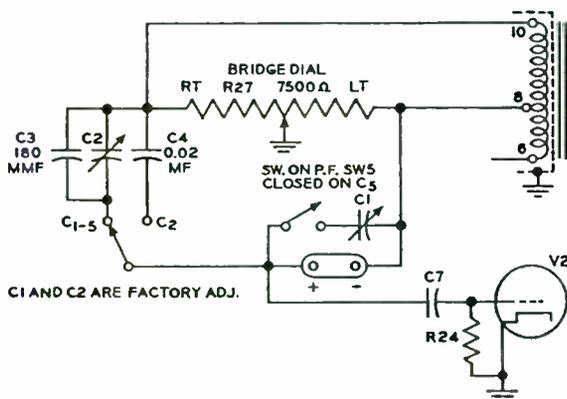
The original electrolytics were equipped with circumferential mounting straps that had been securely riveted to the chassis. Rather than drill out the rivets, which would scatter metal filings under the chassis and create vibrations that might disturb sensitive adjustments, I simply clipped the leads from those capacitors and abandoned the units in place. The replacements, which were much smaller and lighter than the originals, were self-supporting and did not require a special mounting arrangement.

Finally I checked the new 1619, found that it performed very well on my tube tester, and installed it. The TO-4 was ready to try out.

### A BIT OF BASIC THEORY

Before we apply power, though, you should know a bit about the TO-4's theory of operation when in its capacitance-measuring mode. I've included a simplified partial schematic showing the unit as configured for the three lowest capacitance ranges. The switches are positioned for operation on the middle one of those ranges (0.0001–0.005  $\mu\text{F}$ ).

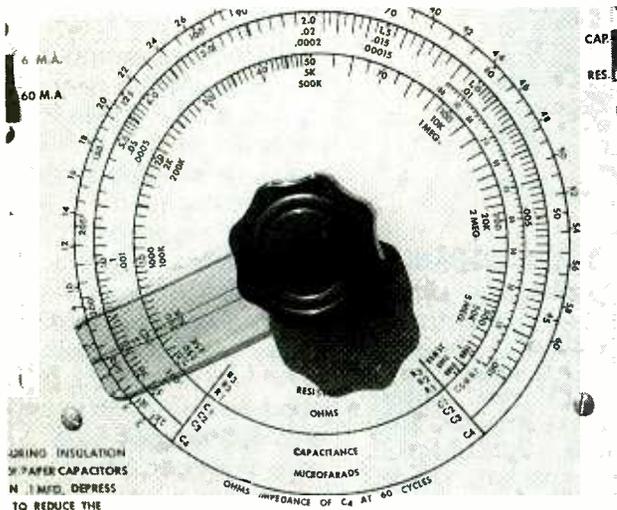
The circuit is a simple AC bridge designed around 7500-ohm precision linear potentiometer, R27, which is the control behind the large indicator knob at the center of the TO-4's front panel. The bridge is connected to an AC source (the power transformer), and the current divides be-



This simplified schematic shows how the TO-4 is configured for capacitance measurements on the three lowest scales.

some very stiff slide switches, and a 1619 tube (used as a grid-controlled rectifier) that tested very poor. The glass was easily re-mounted in proper position, a new tube was ordered, and all switches and controls were given a going-over with Radio Shack contact cleaner/lubricant.

At the end of the session, all knobs and buttons were removed from the front panel so that they—and the panel—could receive a soap-and-water cleaning. The crackle finish of the metal cabinet was also freed of grease and grime, with the help of a thor-



Here's a good look at the instrument's indicator dial. The multipurpose scale can be a bit confusing. Graduations have different values in different places, and must be interpreted with care.

tween the reference capacitor (in this case, C3—which is paralleled by factory-adjusted trimmer C2) and the capacitor under test (which is connected across the terminals labeled "+" and "-").

To find the value of the capacitor under test, R27 is rotated to make the currents through the test and reference capacitors equal. As that begins to occur, the shadows on the screen of magic eye tube V2—which is connected to show the difference between the two currents—begin to separate. At maximum separation, the bridge is balanced and the currents are equal.

If the test capacitor is equal in value to the reference capacitor (in this case, 200 pF), the indicator knob rests exactly in the center of the dial scale, which is marked to read that value of capacitance.

If the test capacitor is larger or smaller than the reference capacitor, the indicator knob will have to be moved in one direction or the other from center to make the bridge balance and obtain maximum separation of the tuning-eye

shadows. The amount of movement is proportional to the size of the capacitor, which is indicated by the scale calibration resting directly under the knob's cursor.

#### TRYING OUT THE TO-4

To test the TO-4's capacitance ranges, I dug out my Heathkit DC-1 "decade condenser." (Yes, this unit is old enough to be called a condenser rather than a capacitor.) The DC-1 provides 30 reference capacitances, each separated by a factor of ten, ranging in value from 100 pF to 0.1  $\mu$ F. Those capacitances have 1% tolerance ratings, making the unit ideal for checking dial calibration.

The first thing I wanted to do was to align the main indicator knob correctly. I had removed it for cleaning, reinstalling it only in the approximately correct position. For a reference point, I decided to use 0.02  $\mu$ F, the value of the internal reference capacitance for the middle capacitance scale of the five offered by the TO-4. That meant I'd be aligning the knob at the exact center of the scale

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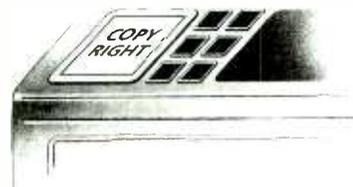


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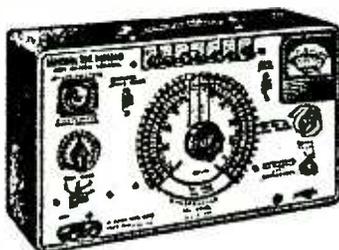
setting, where the bridge is most accurate.

Setting the decade condenser for 0.02  $\mu\text{F}$ , I connected it across the test terminals of the TO-4. With the capacitance checker still out of its case so that I could watch for smoke or detect any other signs of component failure, I flipped on the power switch. Waiting and watching for several seconds, I saw no signs of incipient disaster.

Next, I went about setting the dials for a 0.02- $\mu\text{F}$  capacitance check as directed by the instruction manual. I was gratified to see the tuning-eye tube glow bright green as I punched the button to select the correct measuring range. Moving the indicator knob through its travel, I found that there was indeed a clearly defined spot where the tuning eye opened widest.

Loosening the indicator knob's set screw, I slid it off, then rocked the exposed shaft slightly by hand to be sure that it was still set for maximum opening of the "eye." Finally, I carefully replaced the knob on the shaft, positioned it so that the cursor was directly over the ".02" marker, and tightened the set screw again. Rocking the control once more to check for maximum opening, I found that the knob position was slightly off. But, repeating the procedure, I finally got it right.

Now I was ready to check each of the 30 capacitance values that could be provided by the DC-1 "decade condenser," writing down the reading obtained from each one. Those values were spread out over two of the TO-4's middle measurement ranges, spanning 0.0001–0.5  $\mu\text{F}$ . The lowest range (1–100 pF) and highest two (spanning 0.1 to



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*This description of the TO-4 appeared in the 1958 Newark catalog. Note that the percentage accuracy of the instrument is pointedly not mentioned.*

2000  $\mu\text{F}$ ) would have to be checked using different standards.

After obtaining each of the 30 readings, I calculated the percentage difference of each one from the indicated value of the DC-1. Most differences were under 5% and most of the remaining ones were under 10%. That performance level wouldn't be satisfactory in a laboratory standard, but I felt it would be quite adequate for most radio repair/restoration work.

The differences observed could be due to aging of the reference capacitors in the Sprague instrument, or even in the decade capacitance unit. As a matter of fact, I've been unable to determine what measurement accuracy should be expected of the TO-4. I couldn't find the information either in the instruction book or among the specifications listed for the unit in a 1950's Newark catalogue. So I suppose that the accuracy of the instrument, while suited to its purpose,

was nothing to brag about even when new.

#### CHECKING OTHER RANGES

I don't have any capacitors on hand, precision or otherwise, for checking the TO-4's lowest range. The values in that bracket are not too common in radio work. Radio Shack does offer a "picofarad assortment" of capacitors (containing values from 1–33 pF) using a Cornell-Dubilier decade capacitance box providing values from 1–10  $\mu\text{F}$ . That instrument has a rated accuracy of 3% and came with a calibration sticker giving the actual value of each capacitance to two decimal places. The C-D box was a flea-market item, and I have no idea of its history, age, or current condition. However, I noted that every one of its capacitances measured about 1  $\mu\text{F}$  low on the TO-4.

Because of the consistency of the error, I theorize that the problem stems from drifting of the reference capacitor for that

range. As a matter of fact, while the reference capacitors for the other ranges are molded paper and silver-mica units, the ones for that range are wax-covered paper—the kind you'd replace on sight when doing a thorough restoration of an old receiver.

Two matched 1- $\mu\text{F}$  units are connected in parallel to form the necessary 2- $\mu\text{F}$  capacitance, and either or both of those could easily have developed leakage, or changed in value, over the years. We'll attempt to deal with that problem next time.

As far as the highest scale (45–2000  $\mu\text{F}$ ) is concerned, I checked that with a number of different high-capacitance electrolytics and found that the indicated values were close enough to be satisfactory.

#### RESISTANCE CHECKS

Resistance is measured on the TO-4's bridge circuit in a manner similar to capacitance. Just read the explanation already given for the theory of capacitance measurements, substituting reference resistors for reference capacitors, and you'll get the picture.

I tested the various resistance ranges of the TO-4 using a selection of junk-box resistors pre-measured on a good VOM. While the indicated results were all ways somewhere near the correct value, accuracy was way off. That could only be due to aging of the reference resistors, and I don't think it's worth trying to correct. Resistance measurements can be made much faster with a VOM.

See you next month, when we'll finish working on the TO-4's capacitance ranges and try some of the other functions of the instrument. ■

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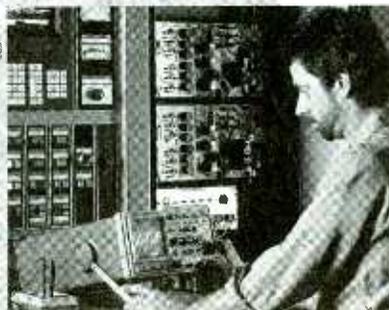
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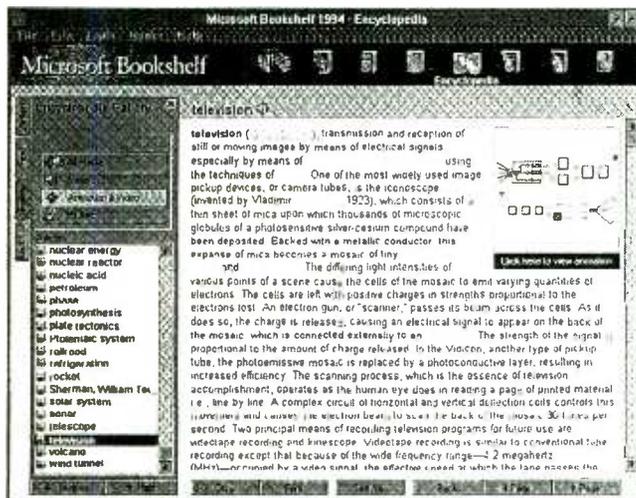
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# COMPUTER BITS

By Jeff Holtzman

## Just for Kids—Not!

The PC industry as a whole is growing up. In some ways that is good; it often means lower prices for consumers. In other ways it is bad, because innovation is often the first victim as the big corporations start swallowing up everything in sight. One area that so far is immune from that syndrome is software aimed strictly at the home market. That category includes games, educational works, and “friendly” versions of standard applications such as word processors.



*Bookshelf '94 contains seven reference works in a spiffy new interface. Full-text searching with Boolean logic helps you find what you need fast.*

For example, I've been looking at several products from Microsoft's "Home" line for the past couple of months, including *Bookshelf '94*, *Creative Writer*, and *Fine Artist*. *Bookshelf '94* is a multi-volume reference work; the other two are a word processor and a bit-mapped graphics editor aimed at kids 8 and older.

### BOOKSHELF

Bookshelf was one of the

earliest CD-ROM-based reference products. Microsoft updates the product more or less annually; the much-improved current version is light years ahead of version 1.0, which came out around 1986. *Bookshelf '94* includes a thesaurus, a dictionary, an almanac, a world atlas, an encyclopedia, a book of quotations, and what it calls a chronology (paragraph summaries of historical events in list form by date).

There are two ways to judge a computer-based reference work: content and user interface. *Bookshelf '94* contains lots of useful information for high-schoolers and undergraduates. But beyond those levels, *Bookshelf '94* begins to look thin. On the other hand, the same criticism applies to most current CD-based products. On balance, in comparison with its peers, I would rate *Bookshelf '94* as an "A," and in absolute terms, I would rate it a "B."

It's interesting to see how the user interface (UI) of *Bookshelf* has evolved over the years. Although it is still very much a Windows 3.x product, you can see a strong ease-of-use push that differentiates the product from common Windows UI conventions. In particular, there is a movement away from having to single-click to select and double-click to activate. Merely moving the mouse pointer over an object highlights it, and a single-click activates it.

For example, the left side of the screen contains a list of articles. By merely moving your mouse pointer over the list, a highlight bar appears; by single-clicking

an article title, the corresponding article appears on the right side of the screen. And as you cursor over the list, the entire text of any title that has been truncated appears, extending beyond the limit of the listbox if necessary. On the other hand, other than selecting among one of the seven included works (or all simultaneously), the product shows no structure. There is no topical breakdown of articles; choices always appear as long alphabetical lists.

I'd love to see that type of product come standard with three UI's: beginning, intermediate, and advanced. Even better, I'd like to see it marketed in a standard database format (or at least a detail-hiding ODBC interface), rather than the proprietary ones currently in vogue, so that advanced users and third-party integrators could build custom front ends using Visual-Basic like-tools and SQL (structured query language) query strings. (ODBC is Microsoft's universal interface to SQL databases.) How about it, guys?

### KIDWARE

*Fine Artist* and *Creative Writer* are aimed at a younger age group, and they apply some interesting twists to the relationship between power and ease of use. In the traditional way of thinking, there is a direct but inverse relationship between power and ease of use. Increase power, and ease of use goes down. Conversely, to increase ease of use, decrease power.

With these new products, Microsoft has not tried to alter that fundamental relationship; rather, its approach has been to push fairly aggressively in the direction of power, and try to obtain ease of use by two strategies: Masquerading traditional interface elements under a graphics-intensive guise, and providing an always-at-hand tutorial function to help with any rough spots.

Creative Writer is chock full of all kinds of fun projects—you can think of it as *Print Shop* on steroids. Primarily you use Creative Writer to build greeting cards, newspapers, and banners. All of the modules depend on common tools for doing things like creating fancy text effects, creating and placing graphics, and defining column and border formats. All contain ongoing step-by-step how-to information presented by a rather silly-looking character called McZee.

Many of those features would appeal as much to adults as to kids—except that the way the product is packaged, few adults would be caught dead using it. Nonetheless, you can do things in Creative Writer that could very well be difficult if not impossible to do in your regular word processor or even a fancy desktop-publishing program.

The results are mixed. My nine-year-old, no stranger to children's software, couldn't figure out how to get started with it. Then it took lots of coaching before he felt comfortable enough to start exploring on his own. By contrast, after very brief introductions to "grown-up" Windows programs like *Microsoft Word*, *Visio*, and *Encarta* (another Microsoft CD-

ROM, this time an encyclopedia), he felt insulted when I tried to help him. It's ironic that a kid feels more comfortable with software intended for grown-ups than kidware.

Despite those criticisms, I would still recommend all of the above programs. They're not perfect, but neither is any other similar software package that is currently available. In a few years, they'll probably look as dated as *Bookshelf 1.0* does now. But in the meantime, they can be useful and fun. And, after all, that's what it's all about. ■

#### Vendor Information

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# CIRCUIT CIRCUS

By Charles D. Rakes

## Ultrasonic Circuits

This month's visit will cover a number of circuits dealing with the fascinating world of ultrasonic sound. Look around and you will see a number of electronic devices operating in the ultrasonic-frequency range. Among them are range finders, remote-control equipment, motion detectors, fish locators, insect repellers, plastic welders, ultrasonic cleaners, and more. The majority of those devices operate over a frequency range of about 19–100 kHz, and sometimes even higher.

One note before we continue: Most commercial ultrasonic devices operate

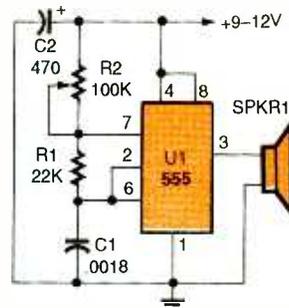


Fig. 1. This basic ultrasonic generator can be built easily and quickly.

at a fixed frequency and use transducers that are designed to peak, or resonate, at that frequency. The limited bandwidth and expense of most of those transducers make them unsuitable for hobby use. But that's not a problem, because just about any piezo speaker can be used as an ultrasonic transducer for both transmitting and receiving ultrasonic signals. While piezo speakers may not match the perfor-

mance of a dedicated, commercial transducer, for our purposes they will do just fine. The unit the author used with the circuits that follow was a 3¼-inch piezo tweeter that was obtained from Radio Shack.

### BASIC ULTRASONIC GENERATOR

Our first circuit, see Fig. 1, is an ultrasonic generator that places the popular 555 IC timer in a variable-frequency astable-multivibrator circuit. The circuit outputs a squarewave that, using R2, can be tuned from about 12 kHz to over 50kHz.

The oscillator's frequency range can be varied by changing the value of C1; using a smaller value will increase the range, while using a larger value will decrease it.

a variable-frequency astable-oscillator circuit with a 50/50 duty-cycle, square-wave output. The remaining four buffers are paralleled to boost the output for the piezo speaker.

The improved ultrasonic generator's frequency range is about the same as that of the previous one. Its main advantage is that it produces a 50% duty cycle over the entire frequency range. Again, the frequency range may be increased by decreasing the value of C1, and lowered by increasing its value. The 100k potentiometer, R3, sets the output frequency.

### PLL ULTRASONIC GENERATOR

A 567 phase-locked-loop (PLL) IC produces the ultrasonic signal in our next generator circuit; see Fig. 3.

### PARTS LIST FOR THE BASIC ULTRASONIC GENERATOR (Fig. 1)

#### RESISTORS

(All fixed resistors are ¼-watt, 5% units.)

R1—22,000-ohm

R2—100,000-ohm, potentiometer

#### CAPACITORS

C1—0.0018-µF, Mylar

C2—470-µF, 16-WVDC, electrolytic

#### ADDITIONAL PARTS AND MATERIALS

U1—555 timer, integrated circuit

SPKR1—Piezo tweeter, see text

Power source, wire, hardware, etc.

### IMPROVED ULTRASONIC GENERATOR

Our next ultrasonic generator, shown in Fig. 2, uses all six buffers of a single 4049 CMOS inverting-buffer IC. Two of the buffers, U1-a and U1-b, are connected in

That generator circuit offers several advantages over the other two circuits. For one, the 567's internal oscillator is designed to operate over a very wide frequency range, from less than 1 Hz to over 500 kHz. The oscillator's output wave-



## PARTS LIST FOR THE ULTRASONIC RECEIVER (Fig. 4)

### SEMICONDUCTORS

U1—567 phase-locked loop, integrated circuit  
 Q1—2N3904 NPN transistor  
 LED1—Light emitting diode, any color

### RESISTORS

(All fixed resistors are 1/4-watt, 5% units.)  
 R1, R2—1,000-ohm  
 R3—2,200-ohm  
 R4—220,000-ohm  
 R5—50,000-ohm, potentiometer

### CAPACITORS

C1, C2—0.1- $\mu$ F, ceramic-disc  
 C3—0.001- $\mu$ F, Mylar  
 C4—0.05- $\mu$ F, Mylar  
 C5—470- $\mu$ F, 16-WVDC, electrolytic

### ADDITIONAL PARTS AND MATERIALS

SPKR1—Piezo tweeter, see text  
 Power source, wire, hardware, etc.

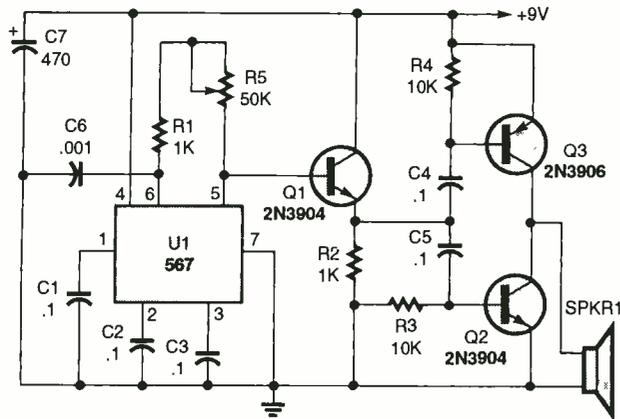


Fig. 4. This tunable ultrasonic receiver is ideal for use with the ultrasonic transmitter. It, too, is built around a 567 PLL.

follower circuit to isolate the 567's output and to drive the output-amplifier circuit that is built around transistors Q2 and Q3.

The circuit can be converted into an ultrasonic cw transmitter by routing the IC's ground circuit, at pin 7, through a normally open telegraph key. If you choose to do that, you will need some type of receiver to listen to your signal; that is the function of our next circuit.

## AN ULTRASONIC RECEIVER

A tunable ultrasonic receiver circuit using a 567 PLL IC is shown in Fig. 4. The IC's tunable oscillator circuit is the same as in the previous generator circuit, and covers the same frequency range. An LED is placed at the IC's detector output (pin 8) as a received-signal indicator. Transistor Q1 amplifies the ultrasonic signals picked up by the piezo speaker and passes them

on to the PLL. To check out our ultrasonic system, power up the generator circuit and aim the speaker across the room. Starting with the lowest setting, adjust R5 slowly until you can no longer hear anything coming from the speaker. That should set the circuit's output frequency somewhere between 16 and 20

kHz, depending on your high-frequency hearing ability.

Power up the receiver circuit and place its speaker about a foot from the generator's speaker, but aim it in the same direction. Tune the receiver using R5, starting from the lowest frequency setting (the potentiometer's maximum resistance setting), and slowly increase the frequency until the receiver's LED lights.

If the receiver does not respond to the generator's signal, aim the receiver's speaker toward the generator's speaker and try again. Once the signal is received, separate the two speakers at least ten feet and re-tune. Once everything is working, use the transmitter's telegraph key and watch the LED on the receiver. It should flash the dot-and-dash pattern you send.

Another application for your ultrasonic generator/receiver combination is as a simple burglar alarm sensor. Connect a 5-volt relay between pin 8 of the receiver's 567 and the

(Continued on page 83)

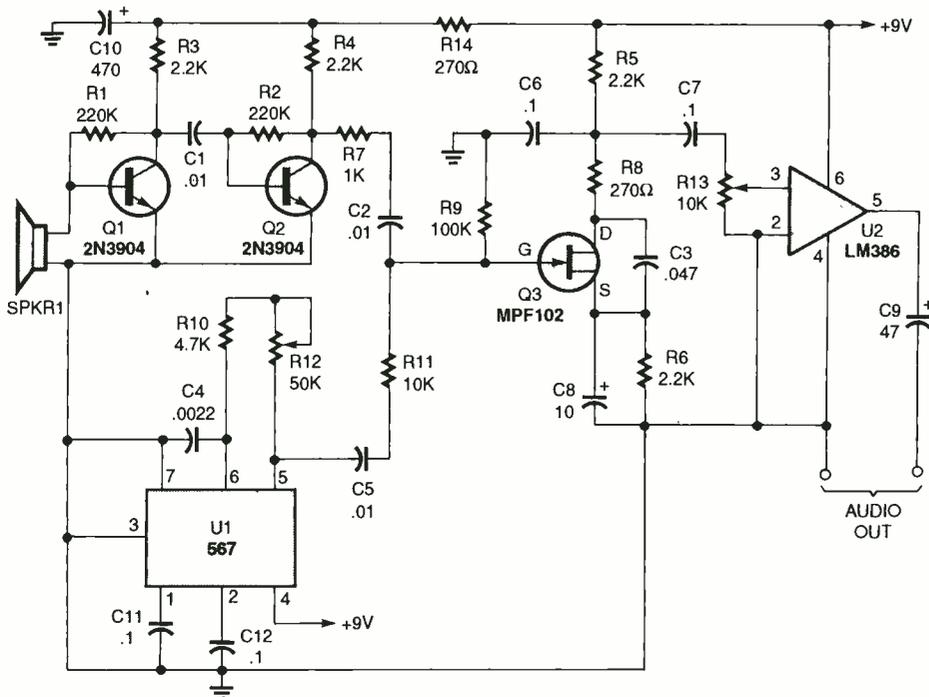
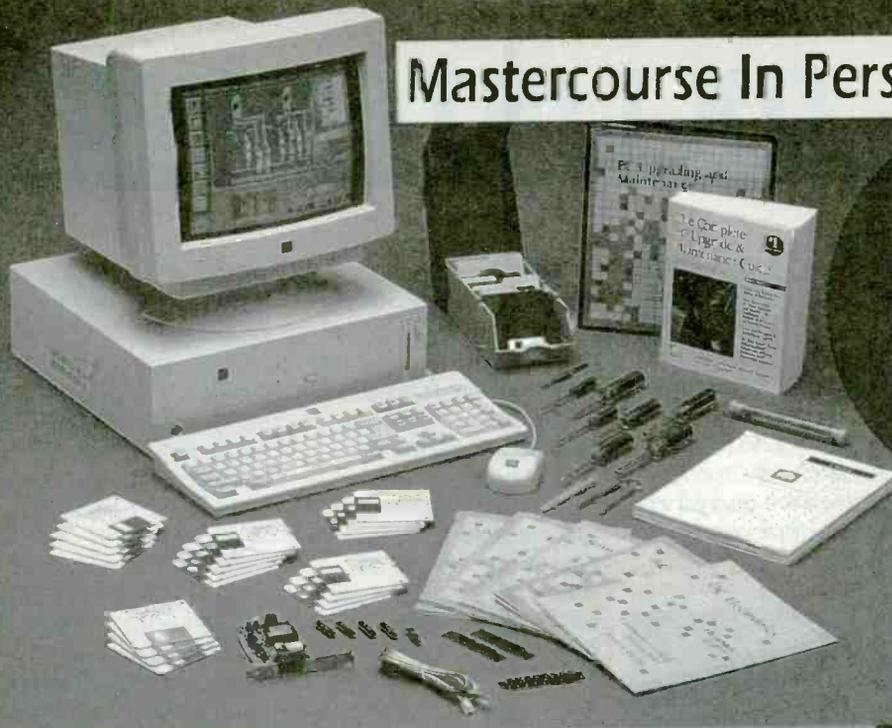


Fig. 5. You won't be disappointed with the performance of this sensitive ultrasonic receiver. It can let you listen to bugs, bats, engines, and virtually any other source of ultrasonic sounds.

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# DX LISTENING

By Don Jensen

## Shortwave Broadcasting in Singapore



Again this Christmas, Britain's Queen Elizabeth II will broadcast her annual message to the Commonwealth peoples on BBC shortwave. It's a tradition begun by her father, King George V in the 1930's. This photo shows a young monarch during one of her first Christmas broadcasts from Sandringham Castle more than 35 years ago.

The "caning" incident in Singapore gained that Asian island nation a good bit of attention earlier this year. People who previously had little knowledge of that small country, no larger than the city of Chicago, suddenly were discussing its hard-line approach to law and order.

The issue of corporal punishment aside, though, Singapore is in many ways progressive, modern, and economically successful.

Befitting its expanding importance in South Asia, Singapore—*Singapura* in the Malay language—not long ago also moved to the front ranks of shortwave broadcasting with new transmitting facilities.

In recent years, Singapore Broadcasting Corp. signals often could be heard fairly well on early winter mornings. Now, though, with powerful new SW transmitters, the SBC's overseas service, *Radio Singapore International*, is a rather easy catch in North America.

Singapore is strategically located at the tip of the Malaya Peninsula, astride the important seaway linking the Pacific and Indian Oceans. Bustling, crowded Singapore is the crossroads of the Orient.

Singapore is a business and banking center, and one of the world's busiest ports. Great Britain controlled the island from 1924 until the mid-1960's, when it first joined the Federation of Malaysia, then, in 1965, became independent.

Broadcasting began in the mid-1920's, during British rule, when an amateur station began operation on the medium-wave band. The first official radio was a shortwave broadcaster with the callsign ZHI, owned by the Radio Service Co. in Singapore. It began transmitting in 1935, but within a year was transferred to the British Malaya Broadcasting Corporation. In the pre-WWII years, that low-powered station on 6,012 kHz was considered a rather tough logging in North America.

With war clouds gather-

ing, the British Broadcasting Corp. made plans to begin broadcasting from Singapore, but the Japanese invasion ended that effort. Instead, the Japanese forces set up a modest transmitter and broadcast to Asia and the Pacific as *Shonan Radio*.

After WWII ended and, eventually, the station was handed back to local civilian authorities, the shortwave voice operated as *Radio Malaya Singapore*. Some facilities were shared with the BBC-controlled British Far East Broadcasting Service.

With independence in 1965, *Radio Singapura* was established. New studios and offices were completed in 1972. At the start of the 1990's, *Radio TV Singapura*, as it evolved, operated with four language services: English, Malaya, Chinese, and Tamil, a southern Indian language also used in polyglot Singapore.

SBC's foreign voice, *Radio Singapore International*, now uses powerful 250-kilowatt shortwave transmitters. For listeners in the U.S. and Canada, listen for its English broadcasts on 9,530 kHz from 1100 to 1400 UTC. It can also be heard in Chinese from 1100 to 1300 UTC on 9,590 kHz., and 2300 to 2400 UTC on 9,550 kHz.

Reception reports, with return postage in the form of International Reply Coupons (available at your post office) should be answered with a QSL card from the station. The address is Radio Singapore International, Singapore Broadcasting Corp., Farrer Road, PO Box 60, Singapore 9128.

## IN THE MAILBOX

"What happened to *Duetsche Welle's* shortwave relay station in Rwanda during the terrible civil war in that east African county?" writes Fred Marshall, Santa Fe, NM.

The German shortwave service has had a run of bad luck with its overseas SW relay operations. A few years back, *Duetsche Welle's* transmitting facility in Sri Lanka was caught in the middle of civil strife in that south Asian country. And now, the same has happened in Rwanda.

At this writing, the tragic events in Rwanda are continuing. I have not heard yet how the *Duetsche Welle* relay station near Kigali, the capital, has fared. It was one of the best-equipped facilities of its type in Africa.

It has been reported, however, that the German engineering staff was evacuated safely. Obviously, DW programming is not being aired by the Kigali station, which, as I write, is silent.

Deutsche Welle, according to a report from an Ontario DX Association member, Colin Miller, asked South Africa's *Channel Africa* to rebroadcast the programs formerly aired by the Kigali transmitter. As you read this, DW programming directed to Africa probably will be coming from South Africa, rather than Rwanda.

Here's a question from reader Margaret Lewin, New York City, who asks about the status of shortwave Clandestine broadcasting: "I haven't heard too many of these Clandestine stations," Margaret writes, "but they have

always interested me. The names of some of these secret stations have cropped up in news stories in the New York Times over the years. I haven't seen any clandestine station references lately. What's happened to Clandestine broadcasting?"

Clandestine radio stations come and go. Wherever there is trouble in the world, you can bet there will be some country or political group getting on the air to stir the pot!

For years, Clandestine broadcasting seemed to be focused on southeast Asia. Then it was Cuba and Latin America, and in recent years, the Middle East.

But, yes, while it is no doubt a temporary condition, Clandestine broadcasting activity is down. The best data I have is Mathias Kropf's *Clandestine Activity Survey*, which compares 1993 activity with the previous year's.

Kropf reported that overall Clandestine activity dropped 11.1 percent in 1993, to an average total of 1,883 hours weekly. That, he says, is the lowest level of Clandestine broadcasting since 1986.

Most affected was Africa, where Clandestine broadcasting decreased by about 30 percent from 1992. Broadcasting to Asia went down 9.2 percent.

The top three most-active Clandestine target areas, Kropf reported, were Cuba, Iraq, and Iran, with 388, 288, and 244 weekly broadcasting hours, respectively. With the independence of Eritrea from Ethiopia in Africa, Clandestine broadcasting to the latter plummeted from nearly 150 hours a week to zero. What were the new Clandestine radio targets in 1993? They were Turkey; Tajikistan, one

of the former Soviet republics; Somalia; and Egypt.

I'm looking forward to Kropf's Clandestine Activity Survey for 1994 to see if there have been any significant changes from that data during the past 12 months.

## DOWN THE DIAL

Here are some of the stations that are being reported on the shortwave frequencies recently:

**BRAZIL**—4,805 kHz. *Radiodifusora Amazonas* has been heard just before 0100 UTC with popular Brazilian songs, rock oldies, and jingle identifications in Portuguese.

**CANADA**—6,015 kHz. *Radio Austria International's* English "Report from Austria" is relayed by a Canadian transmitter at 0630 UTC until 0655 UTC sign off.

**GHANA**—4,915 kHz. *Ghana Broadcasting Corp.* operates on this frequency until 0100 UTC sign off with the national anthem, following news highlights and final announcements.

**PAPUA NEW GUINEA**—4,890 kHz. Back on this frequency is the *National Broadcasting Co. of Papua New Guinea*, noted at 1050 UTC with music and NBC news at 1100 UTC.

**SINGAPORE**—9,530 kHz. *Radio Singapore International* has been logged here in English at 1158 UTC, with country and western music, pop oldies, and a time announcement at 1200 UTC.

**SLOVAKIA**—5,930 kHz. *Slovak Radio* has its English transmission on this frequency at 0100 UTC with news, a business report, and a press review. ■

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# HAM RADIO

By Joseph J. Carr, K4IPV

## A Funny Little Antenna

The problems associated with designing and building limited-space antennas can be challenging, to say the least. But with the large number of hams living in apartments, condos, townhouses, row houses, or just small houses on cramped lots, I get a lot of requests for information on those types of antennas. Most of those folks don't have enough space to put

needs an antenna that the transmitter will load into without blowing the finals. So much for bits of wire strung around.

The only way a ham operator can use a random-length wire is to either provide a "good ground" (which is often impossible for the same reasons that keep a better antenna from being built in the first place), or a radial field similar to that of a vertical. Even a single radial can take up a lot of space.

One answer to the problem is to use transmitting loop antennas. Although there are a number of different designs, including a couple pioneered by the late Johnnie H. Thorne, K4NFU/5, most of them suffer from too many problems to take seriously. There is an exception to that, however.

### THE DDDR

One popular form of small transmitting loop antenna is the Directional Discontinuity Ring Radiator (DDRR) shown in Fig. 1. The DDDR antenna is a small-diameter ring mounted a few inches to a few feet off a ground plane made of sheet metal, metal-wire window screen, or even chicken wire. The radiator ring is made of copper tubing bent into a circular shape. For antennas designed for the upper end of the HF bands, you can use the soft-drawn pipe sold in do-it-yourself hardware stores and plumbing-supplies stores.

I particularly like the 0.5- to 2-inch soft-drawn copper tubing because it comes wrapped in a coil at

the store. Art Stokes, N8BN, of VLF-receiver and solar-monitoring fame, hit me with a "BFO" (blinding flash of the obvious) when he related how he built a VLF shielded loop. He used that same copper tubing for the shielding. Art told me that he had the clerk at the store very carefully cut the one-turn segment that he wanted without unwinding the coil, so that he wouldn't have to bend the material when he got it home.

If you have to bend it yourself, then good luck—it's a chore. However, there are some things that make it easier. For one thing, the circle need not be perfect. Since it is best that the antenna be built on a plywood backing anyway, you could scribe a circle of the right diameter onto the plywood with a piece of chalk and string. Place a small nail at the center of the circle, and then tie one end of the string to it. The string should be a bit longer than the radius of the desired circle. Tie the chalk to the end of the string, and then drag it around the nail, making a circle on the plywood surface. Next, place some 10-penny nails every couple of inches all the way around the circle. That array of nails becomes the form for bending the ring. Anchor the copper at one point on the circle (a long sheet metal screw through both the copper tube and the plywood will do well). Gently bend the copper tube in segments around the circle by pushing it against the nails.

You will note in Fig. 1 that the loop is not continuous; it

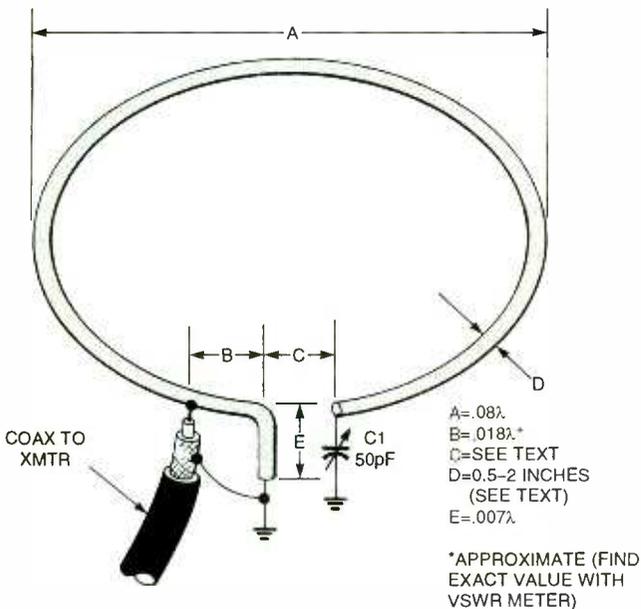


Fig. 1. The DDDR antenna can be an adequate performer when space considerations prevent building a larger antenna.

up a half-wavelength dipole. Even a vertical can be a challenge because the radial field needed to make the thing even the least bit efficient takes up considerable space. The radials must each be  $\frac{1}{4}$ -wavelength long, and that might mean 33 feet or so at 40 meters.

A receiver operator can get away with just a wet string and a prayer, but the ham operator is in a different pickle: The ham

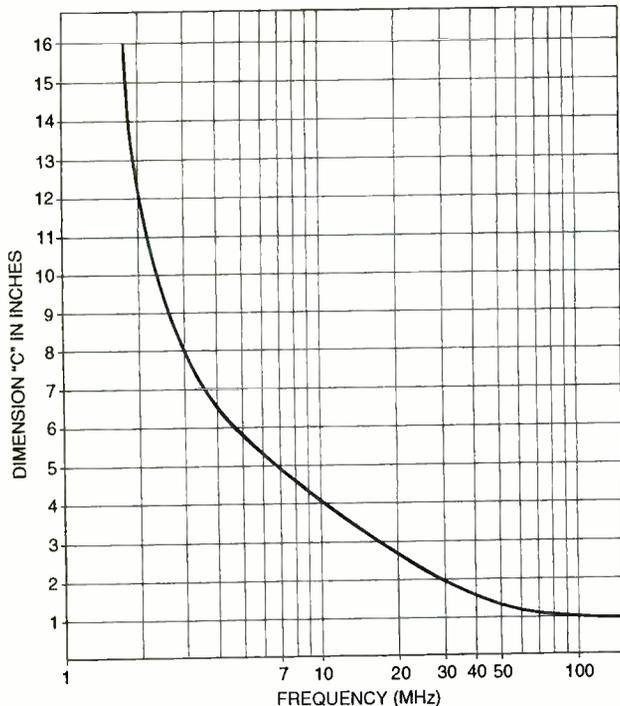


Fig. 2. The length of the air gap will depend on the operating frequency and can be found using this chart.

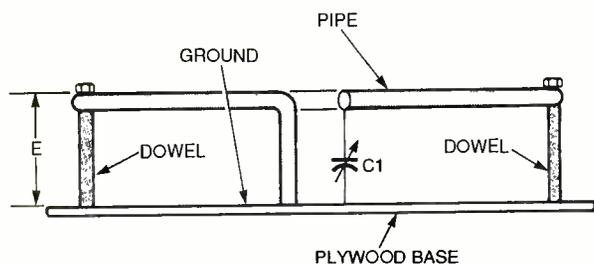


Fig. 3. Here's a side view of the DDDR. The ground plane can be made of sheet metal, metal screening, or even chicken wire.

is broken at the feedpoint. The length of the break (dimension *c* in Fig. 1) is important and depends on the operating frequency. Figure 2 is a graph that gives the dimension for various frequencies.

Once the loop is formed, the end closest to the coaxial cable is bent 90 degrees and grounded. The length of the small vertical section (labeled *E* in Fig. 1) is 0.007 wavelength. The far end of the ring is connected to a variable capacitor. At even moderate transmitting power, that is a high-voltage point, so use a transmitting variable capacitor with a relatively wide air gap (greater than

0.125 inch), or a vacuum variable capacitor. The latter are expensive new, but can often be bought surplus at a reasonable price.

The ring diameter is 0.08 wavelength. For 7 MHz that works out to  $(0.08)(300)/7 = 3.43$  meters, or 135 inches (11.25 feet). At 24 MHz, it works out as  $(0.08)(300)/24 = 1$  meter, or 39.4 inches (3.28 feet).

A side view of the DDDR is shown in Fig. 3. As you can see, the antenna mounts just a short distance above the ground plane. The base of the antenna is a piece of 3/8- or 1/2-inch plywood covered on top with a conductor (sheet metal, wire screen, or chicken

TABLE 1

Dimension	Band (MHz)					
	7	10	14	18	21	24
A	3.43 m	2.23 m	1.67 m	1.3 m	1.1 m	0.98 m
B	7.7 cm	5.4 cm	3.9 cm	3 cm	2.6 cm	2.2 cm
E	30 cm	21 cm	15 cm	12 cm	10 cm	8.8 cm

wire) used as a ground plane as discussed earlier. If the DDDR is mounted on the ground, rather than in an attic or elsewhere, then earth ground the ground plane.

The stand-off insulators are ideally ceramic RF insulators, but those are hard to find. Suitable insulators can be cut from 1 inch or larger rods of Lucite or other material. The material must be capable of withstanding high RF voltages. Some people use wooden dowels that have been treated with lacquer or other coatings to prevent their absorbing moisture. I don't recommend those for higher power levels, but they should work well at low power levels.

For your convenience, dimensions for the common ham bands from 7 to 24 MHz are given in Table 1. Below 7 MHz, the ring conductor must be pretty large

for efficient operation, and that makes 1.8- and 3.5-MHz DDDR antennas a bit much to build. Above 24 MHz, a dipole will fit inside a typical upstairs bedroom and is a lot more efficient, so there is some question as to why anyone would build a 28-MHz DDDR.

### A SAFETY NOTE

The last thing that I'll say about the DDDR concerns safety: At even moderate power levels, and certainly at power levels within the legal limit for ham transmitters, huge currents and very high RF voltages are present on the antenna. You must take care to prevent anyone from accidentally touching it during operation. An RF burn is rather painful and deep. Also, keep it away from nearby objects that could either catch fire (which is true for any antenna) or be damaged by an arc. ■

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# SCANNER SCENE

By Marc Saxon

## Christmas Stocking Stuffer

**H**ere's a gutsy little handful that would fit just fine into a Christmas stocking. It's the *Uniden Bearcat BC-2500* continuous-band scanner, a 400-channel handheld dynamo. The unit is notable for its wide frequency coverage, including practically everything between 25 MHz and 1.3 GHz. There is a small coverage gap from 550 to 760 MHz, which lies in the UHF-TV band, and the cellular bands are blocked out at the factory.



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When in search/scan mode, there is a feature that can store wanted frequencies at available memory locations in any bank. When that is accomplished, the unit automatically returns to its search/scan tasks.

In addition, frequencies can be selected using the keypad, and a rotary tuning (VFO) control makes it easy to closely examine groups of frequencies. A special key accesses and scans the NOAA weather band.

Selectable operating modes include NFM, WFM, and AM. Selectable increments during search are 1.25, 5, 25, or 50 kHz, or "Auto."

This is a scanner you can ask Santa to bring—or ask any Uniden scanner dealer about this versatile handheld.

### CIVIL AIR PATROL VHF

The Civil Air Patrol (CAP) is the U.S. Air Force Auxiliary. The CAP is staffed by civilian volunteers who are always ready to undertake various

important emergency tasks. The CAP is perhaps best known for its successful Search-and-Rescue (SAR) and disaster-area operations.

We have seen many bits and scraps regarding the VHF communications frequencies used by the Civil Air Patrol, but nothing comprehensive. A Texas reader, Jack L., of Tarrant County, provided information that he claims is complete and national in scope.

The primary repeater frequency is 148.15 MHz (143.90 MHz input); the secondary repeater is 148.125 MHz (143.75 input). Each repeater has a standard CTCSS of 100 Hz, and will also respond to a locally assigned CTCSS. The repeater output frequencies are also used for simplex. Air/ground use of repeaters is limited to making the initial contact, then switching to the air/ground frequency.

The CAP's air/ground frequency is 149.5375 MHz. Search-and-Rescue operations are on 123.1 MHz, with practice SAR's on 122.9 MHz. The control channel is 148.1375 MHz. Packet operations are on 149.895 MHz. CAP AM and USB operations are on 26.620 MHz. There are USB operations on 26.617 MHz.

### BEHIND THE SCENES

When you tune in a VHF or UHF station intended for wide-area signal coverage, keep in mind that the transmitter and antenna site is most likely situated at a very

high point some distance from its control point. In a metropolitan area, that could be on a tall building or tower. Outside of urban areas, the only sufficiently high locations are sites atop mountains or other high points, and they have been popular installation points for VHF/UHF transmitters and antennas.

Regardless of their locations, remote transmitter and repeater sites have certain basic needs. They must be powered, and they must be fed the information that they are to transmit. In metro locations, these things can usually be provided by power lines and land lines. In remote, suburban, and rural areas, or any place where commercial power isn't readily available, it might need to come from on-site storage batteries, generators, etc.

The signal information to be passed to a distant remote VHF or UHF transmitter might be transferred there from the control point by a microwave link. Many installations, however, don't use microwave. Instead, they use VHF or UHF links that consist of control stations and relay stations. Those signals are "behind the scenes" transmissions, and make for interesting signal hunting.

NOAA weather-forecast transmitters in the 162-MHz band are usually fed signals by land line. Where that isn't feasible, UHF control links are used on 410.10, 410.575, 415.90, and 416.375 MHz. Where a NOAA transmitter is so distant from a control point that it can't be accessed with a single hop, a relay link may be added midway to reach the transmitter. When that is done, the relay output of 410.575 MHz is mated with the input of 410.10 MHz. Alternately, the output frequency

416.375 MHz is paired to the input, 415.90 MHz.

Where are good places to look for control and relay links? If your scanner can tune the 72-76-MHz band, you'll find many signals there. Most will probably be radio paging stations, possibly a few with voice paging.

Any paging signals that you hear in the 157.77-158.67-MHz bands, as well as 459.025-459.65 MHz, are control links used by radio-paging companies. None are signals intended to be received directly by beepers. Although I haven't picked up any activity in the 157-158-MHz band, the 459-MHz band is quite filled with those transmissions.

Remote transmitter relay and control links aren't limited only to NOAA and pagers. Readers have reported them in use by some state police agencies, and they are also used in other services. The one great repository for those stations seems to be the 72-76-MHz band.

### FROM THE MAIL SACK

Paul Castle, of Connecticut, reports that during a scan/search, he discovered a considerable amount of unusual activity on 167.15 MHz. There is some occasional voice communication, he notes, but much of what he hears consists of bursts of "hissing." About twice an hour, the station transmits a message in CW. Paul doesn't read CW, but he taped it, then played the tape at half speed and copied that the station had sent "KEC281."

The call letters are assigned to the FBI office in Richmond Hill, New York, and that frequency belongs to the agency. The hissing is the sound of digital voice scrambling. ■

## CIRCUIT CIRCUS

(Continued from page 74)

positive terminal of the battery. Set the two speakers about one foot apart and aimed in the same direction, but away from any close object. When someone moves close to and in front of the two speakers the sound will reflect back causing the receiver's relay to activate. The relay's output can then be used to activate some type of alarm or annunciator.

The circuit, shown in Fig. 5, operates on the direct conversion principle. Transistors Q1 and Q2 amplify the ultrasonic signals picked up by the speaker. The output, at Q2's collector, feeds the input of the JFET (Q3), which is connected in a product-detector circuit. The PLL (U1) here is used as a tunable heterodyne oscillator that also feeds the input of the JFET detector circuit. The incoming ultrasonic signal mixes with the heterodyne-oscillator signal producing a sum and dif-

### PARTS LIST FOR THE SENSITIVE ULTRASONIC RECEIVER (Fig. 5)

#### SEMICONDUCTORS

U1—567 phase-locked loop, integrated circuit  
U2—LM386 audio power amplifier, integrated circuit  
Q1, Q2—2N3904 NPN transistor  
Q3—MPF102 JFET transistor

#### RESISTORS

(All fixed resistors are 1/4-watt, 5% units.)

R1, R2—220,000-ohm  
R3-R6—2,200-ohm  
R7—1,000-ohm  
R8, R14—270-ohm  
R9—100,000-ohm  
R10—4,700-ohm  
R11—10,000-ohm  
R12—50,000-ohm, potentiometer  
R13—10,000-ohm, potentiometer

#### CAPACITORS

C1, C2, C5—0.01- $\mu$ F, Mylar  
C3—0.047- $\mu$ F, Mylar  
C4—0.0022- $\mu$ F, Mylar  
C6, C7, C11, C12—0.1- $\mu$ F, ceramic-disc  
C8—10- $\mu$ F, 16 WVDC, electrolytic  
C9—47- $\mu$ F, 16 WVDC, electrolytic  
C10—470- $\mu$ F, 16 WVDC, electrolytic

#### ADDITIONAL PARTS AND MATERIALS

SPKR1—Piezo tweeter, see text  
Power source, headphones or speaker, wire, solder, etc.

### A SENSITIVE ULTRASONIC RECEIVER

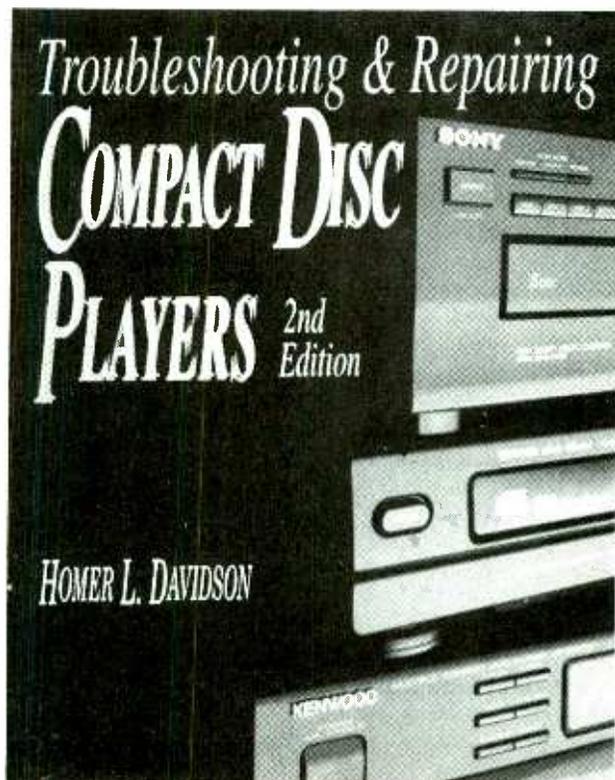
Our last entry this month is a very sensitive ultrasonic receiver that can tune in just about anything in the ultrasonic frequency range. You can hear bugs, bats, engines, etc.; it can also be used with our ultrasonic generators. ■

ference frequency. The high frequency content is filtered out by the combination of C3, R8, and C6. The remaining low-frequency output is passed on to the input of the LM386 audio amplifier. A speaker or headphones may be connected to the circuit's audio output. ■

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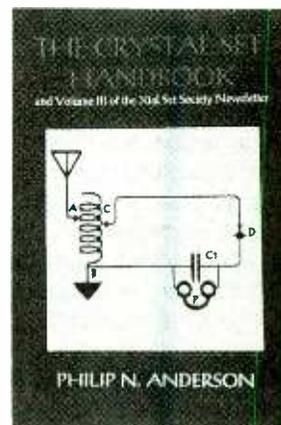
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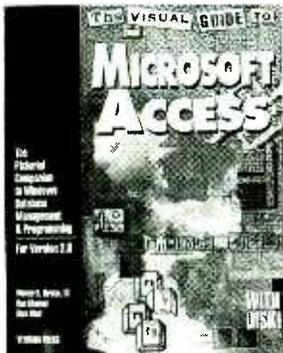
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*The Visual Guide to Microsoft Access book-and-diskette package costs \$29.95 and is published by Ventana Press, P. O. Box 2468, Chapel Hill, NC 27515; Tel: 919-942-0220; Fax: 919-942-1140.*

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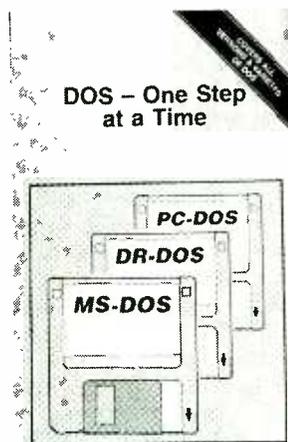
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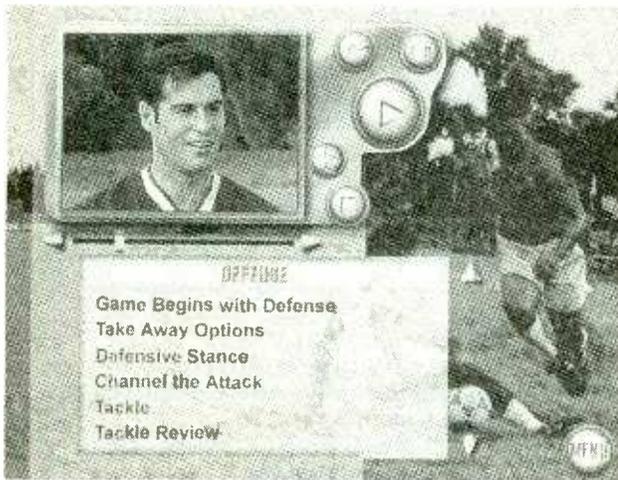
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# NEW PRODUCTS

## Interactive Sports Instruction

Soccer fever has hit the country, thanks to the U.S.-hosted World Cup games. Budding soccer stars can get personalized soccer instruction from U.S. World Cup team member John Harkes and women's national team member Mia Hamm, with *IntelliPlay's ESPN: Let's Play Soccer* on CD-ROM. For more experienced players, U.S. World Cup team goalie Tony Meola joins Harkes and Hamm in *ESPN Interactive Soccer: Skills and Strategies*.



*ESPN: Let's Play Soccer* is narrated by *Home Improvement* star Zachary Ty Bryan, and provides a youth-oriented view of the game. Bryan learns defensive and offensive play, strategy, and basic concepts of fair play along with the user, in a self-paced, interactive instruction program. *ESPN: Let's Play Soccer* is available for the 3DO, MPC, and Macintosh multimedia platforms.

*ESPN Interactive Soccer: Skills and Strategies* demonstrates skill-honing techniques and provides offensive and defensive strategies. In addition, Tony Meola covers goalkeeping fundamentals. The CD-ROM is currently available for MPC, with a 3DO version planned for first-quarter 1995.

The *IntelliPlay* sports-instruction CD-ROM's—which also include baseball, golf, and foot-

ball titles—are priced from \$34.95 to \$84.95. For more information, contact Intellimedia Sports Inc., Two Piedmont Center, Suite 300, Atlanta, GA 30305; Tel: 404-262-0000; Fax: 404-261-2282.

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### EMF/ELF METER

*Extech's Model 480822* single-axis EMF/ELF meter is used to measure electromagnetic radiation levels in the 0.1–199.9-milliGauss range, with an ELF frequency bandwidth of 30–300 Hz. The unit is accurate to 4% at 50–60 Hz, with a sampling rate of 2.5 conversions per second to ensure reliable readings. The meter monitors electromagnetic radiation levels from video terminals, fans, wiring, power lines, and numerous other sources. It weighs only six ounces and offers a 3½-digit, 0.5-inch LCD readout with over-range indication.



The Model 480822 EMF/ELF meter, complete with a 9V battery, an instruction manual, and application notes, has a list price of \$89. An optional carrying pouch costs \$10. For additional information, contact Extech Instruments Corporation, 335 Bear Hill Road, Waltham, MA 02154-1020; Tel: 617-890-7440; Fax: 617-890-7864.

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### VIDEO POST-PRODUCTION CENTER

*Sima's Video Pro-Magic* is a digital art effects generator and audio mixer that offers professional effects at a reasonable price. High-tech effects are generated at the touch of a button.



Strobe is offered in high, medium, and low speeds, and a freeze option stops motion for as long as the videomaker desires. Paint mode is used to create professional posterization, an artistic distortion of color and form that duplicates MTV-like effects. Strobe and paint can be used together, doubling the creative possibilities. The Mosaic mode of the unit can be used to create large and small geometric patterns made up of both positive and negative images.

The Video Pro-Magic also provides picture-in-picture and multiscreen options. Picture-in-picture (PIP) can be added to any corner of the screen, in motion or still. The two images can be reversed at the touch of a button. The multiscreen effect creates either four or nine frames. By touching the SELECT key, the videomaker can revolve a moving image around the screen, leaving a series of still images behind. Pressing the AUTOCYCLE key automatically cycles a moving image around the screen.

The Video Pro-Magic has a suggested retail price of less than \$500. For further information, contact Sima Products Corporation, 8707 North Skokie Boulevard, Skokie, IL 60077; Tel: 708-679-7462; Fax: 312-286-7227.

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## FAX/MEMORY PCMCIA COMBO CARD

By combining 2- or 4-Mbyte expanded memory with a powerful fax/modem and interface software in a single Type II PCMCIA card, *Smart Modular Technologies* has overcome the functional limitations of low-memory, single-slot sub-notebooks, PDA's, and palmtop computers. Intended for machines like the HP100LX, which has only one PCMCIA slot, a minimum amount of memory, and no disk drive, the *FMM* fax/memory cards allow users to communicate everything from binary files and fax messages over phone lines to e-mail via the Internet. The user can access on-line services and download files without running out of memory.



The *FMM* card features a battery-saving, ultra-low-power sleep mode; built-in interface software; flash memory to upgrade the modem's operating program code on-line; and built-in DAA line-interface circuits.

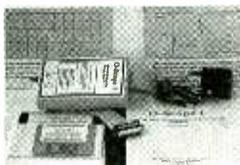
The card's modem provides complete data and facsimile capabilities. It has built-in high-level error correction and data compression, and offers full-duplex data communication at 2400 bps. Other features include auto dial and auto answer. The modem sends and receives faxes at 9600 bps.

The 2-Mbyte *FMM* has a list price of \$349; the 4-Mbyte version costs \$449. For more information, contact *Smart Modular Technologies*, 45531 Northport Loop West, Building 3B, Fremont, CA 94538; Tel: 510-623-1231; Fax: 510-623-1434.

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## DIGITAL STORAGE SCOPE MODULE

The *O-Scope I* from *Allison Technology Corporation (ATC)* is a low-cost digital storage oscilloscope module that connects to IBM PC/AT-compatible computers and converts the computer into a digital storage



oscilloscope that is capable of capturing and displaying DC, audio, and low-end ultrasonic frequency input signals. Small, lightweight, and portable, the device is powered from 12VDC and draws less than 40 mA of current. It uses standard  $\times 1$  and  $\times 10$  oscilloscope probes and works with both desktop and laptop PC's, connecting via the printer port. Trace sweeps can be frozen on the screen, saved to disk for use with other programs, or output to a printer. Vertical ranges of 10 volts per division down to 50 mV per division are provided. Sweep rates of 100 seconds per division down to 500 microseconds per division (in  $\times 1$  mode) are available from most AT compatibles.

A 128-point Fourier spectrum analyzer mode provides frequency spectrum information from DC to one half of the current sample rate. There are 50 samples per division in the  $\times 1$  sweep mode, and two forms of sweep expansion are provided.

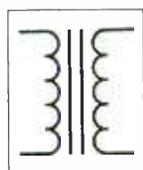
In addition to sweep, the *O-Scope I* provides voltage, frequency, and period calculations. Voltages include peak-to-peak, average, peak, minimum, and RMS.

The *O-Scope I* digital storage scope module, including an AC adapter and cable, costs \$169.95. A kit version is also available, without the shielded case, for \$119.95. For more information, contact *Allison Technology Corp.*, 8343 Carvel, Houston, TX 77036; Tel: 713-777-0401; Fax: 713-777-4746.

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## PIN DIODES

(Continued from page 42)

pair of PIN diodes is used as a transmit/receive (T/R) switch in a radio transmitter. When switch S1 is open, diodes D1 and D2 are unbiased, thus presenting a high impedance to signals. Diode D1 is in series with the transmitter, so it keeps the transmitter signal from reaching the antenna and diode D2, which is across the receiver input, does not attenuate the receiver input signal. However, when S1 is closed,

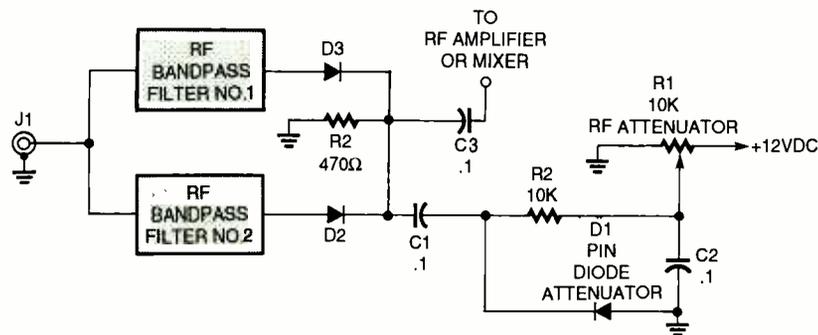


Fig. 9 This PIN-diode front-end RF attenuator circuit contains a simple shunt circuit. The DC voltage from the potentiometer sets the attenuation level.

both D1 and D2 are forward biased. So D1 acts as a low resistance in series with the transmitter output signal, effectively conducting it to the antenna. Diode D2 is also a low resistance, and being across the receiver input, shorts it to ground. The isolation network shown can be either a quarter-wavelength transmission line, microstrip line designed into the printed circuit board, or an LC  $\pi$ -section filter.

Wherever you see a so-called "relayless T/R switch" on equipment that operates from the low-HF band to microwave frequencies, it is almost certain that such a network is inside. Transmitters up to several kilowatts have been designed using that form of switching, and almost all current VHF/UHF portable "handi-talkies" use PIN-diode switching.

Figure 7 shows how IF bandpass filters can be selected by using PIN diodes. A set of input and output PIN-diode switches are connected as shown, and fed by a switch that selects either  $-12$  VDC or  $+12$  VDC alternately. When the switch is in the position shown,  $+12$  VDC is supplied to the filter No. 1 diodes, so that filter is activated. When the switch is in the

other position, the other filter is turned on. That same technique can be used in the front-end of the receiver, or the local oscillator, to select L-C components for different bands.

Another filter-selection method is shown in Fig. 8. The circuit is a partial representation of the front-end circuitry for the Heathkit SW-7800 general-coverage shortwave receiver, which includes six filter sections. In each bandpass filter, a network of inductor and capacitor elements are used to set the center and both edge frequencies of the band.

The circuit shown has a switch (S1) to apply or remove the  $+12$  VDC bias potential to the diodes, but in the actual receiver that potential is digitally controlled. The digital circuitry senses which of thirty bands is desired, and selects the RF-input filter accordingly.

Another application for PIN diodes is as a voltage-variable attenuator in RF circuits. Because of its variable resistance characteristic, the PIN diode can be used in a variety of attenuator circuits. One of the simplest is the shunt attenuator of Fig. 9. The front-end of this circuit is a bank of selectable bandpass filters (like those in Fig. 8). The output of the filter banks are shunted to ground via capacitor (C1) and PIN diode (D1). The PIN diode acts like an electronically variable resistor. The resistance across the diode's terminals is a function of the applied bias voltage. This voltage, hence the degree of attenuation of the RF signal, is proportional to the setting of potentiometer R1. The series resistor (R2) is used to limit the current when the diode is forward biased. This step is necessary because the diode becomes a very low resistance when a certain rather low potential is exceeded. ■

## THERMAL CALCULATIONS

(Continued from page 57)

integrated circuits is the same as presented above. The power dissipated is determined and then a thermal diagram is drawn. If the IC is meant to be bolted to a heat sink (such as when using a 3-terminal regulator),  $\theta_{JA}$  will be given. If the IC is a CMOS or bipolar logic device with no mechanism for heat removal other than the package (and the lead frame), then a maximum ambient temperature or  $\theta_{JA}$  must be provided. Table 1 gives some estimates for common package types and some estimated thermal parameters. As a rule, junction temperatures should be kept  $25^\circ\text{C}$  below the maximum rated temperature for increased reliability. IC's that dissipate small amounts of power and over which the designer may have little control will list a maximum rated ambient temperature. This value ( $70$ – $125^\circ\text{C}$ ) is based on  $\theta_{JA}$  and/or  $\theta_{JL}$  for the package.

**Heat Sinks.** So how do you determine heat-sink efficiency? The easiest way is look up a heatsink's  $\theta_{SA}$  values in a catalog. In most cases, there will be several curves like those in Fig. 7. In the figure, one curve (denoted "curve A") is used to determine  $\theta_{SA}$  without forced-air cooling. The temperature rise (on the Y-axis) is divided by the power dissipated (read off the X-axis). The heat is dissipated by heat-sink radiation, conduction to the ambient air, and natural convection. The arrows on the curve indicate which axis to use. The second curve (curve B) indicates the values for forced-air cooling. In this case, the air-cooling velocity (X-axis top) is used to determine the  $\theta_{SA}$  directly from the Y axis to the right.

However, forced-air cooling should be avoided whenever possible for a number of reasons. First, fans have a relatively high failure rate (compared to electronic parts) so when the fan eventually stops, the electronics will cook unless there is a backup fan or a failure-detection circuit. Also, they greatly increase the amount of contaminants drawn over the electronics, which will cause trouble with non-hermetically sealed components such as relays, etc. ■

## PROJECT PHOTOGRAPHY

(Continued from page 64)

eting." When you get your photos, compare the results with your exposure record to see the best results for your specific setup. Next time, you won't need to bracket.

**Project Photos.** To begin with, prop an artboard white-side up on a couple of chairs so it slopes upward toward the rear to form a plain non-reflective backdrop. Don't try using paper or cloth sheets—you'll get distracting shadows from the folds and

satisfaction, and set the focus to the center of the subject. Now, waving the light around while you are looking through the viewfinder, check for reflection "hot spots." If you have any, reposition the lighting or the object.

If you haven't already done so, close the lens opening to  $f16$ , and write your exposure settings on your exposure record. Now it's simply a matter of squeezing the trigger release for the proper exposure time while waving around the light bulb in a close arc over and to the sides of the camera.

Figure 2 shows my recommended exposure times. Notice that this as-

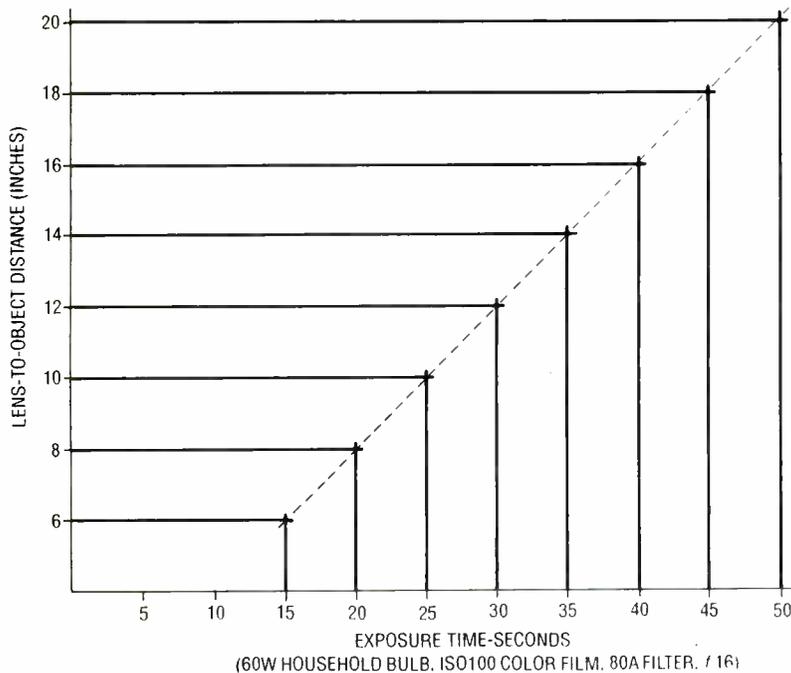


Fig. 2. Here are some recommended exposure times for various object distances. Note that this graph is only applicable for the recommended film, lighting, and filter.

creases, and may even be able to see the fabric weave in a closeup.

Load the camera with the film I've suggested and attach it to the tripod. Connect the manual cable release to the camera. Get your 60-watt light bulb set up so you can freely swing it above and around the camera. Since this incandescent bulb is not in the same light spectrum as daylight, for color film you'll need an 80A blue filter attached in front of your lens. This greatly attenuates the light getting through to your lens, but I've taken that into account with the exposure settings I'll recommend in a moment.

Looking through the camera viewfinder, compose the picture to your

sumes you have the lens closed to  $f16$ , your using ISO 100-speed color film with an 80A filter, and painting with a 60-watt incandescent light bulb. Again, to play it safe, bracket your exposures  $\frac{1}{2}$ -stop in each direction, and keep track of all exposure information on your Exposure Record.

**Developing & Printing.** I've had excellent results with a local photo service that does "color correction." Incandescent bulbs vary in their light spectrum, and it may be necessary, even using the 80A blue filter, to have color correction during printing. Typical mail-order houses don't provide color correction. ■

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## THINK TANK

(Continued from page 31)

circuit is that it can be made very tiny. But considering how the gain of transistors can vary, it probably will take some experimenting to get everything to work right.

## CAR-AUDIO SUPPLY

This high-current power supply (see Fig. 4) was built to power car-stereo equipment since the one-amp output of many commercial supplies is not up to the task. I tried to make the power supply as versatile as possible, while keeping the parts count low. The result

was a fixed/adjustable-voltage supply capable of supplying 10 amps.

The voltage output is controlled by the circuit consisting of R4, R5 and S3; note that S3 is part of R4. For a fixed-voltage output, R4 should be set for zero ohms (fully counter-clockwise). In that position, switch

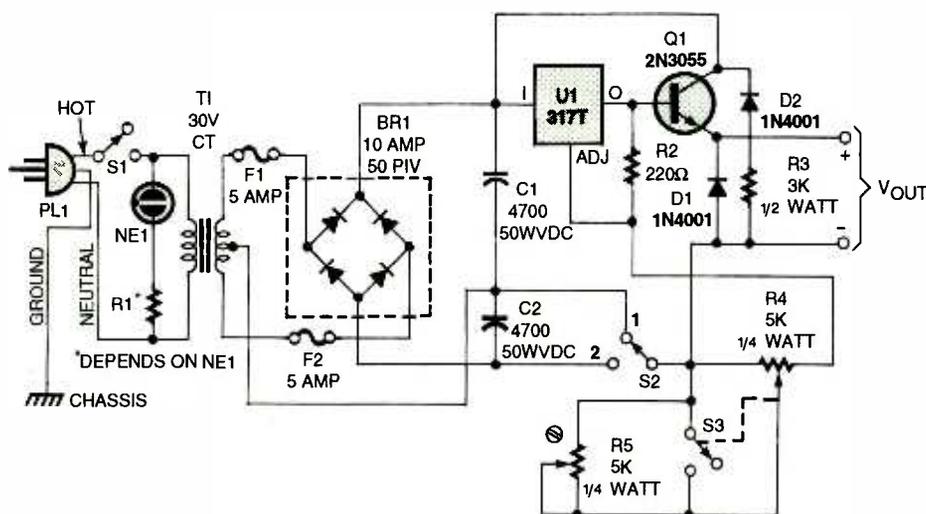
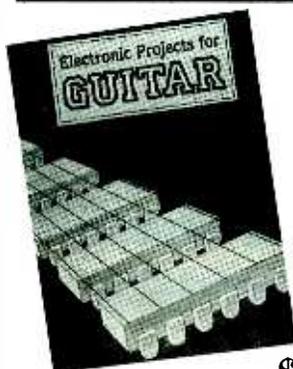


Fig. 4. With this high-current power supply you can power those old car stereos you have lying around your workshop. It's not a bad idea considering the quality of some car-audio units.



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S3 will open. Trimmer potentiometer R5 should then be adjusted so that the circuit produces a 12-volt output (or whatever output your application demands).

For an adjustable output, R4 is turned clockwise, closing S3 and removing R5 from the circuit. The output voltage is then controlled by the resistance offered by R4 alone.

When SPDT switch S2 is in position 1, the maximum output current is achieved with both halves of T1 providing current to the filter section, to double the overall current output. However, the maximum output voltage is halved in that position. That is a more efficient setting since the power transistor need not drop as large a voltage. In position 2, the maximum voltage almost equals the rating of T1.

I used a 24-volt center-tapped transformer for T1. Finally, D1 and D2 were included in case power was turned off with an inductive load attached.

—Michael Ford, Troy, NY

I wish I had received this circuit about a month sooner. I needed to power a car subwoofer I attached to my PC for adding realistic explosions to my computer games. My solution was to use an old PC power supply I had around. Oh well.

That's all for this month. If you would like to contribute to these pages, write to *Think Tank*, **Popular Electronics**, 500-B Bi-County Blvd., Farmingdale, NY 11735. If your work appears here, you'll receive a *Think Tank II* book. ■



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## POWER CONTROLLER

(Continued from page 60)

required that the leads be bent so that the metal tabs of the MOSFET's could be attached to the metal lid of the enclosure. The LED is installed on the solder side of the board. The board was then mounted to the enclosure lid, with the MOSFET tabs flush against the lid and the LED lens protruding through a small opening in the lid. When handling and soldering the MOSFET's, be sure to take all the usual precautions to protect the devices from possible damage due to static discharge.

The type of input and output connectors used in your unit is up to you and will depend upon your application. The author used an automobile cigarette-lighter plug at the input (P1, P2) and cigarette-lighter jack at the output (OP1, OP2).

After all the components have been installed, attach five wires to the appropriate points (denoted as A-E) on the main printed-circuit board (see Fig. 3) for inter-board connections. Then solder the free ends of the wires to the corresponding points on the driver board (point A in Fig. 3 to point A in Fig. 4, point B in Fig. 3 to point B in Fig. 4, and so on).

Once the inter-board connections have been made, check your work for the usual construction errors—cold solder joints, solder bridges, and misplaced or misoriented components. After confirming assembly accuracy, you are ready to do a practical check on the your work.

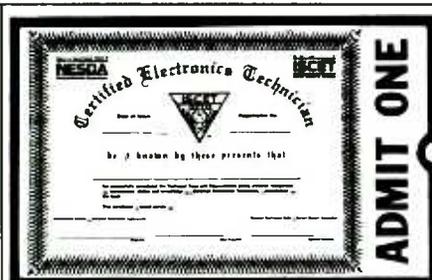
**Testing.** You'll need a multimeter and/or an oscilloscope, and a power supply to test the circuit. Apply power to the circuit and, using the scope, check U1 pins 2 and 6 for a sawtooth waveform with maximum and minimum amplitudes of about 66% and 33%, respectively, of the supply voltage. Also check that the voltage at potentiometer R1's moving contact varies as R1 is adjusted.

After that, check the frequency of the signal at pin 2 of U2; that signal should vary from 0 Hz to 3.5 kHz, with the positive-voltage swing reaching a peak of about 2 volts less than the supply voltage. Next, check the voltage at pin 4 of U2. Depending on the

position of R1, the voltage on pin 4 should vary from slightly below  $\frac{1}{3} V_{CC}$  to slightly above  $\frac{2}{3} V_{CC}$ . Following that, check the voltage at pins 7 and 6 of U2; pin 7 should measure about 5.1 volts and pin 6 should be above 5.1 volts when the input voltage to the circuit is 10 volts.

The next check is a practical test of the unit. Connect the output of the unit to a lamp (any 12-volt, 0.5- to 20 watt unit will do), and then connect the input of the circuit to a suitable power source (a car battery will do fine). The LED should light. The lamp should be shut off with the potentiometer rotated to one extreme; the lamp should become progressively brighter as the potentiometer is rotated in the other direction.

Note: The unit will hum when in use; that's normal. A fuse was not used in the author's unit, since the circuit was designed to be powered through an automobile cigarette lighter, and most cars have a fused lighter socket (most battery packs also have built in fuses). If your unit is to be run directly off a battery, it is important that a 10- to 20-amp, in-line fuse be connected in the power-supply line. ■



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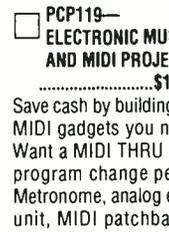
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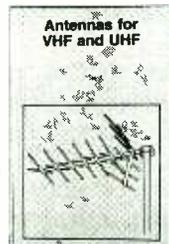
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## HEILMEIER AND THE LCD

*(Continued from page 39)*

**A Major Breakthrough.** Heilmeier and his colleagues realized almost immediately that the effect they were seeing could be used to produce a totally new type of electronic display device. Voltages of 10 volts or less were enough to change the color of the liquid-crystal material. The power required was less than one-micro-watt-per-square-centimeter of surface area.

Many technical problems had to be solved, however, before liquid-crystal displays (LCD's) would be ready for commercial marketing. For example, the dyes and the liquid crystals Heilmeier and his colleagues were using were not stable when exposed to electric fields for long periods of time. Also, the change of color phenomenon required a source of polarized light behind the display. In addition, a compound that had a liquid-crystal phase at room temperature would have to be found. The list of hurdles to be overcome was long.

**Dynamic Scattering LCD's.** Soon Heilmeier and his co-workers found that, in certain types of nematic liquid crystals, an applied electric field produced turbulent motion of small clusters of the molecules rather than molecular reorientation. That turbulent motion is the result of electrically charged impurity molecules (ions) that move in the electric field and induce shear stresses in the liquid-crystal material.

An intense scattering of incident light is produced by that turbulent motion. As a result, the normally clear liquid-crystal material takes on a milk-white appearance that can be observed without the use of polarizing filters. Making the electrode behind the liquid-crystal material both reflecting and conducting allows the effect to be seen with ordinary room light. "Dynamic scattering" was the name chosen to describe the phenomenon.

**Other Important Developments.** Three of Heilmeier's colleagues soon developed a nematic material that is in the liquid-crystal phase at room temperature. With that breakthrough,

the commercial future for liquid-crystal displays was virtually assured. Heilmeier and others now earnestly began designing prototype examples of alpha-numeric displays, electronic clocks, windows whose transparency could be electrically controlled, and airplane-cockpit displays.

From the time of Heilmeier and his colleagues' original liquid-crystal demonstration in 1964 until the time when prototypes of commercially marketable applications of LCD's had been developed, RCA had not been willing to divulge many details of the progress that had been made. Finally, in late May of 1968, RCA was ready to announce to the world what had been accomplished, as well as what could be expected in the future. Worldwide excitement over liquid-crystal displays surged practically overnight following that announcement. However, it took more than ten additional years before LCD's of truly high quality and acceptable reliability could be manufactured and marketed to the public.

Most of the earliest commercial LCD's used the dynamic-scattering principle of operation. Because the contrast between the cloudy white numerals and the clear background is poor in that type of LCD, it is seldom used today. The various "twisted," as well as "super twisted" and "double super twisted," nematic-mode technologies that have since been developed have led to larger, relatively low cost LCD panels with significantly increased contrast, sharper resolution, and the ability to display multi-colored images. Other liquid-crystal technologies currently being developed offer the promise of even greater improvements.

**Good Chemistry.** While George Heilmeier was the central figure and "spark plug" of the group of young scientists who made the crucial, initial discoveries in liquid-crystal technology, he is quick to praise his colleagues and acknowledge their important contributions. In his personal account of the events, published in 1976, Heilmeier describes the research group of which he was a part as "A great bunch of young guys having fun working together and playing together."

Heilmeier believes that an impor-

tant factor leading to the group's successes was "the ability of organic chemists and electrical engineers to work together in an atmosphere of mutual respect." He adds, "We simply weren't afraid to appear stupid to each other when out of our respective fields." It seems clear that those researchers were able to achieve important results in liquid-crystal chemistry, in part, because the right "personal chemistry" existed between them.

Not surprisingly, George Heilmeier's career has continued to be one of great achievement. After leaving RCA, he became a White House Fellow, held several important Department of Defense positions, including the directorship of the Defense Advanced Research Projects Agency (DARPA), and was a senior vice president at Texas Instruments. Currently, Dr. Heilmeier is the CEO of Bellcore, the research organization with headquarters in Livingston, New Jersey that serves the seven regional telephone operating companies formed as a result of the breakup of the former Bell System. ■

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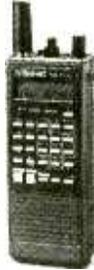
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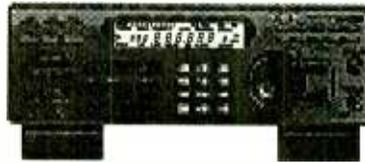
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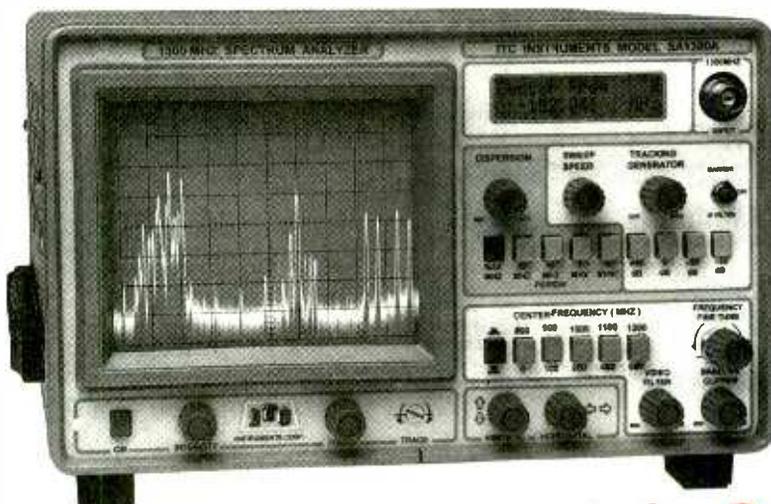
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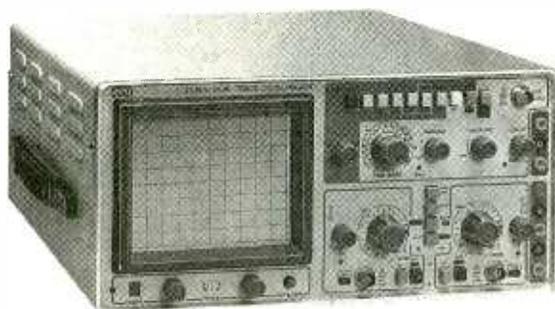
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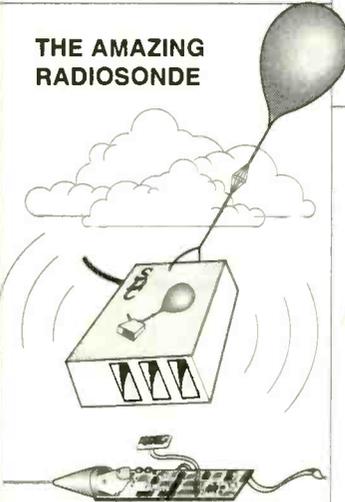


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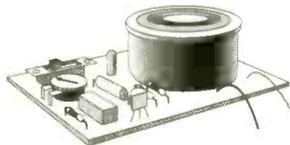
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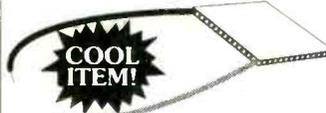
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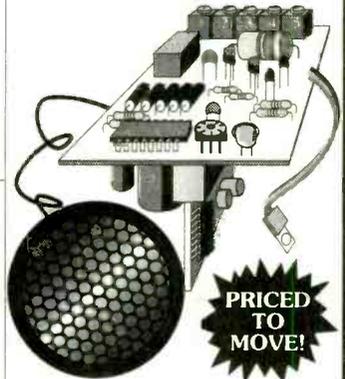


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**AC/DC CURRENT**  
**TRANSISTOR**  
DUTY %  
20 Amp

**150 LE**  
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**\$29<sup>95</sup>**

**200 LE**  
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**\$49<sup>95</sup>**

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**400 LE**  
Stock # 990124  
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**KELVIN 100 Basic**  
# 990087 **\$19<sup>95</sup>**

- AC & DC VOLTAGES
- DC CURRENT
- RESISTANCE
- 3 1/2 Digit LCD
- CONTINUITY TEST
- Buzzer
- LOW BATTERY INDICATOR
- DIODE TEST ● BATTERY TEST



**CAPACITANCE KELVIN METER 250 LE \$59<sup>95</sup>**  
# 990126

- 0.5% ACCURACY
- RANGES: 20mF, 200uF, 200uF, 20uF, 2uF, 200nF, 20nF, 2000pF, 200pF
- Zero Adjust
- Safety Test Leads
- Test Socket for Plug-in Components



Designed to meet IEC-348 & UL-1244 safety specifications.

**Protective Cases**

For Models 100 Basic, 150LE, 200LE, 300LE  
..... \$4.<sup>95</sup> (#990088)  
Case For Model 400LE ..... \$9.<sup>95</sup> (#990116)

**2 Year Warranty (Parts & Labor)**

**The Ultimate Meter**  
TRUE RMS - LCR - Hz - dBm

Popular Electronics (Reviewed - May 1993)

"Not only does the Kelvin 94 boast alot of features ... the features go the extra distance."

"If we had to run into a burning building to do some emergency trouble-shooting and could carry in only one piece of equipment, the Kelvin 94 would be it!"

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- TRUE RMS on AC VOLTAGES & CURRENT
- FREQUENCY COUNTER TO 20 MHz
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- SHOCK RESISTANT HEAVY DUTY CASE WITH YELLOW RUBBER HOLSTER & TILT STAND
- WATER RESISTANT SEALED CASE
- 30 DAY MONEY BACK SATISFACTION GUARANTEE

**\$199<sup>95</sup>** MODEL 94 #990111

COMES COMPLETE WITH YELLOW HOLSTER, PROBES, BATTERY, FUSE, STAND

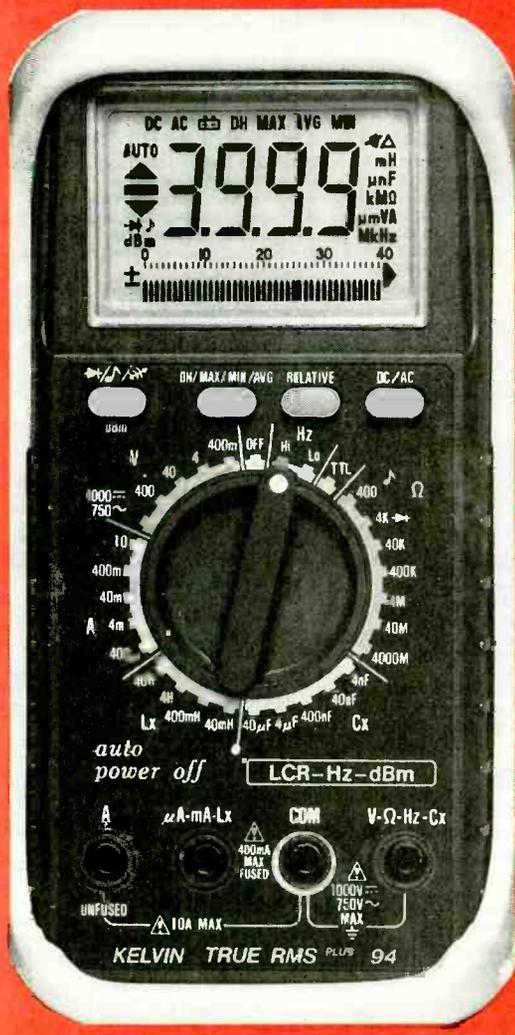
0.1% ACCURACY on DC Voltages Water Resistant

Freq Counter to 20 MHz

**Protective Cases for Model 94**

Regular Padded Zippered ..... \$9.<sup>95</sup> (#990116)  
Deluxe Padded Zippered ..... \$14.<sup>95</sup> (#990115)

Meter is designed in accordance with safety requirements specified in IEC-348, UL-1244 VDE-0411.



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BEST PRICE



## DMM 89 \$199.95

### Most Advanced DMM

All Purpose & Communication  
-80.7 to 81.4 dBm with 4Ω-1200Ω  
20 reference impedances  
True RMS  
Frequency counter: 0.01Hz-10MHz  
Capacitance: 1pF-50,000μF  
Measure AC volt to 20kHz  
5000 counts, 0.1% accuracy  
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Min/Max/Ave/DH/Relative/Zoom  
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Input warning  
Splash proof  
Volt, amp, ohm, logic, diode, continuity  
Ruggedized case  
Rubber holster included



## DMM 2360 \$119.95

### DMM+LCR Meter Very Versatile DMM

Inductance: 1μH-40H  
Capacitance: 1pF-40μF  
Frequency: 1Hz - 4MHz  
Temperature: -40-302 °F  
TTL Logic Test: 20MHz  
Diode, Continuity  
Volt, Amp, Ohm  
3999 count display  
Peak Hold  
Auto power off  
Ruggedized case  
Rubber Holster \$8.00  
Temperature probe \$7.00



## DMM 21 \$74.95

Inductance: 1μH-40H  
Capacitance: 1pF-200 F  
Frequency: 1Hz-1MHz  
Volt, amp, ohm, diode, continuity  
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TTL logic, HFE  
Peak hold  
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ruggedized, solar cell,  
automotive, heavy  
duty, industrial,  
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Fluke 12 \$84.95  
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Fluke 70 II \$67.5  
Fluke 73 II \$94  
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Fluke 77 II \$149  
Fluke 79 II \$169  
Fluke 29 II \$169  
Fluke 83 \$225  
Fluke 85 \$259  
Fluke 87 \$237  
Fluke 97  
Scope Meter \$1785



## LCR Meter 131D \$229.95

### Most Advanced LCR

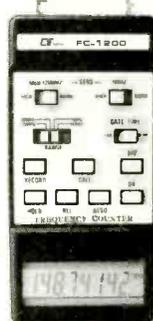
Dual display: L/Q or C/D  
Inductance: 0.1μH-1000H  
Capacitance: 0.1pF-10,000μF  
Impedance: 1mΩ-10MΩ  
0.7% basic accuracy  
Dissipation factor & Q factor  
Serial & parallel mode  
Relative mode for comparison  
and to remove parasitics  
Statistics, tolerance,  
Best for design, incoming  
testing & production  
SMD and chip component  
test probe \$25.00



## LCR Meter 814 \$189.95

### Best Resolution LCR

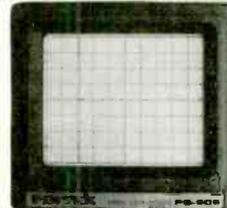
Inductance: 0.1μH-200H  
Capacitance: 0.1pF-20,000μF  
Resistance: 1mΩ-20MΩ  
1% basic accuracy  
Dissipation factor indicates leakage  
in capacitor and Q factor in inductor  
Zero adjustment to reduce parasitics  
from test fixture  
Best for high frequency RF  
and surface mount components.  
SMD and chip component test probe  
\$25.00, Deluxe carrying  
case \$5.00



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Frequency: 0.1Hz-1.25GHz  
Display: 8 digit LCD  
Period: 0.1μs-0.1s  
Records: Max/Min/Average  
Data hold, relative mode  
Telescoping antenna \$8.00  
Deluxe case \$5.00

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Anemometer, Electronic scale,  
Force gauge, Tachometer,  
Stroboscope, Humidity & EMF  
adaptor, Sound level meter,  
Frequency counter, SWR/field  
strength/power meter, Dip meter

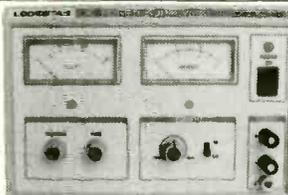


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Dual Trace, Component test, 8" CRT, X-Y Operation, TV Sync, Z-Modulation, CH2 Output, Graticule Illum, 2 probes each has x1, x10 switch. Best price with delay sweep.  
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PS-605 60 MHz DELAY SWEEP \$789.95  
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Expanded Timebase 10ms/div - 0.5 s/div  
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Plotter Control  
250MHz x1, x10 \$29, 250MHz x100 \$38



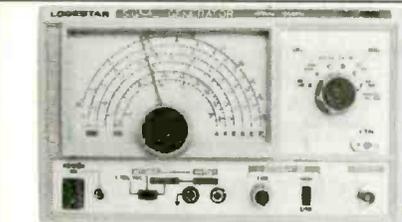
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One fixed 5VDC, 3A output  
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AM modulation  
Audio output 1 kHz, 1 Vrms

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10Hz - 1MHz in 5 ranges  
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Output: 0-8Vrms sinewave  
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Synchronization: ±3% of oscillation  
frequency per Vrms  
Output distortion:  
0.05% 500Hz - 50kHz  
0.5% 50Hz - 500kHz  
Output impedance: 600 ohm

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0.2 Hz - 2 MHz in 7 ranges  
Sine, square, triangle, pulse and ramp  
Output: 5mV-20Vp-p  
1% distortion, DC offset ± 10V  
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Generates RF signal same as SG-4160B  
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Frequency counter 1Hz-150MHz  
for internal and external sources  
Sensitivity <50mV

## FUNCTION GEN./COUNTER FG-2102AD \$229.95

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Frequency counter 4 digits  
Feature TTL and CMOS output

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CAT # LED-23

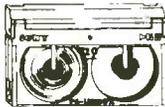
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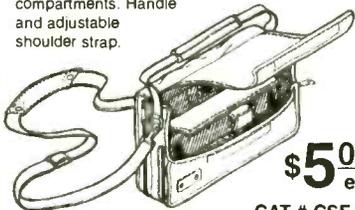
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CAT# VCU-8

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CAT # CSE-1

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Optrex # PWB 40218-CEM-NY-EB  
5 X 8 dot format. 0.23" characters. Display size: 6" X 0.67". Built-in Drivers and controllers. Hook-up diagram included. Module size: 7.185" X 1.32". Inverter for electroluminescent backlight not included.

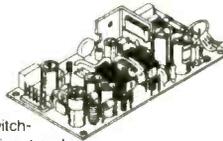
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CAT # LCD-21

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Output:  
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-12 Vdc @ 3 amp  
Small single board switching supply with fused input and adjustable output. 6 pin, snap-lock type header for output. 2 pin header for input. 5.5" X 3.15" X 1.45" high.



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CAT # PS-1245

## 3 1/2 DIGIT LCD DIGITAL PANEL METER

- 200 MV full scale sensitivity
- Single 9 - 12 Vdc operation
- Decimal point selectable
- 13 mm figure height
- Automatic polarity indication
- Guaranteed zero reading for



0 volt input high input impedance (>100 M ohm)  
1 mA DC power dissipation. LCD size: 1.83" X 0.8". Overall size: 2.67" X 1.73". 0.28" above panel thickness. 0.57" overall thickness. Add resistors and disconnect jumpers for voltage ranges to 500 Vdc. Instructions included.

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## 9 VOLT 60 MA SOLAR PANEL



These 6" X 6" glass enclosed photovoltaic panels produce 9 Vdc at 60 ma. Ideal for charging batteries and powering small devices. Put two or more together for more current and voltage. Includes hook-up instructions.

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## MINIATURE TOGGLE

S.P.D.T. (ON-ON)

Right-angle, pc mount.  
0.25" threaded bushing  
Rated 5 amps @ 125 Vac.

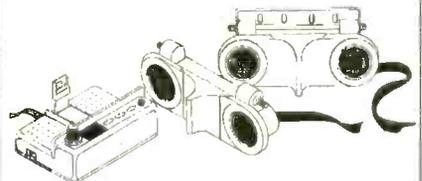
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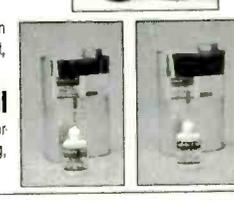
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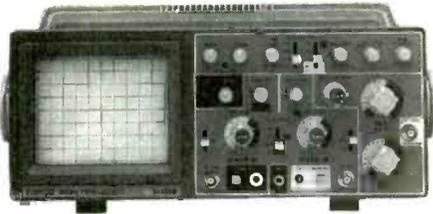
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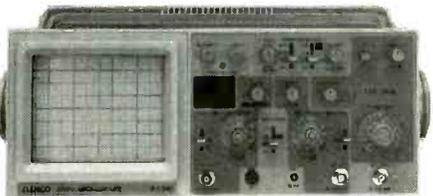
**S-1360 \$775**

Delayed Sweep

**S-1365 \$849**

Cursor Readout

- ♦ Voltage, Time
- ♦ Frequency differences displayed on CRT



**40MHz**

**S-1340 \$495**

2- Channel

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- ♦ Component Tester



**25MHz**

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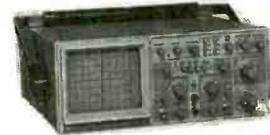
- ♦ Beam Find
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- Video sync separators
- Z axis input
- Single sweep
- V mode-displays 2 signals unrelated in frequency

**60MHz DUAL-TRACE**

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- 1mV/div sensitivity
- Sweep to 5ns/div
- Dual time base
- Signal delay line
- Component tester
- V mode-displays 2 signals unrelated in frequency

**100MHz THREE-TRACE**

**Model 2190  
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- Sweeps to 2ns/div
- Dual time base
- Signal delay line
- 19kV accelerating voltage
- Calibrated delay time multiplier

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- 20MHz analog bandwidth
- 20MS/s sampling rate
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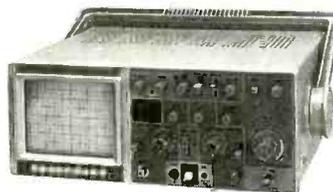
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VC-6045A - 100MHz, Digital Stor	CALL
VC-6025A - 50MHz, Digital Stor	CALL

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Digital Storage Oscilloscope**



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Resolution • Much More....

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A handheld instrument that combines a 50MHz, 25MS/s dual channel digital storage oscilloscope with feature-packed 3000 count digital multimeter.

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SA - 3	\$59	\$55	\$49
M80 (orig)	\$75	\$65	\$59



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- Parental Control
- Favorite Channel Memory
- Sleep Timer
- Wireless Remote Control
- Last Channel Recall
- HRC / STD Switchable
- 99 Channel

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- Favorite Channel Memory
- Wireless Remote Control
- Last Channel Recall
- HRC / STD Switchable
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- Available With Built In Descrambler
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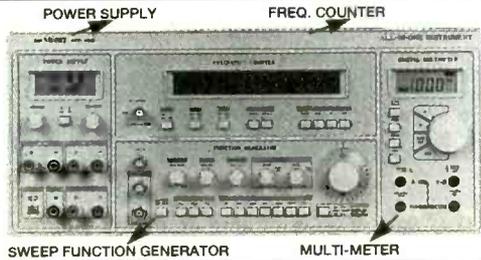
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**\$399.00**

## Four Instruments in One Instrument

- 1 Function Generator**
  - Sine, Square, Triangle, Pulse, Skewed Sine, Ramp, TTL
  - 0.02 Hz ~ 2MHz
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  - 8 Digit LED
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  - ± (1 Hz + 1 dgt. + Time Base Error)
- 3 Power Supply**
  - 3-1/2 Digit LCD
  - Triple output: #1. 0-50V, 0.5A MAX
  - #2, 15V, 1A #3. 5V, 2A
- 4 Digital Multimeter**
  - 3-1/2 Digit LCD
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  - ± (0.5% + 2 dgts)

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**25 MHz Dual**

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**\$299.00**

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Dual/Delay

Reg. \$695.

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**OS-3304/3324, 25 MHz**

- DC to 25 MHz. Dual Channel
- 6" Rectangular CRT with Internal Graticule 10x8cm (Phillips P31)
- Uncalibration LED.
- High Sensitivity 1 mV/div to 20V/div X-Y modes, Z Axis (intensity modulation)
- Rise time 14n Sec. or less.
- Full TV Trigger for TV-V & TV-H
- Acceleration Potential 2kV

**OS-3315, 40 MHz Sweep Delay**

- DC to 40 MHz. Dual Channel
- Delayed Sweep 100nS to 1 Sec.
- 6" Rectangular CRT with Internal Graticule 10x8cm (Phillips P31)
- Uncalibration LED.
- High Sensitivity 1 mV/div to 20V/div X-Y modes, Z Axis (intensity modulation)
- Rise time 8.5nS or less.
- Full TV Trigger for TV-V & TV-H
- Acceleration Potential 12kV

### GoldStar Oscilloscopes

- OS-7020A. 20MHz Dual  
Reg. \$525. **\$395.00**
  - OS-902RB. 20MHz Dual/Read Out  
Reg. \$795. **\$595.00**
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Reg. \$695. **\$575.00**
  - OS-904RD. 40MHz Dual/Read Out  
Reg. \$895. **\$695.00**
  - OS-8100. 100MHz 8 Trace  
Reg. \$1,395. **\$1,145.00**
- Other Models Call for Price

**FG-150**

Reg. \$395. **\$229.00**



**2MHz Sweep / Function Generator w/Built-in Frequency Counter**

- 4 Digit LED Display
- 0.2 Hz ~ 2.0 MHz
- Sine, Square, Triangle, Pulse, Skewed Sine, Ramp, TTL
- Linear or Logarithmic Sweep
- Variable DC Offset Control
- 10 MHz Frequency Counter

*Best Buy!*  
**1.0 GHz Counter FC-200**  
Reg. \$395. **\$199.00**



**High Resolution Frequency Counter**

- 1.0 Hz ~ 1.0 GHz
- 8 Digit LED Display
- Auto & Manual Range
- Measured Value Hold
- 4 Selectable Gate Times
- Below 20mV Input Sensitivity
- 1mΩ & 50Ω Input Impedance
- 10:1 Input Switchable Attenuator

Reg. \$199. **\$119.00**



**RF Signal Generator, SG-310**  
**100KHz - 150MHz**

- 100KHz ~ 150MHz, 6 Ranges.
- Accuracy : ± 5%
- RF Output: 100 m Vrms (Up to 35MHz Unloaded)
- Modulation  
Int. 1KHz (AM) 30%  
Ext. 50Hz ~ 20KHz
- Audio Output: 1KHz Min 2 Vrms

Reg. \$199. **\$119.00**



**Audio Generator, AG-350**  
**10Hz ~ 1MHz**

- 10Hz ~ 1MHz, 5 Ranges.
- Accuracy : 5% ± 2
- Output Impedance : 600Ω
- Sine Wave Output  
• Range : 10Hz ~ 1MHz  
• Output Voltage : 8 Vrms
- Square Wave Output  
• Range : 10Hz ~ 100KHz  
• Output Voltage : 15Vp-p

Reg. \$249. **\$159.00**



**DC Power Supply, PS-500**  
**0-30VDC, 0-3A**

- 0 ~ 30VDC Continuously Variable
- Regulation : ≤ 0.01% + 3mV
- Ripple Voltage : p-p ≤ 2m Vrms; ≤ 1mV
- 0.1A ~ 3A Constant Current
- Regulation : ≤ 0.2% + 3mA
- Ripple Current : ≤ 3m Arms
- Short Circuit Overload Protection w/Indicating Lamp

Reg. \$399. **\$289.00**



**DC Power Supply, PS-540**  
**0-16VDC, 0-10A**

- 0 ~ 16VDC Continuously Variable
- Regulation : ≤ 0.01% + 3mV
- Ripple Voltage : p-p ≤ 2m Vrms; ≤ 1mV
- 0.1A ~ 10A Constant Current
- Regulation : ≤ 0.2% + 3mA
- Ripple Current : ≤ 3m Arms
- Short Circuit Overload Protection w/Indicating Lamp

**Oscilloscope Probes**  
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- 32 Seg. Bargraph
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- Auto Power Off
- Low Battery Mark
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**\$44.00**

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**Multi-Function w/Holster**

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  - Capacitance
  - TR-hFE
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  - Over Range Mark
  - Protective Holster
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- DM3050 Only
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# ARE YOU BEING "BUGGED?"

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# Counter-Surveillance Device

EVEN AS YOU READ THIS, countless individuals and firms are being enormously damaged by having their private conversations overheard, monitored, and/or recorded.

Almost without exception and AFTER the fact, the victims make a statement something along the lines of "But, I never thought it would happen to ME!"



### THE ULTIMATE IN "BUG" DETECTION EQUIPMENT "DEBUGS" ROOMS AND TELEPHONES!

If you require GUARANTEED PROTECTION against electronic telephone monitoring devices and also require COMPLETE CONFIDENTIAL PRIVACY in certain rooms and areas, we highly recommend the COUNTER-SURVEILLANCE DETECTOR CSD-18.



### CONDUCT A PROFESSIONAL SEARCH... ANYTIME... ANYWHERE!

Every newspaper and magazine article and every radio and TV story discussing some new episode involving "Bugging" devices, continues to increase the ever growing demand for electronic Counter-Surveillance "sweeps" and equipment. The very limited supply of competently trained and equipped Counter-Surveillance specialists has created a situation where "sweep" rates exceeding \$250 per hour are now considered reasonable and appropriate.

This is an exciting, immensely interesting and profitable field that you can enter with a minimum investment. Two hour actual practice with the CSD-18 will have you "reading" and "clearing" telephones and rooms with professional ease and competence. The average fee for "debugging" a single telephone is over \$200.00. It requires about 45 minutes to complete the job and once it gets around that YOU can provide this service, you'll quickly have more clients than you can handle. Even if you choose to provide "sweeps" for only a small number of friends and associates, your Initial Investment will quickly be returned many times over.

### EXTREME SENSITIVITY!

This is our finest piece of detection equipment! The CSD-18 quickly locates electronic eavesdropping devices in telephones, homes, offices, vehicles, boats, or concealed on the body. It will actually pick up many eavesdropping transmitters at ranges exceeding 25 feet! Extreme sensitivity is obtained via ultra-efficient amplification circuitry following the RF detection stages. Excellent quality Dynamic Headphones exclude all external sounds to further enhance detector output.



FULL RANGE DYNAMIC HEADPHONES

The presence of any "bug" is immediately indicated via a pronounced meter deflection. The CSD-18 quickly "homes-in" on eavesdropping transmitters and immediately pinpoints their location. The closer you get to the "bug", the further the needle moves to the right. It's as simple as that.

### "FLASHING" LED Warns You Instantly!



And, for maximum telephone security, the CSD-18 automatically analyzes a sophisticated series of electronic measurements along the telephone line and converts the analysis into an easy to follow, step by step, test procedure. No technical knowledge is required or necessary. A visual indication (via a flashing LED) immediately reveals the presence of the various types of telephone "taps" and the flashing sequence identifies the actual type of eavesdropping device.

### MAXIMUM SECURITY - EASY OPERATION!

Latest Computer-Age IC circuitry designed exclusively for maximum security and ease of operation, assures the utmost privacy protection possible today against virtually all types of room "bugs" and telephone "taps". The CSD-18 detects even the very latest ultra-sophisticated devices specifically designed to defeat detection via polarity negating circuitry. Also includes multi-line option for testing business telephones.

### FREE BONUS!

### FASCINATING HI-TECH INFORMATION PACKAGE INCLUDED FREE!

#### LATEST EAVESDROPPING DEVELOPMENTS

A detailed analysis of a variety of extremely fascinating hi-tech devices and procedures used for ultra-sophisticated audio and video eavesdropping including infrared monitoring, multi-data eavesdropping and interception, miniature micro-wave devices, new methods for listening thru walls, etc., with many schematics included. You'll learn about electronic voice changers, corporate spying, how data banks are accessed to research anyone and anything, eavesdropping by neighbors; space age personnel and vehicle tracking systems, how missing persons are found, how lie detectors are deceived, and a fact-filled section on Eavesdropping Law.

#### BIG MONEY IN COUNTER-SURVEILLANCE

Complete information describing the fantastic opportunities that are now open to trained Counter-Surveillance technicians and exactly how a number of individuals and firms are reaping a huge bonanza in the booming "Debugging" business! You'll learn how the ever increasing use of Electronic Listening Devices by investigative agencies, government agencies, unscrupulous business competitors, jealous suitors, etc., has created a tremendous demand for this type of service.

A comprehensive information package JAM-PACKED FULL of some of the most exciting and fascinating reading imaginable. Reads like a James Bond novel, with one important exception...IT'S NOT FICTION!

### THE ONE "BUG" TO FEAR MOST!

While most individuals are now somewhat guarded in their telephone conversations, they still rather naively feel secure in the "privacy" of their own home or office. However, the most common type of tap presently used by eavesdroppers picks up ALL SOUNDS AND CONVERSATION WITHIN A ROOM...WITH THE TELEPHONE STILL ON THE HOOK!

Due to this devastating capability, this "Infinity" tap (variously referred to as Infinity Transmitter, Hookswitch Bypass, 3rd Wire, Harmonica Bug, etc.), has become the "bug of choice".

In flagrant violation of federal law prohibiting their use and sale, these devices in various forms are openly advertised in many technical publications for as little as \$75. Literally thousands of these devices are now in the hands of unscrupulous individuals all over the country!

In response to this ever-growing threat, a uniquely engineered feature of the CSD-18 now also detects Infinity type devices anywhere "down the line".

In other words, if anyone ... ANYWHERE ... is utilizing the telephone tip and/or ring wires to monitor your private room conversations while your telephone is on the hook, you'll immediately be made aware of it via a flashing LED!

#### 100% POSITIVE INDICATION

The CSD-18 also flawlessly detects "Series" and "Parallel" telephone transmitters and "Telephone Recording Devices". And, a separate feature silently indicates when extension phones are picked up or being used. The CSD-18 completely eliminates all doubt and guesswork.

#### EXCLUSIVE "LISTEN-IN" FEATURE!

The CSD-18 will even allow you to "listen-in" to exactly what the eavesdropper is monitoring. And, without the eavesdropper ever becoming aware that he has been detected! We are unaware of ANY other detection equipment having this combined capability AT ANY PRICE!

### MAXIMUM PROTECTION

The CSD-18 provides maximum protection against ALL major categories of surveillance equipment including:

- ALL TYPES OF "CONCEALED TRANSMITTERS"
- "BUMPER BEEPERS"
- "INFINITY" DEVICES
- "BODY" TRANSMITTERS
- "TELEPHONE RECORDING DEVICES"
- "SERIES" & "PARALLEL" PHONE TRANSMITTERS

CSD-18 \$ **295** Complete

Including batteries, antenna/probe, headphones, all plugs & adapters, extensive information package and instructions.

### HOW TO ORDER

Order NOW by Mail or Telephone. 10 DAY MONEY BACK GUARANTEE if you're not 100% pleased and completely satisfied. We pay shipping charges on all prepaid & credit card orders. Add \$15 for CODs.

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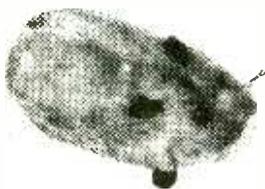
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### ELECTRONIC HAMSTER

This furry critter used to come with its own transparent ball. The balls are all gone, but the robot hamster survives. This rodent "listens" for a sharp noise (handclap) which sends it scurrying off to crash headlong into whatever is in its path - just like the real thing. Runs on 3 "AA" batteries (not included). (92T006) **3 for \$9.95**



### ROBOT ARACHNID

A smart electronic toy that performs "wiggle" tricks ("come," "sic 'em," "obey," "go play") to your command. "Sleep" mode conserves batteries. Uses 4 "C" cells (not included). (93T002) **\$29.95 each**

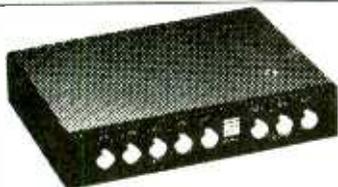
### PRECISION EYEPIECE

21mm f:3.5. Four coated glass lenses in black aluminum case measuring 1.15625" long by 0.0625" diameter. Excellent correction of all aberration for an angle of 35 deg. without vignetting (obstruction of view at edge), or 45 deg. angle with slight vignetting. Linear resolution in focus is very near the theoretical limit of 385 lines/mm when the image of object is in focus (D=6mm), or 500 lines/mm when object is in focus (numerical aperture=1.41). Possible applications include: objective lens for scanners; photographic objective enlarging nearly 10X; objective for a hand-held microscope, enlarging from 30X to 120X (numerical aperture=1.41); lens working with light sensor or emitter as a precise focusing element; or lens for shaping a laser beam. (92L031)

**Special Price until 12/31/94 - \$7.95**

### FM TRANSMITTER BUG

The most powerful bug for its size, 3V supply and number of components. Based on proven design. Uses trimcap for easy tuning in the FM band. 50 meters within buildings, 300 meters or more in open. Full documentation and battery holder included. (Kit #16) **\$12.99 each**



### VIDEO SWITCHING CENTER

Five inputs (VCR, Game, CATV, Aux, Ant), two outputs (TV, VCR). Measures 6.25"W x 5.5"D x 1.5"H. These units are new in box and come with instructions. (94V004) **\$9.95 each**



### 14-DAY PROGRAMMABLE TIMER

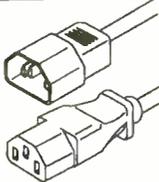
Originally used to control a satellite receiver through its IR port at a distance of up to 23 ft. Time on/off for eight distinct events. Modify it for your needs or dismantle it for its parts. Programmable with a 2732 EPROM in a removable "personality" module, the unit may be modified to control any IR device through its IR port. Contains Z8 CPU, clock display and associated parts. Operates from 9VDC 500 mA wall transformer which is included. **BRAND NEW! (92V014)**

**Special Price until 12/31/94 - \$9.95**

### 1' MONITOR POWER CABLE

If your monitor has a permanent AC power cord attached, plug it into its adapter and then into the back of your computer. (94W002)

**\$2.95 each**



### 3' MONITOR POWER CABLE

(94W014) **\$2.49 each**  
*Dealer Inquiries Invited*

### SUPER-POWERFUL MAGNET ASSEMBLY

Two magnets approx 1.75"x2.25" mounted in a metal frame. Strength is approx. 1300 Gauss each. These magnets are epoxied in place and are not easily removed. Makes excellent clamping/holding assembly. (92N001) **\$15.95 Pair**



### 150 WATT REGULATED POWER SUPPLY

36VDC, 4.2A output, 120-220VAC input. Attractive black shockproof case, 4.75" x 3" x 10.5". Designed for Convert Computer Co.

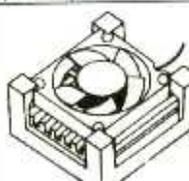
(92E026) **\$19.95 each**



### '486 FAN

Brand new, in package. (93F004)

**\$11.95 each**



(92C002) **2 for \$19.95**



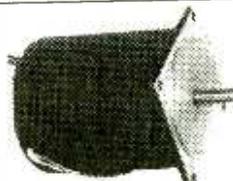
### 1x16 LCD DISPLAY

Standard 14 pinout interface. Specs included. (94L002) **\$9.95 each**



### RAPIDSYN STEPPER MOTOR

1.8 deg/step, 2.9VDC @ 3.0A. Large mounting flange measures 3.25" square. Rapidsyn model #340D-9106A. (94M004) **\$24.95 each**



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9600 Baud - N-8-1  
On-Line Ordering

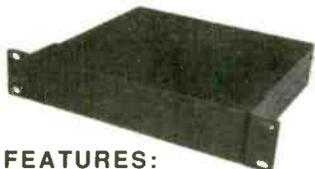
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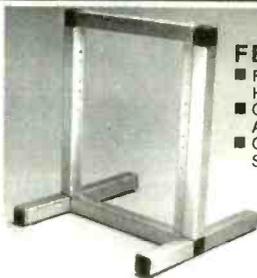


## FEATURES:

- 1/2 RACK SIZE FOR COMPACT DESIGN
- CAN BE USED ON TABLE OR IN RACK
- FULL LINE OF ACCESSORIES
- THREE COLORS AVAILABLE: CLEAR STANDARD, FOR BLACK OR GOLD ADD \$5.00 PER BOX

### RACKEM 'N' STACKEM™ Box

MODEL	DESCRIPTION W x H x D (in.)	PRICE \$
RSB-3	7.5 x 1.65 x 3	25.00
RSB-5	7.5 x 1.65 x 5	31.25
RSB-7	7.5 x 1.65 x 7	38.00
RSB-9	7.5 x 1.65 x 9	45.00
RSB-11	7.5 x 1.65 x 11	51.50
RSB-13	7.5 x 1.65 x 13	58.25



## FEATURES:

- FOUR MODELS AVAILABLE IN HALF AND FULL RACK WIDTHS
- CLEAR, BLACK AND GOLD ANODIZED FINISHES
- CONSTRUCTED OF 1.0" SQUARE ALUMINUM TUBING

### RACKEM 'N' STACKEM™ Table Top Racks

MODEL	DESCRIPTION W x H x D (in.)	PRICE \$
RSR-6	11.4 x 15.2 x 11	60.00
RSR-8	11.4 x 18.8 x 11	65.00
RSR-10	11.4 x 22.6 x 11	70.00
RSR-12	11.4 x 26.4 x 11	75.00
RSR-6-19	20.9 x 15.2 x 11	70.00
RSR-8-19	20.9 x 18.8 x 11	75.00
RSR-10-19	20.9 x 22.6 x 11	80.00
RSR-12-19	20.9 x 26.4 x 11	85.00

**NEW**

## RACKEM 'N' STACKEM™ SERIES



### RACK CHASSIS

PANELS ARE .063" ALUMINUM; STANDARD FRONT AND REAR PANELS ARE CLEAR ANODIZED, BLACK OR GOLD PANELS ALSO AVAILABLE FOR ADDITIONAL \$5.00

### Rack Chassis

MODEL	DESCRIPTION W x D x H (in.)	PRICE \$
1RU5	19 x 5 x 1.75	34.00
1RU7	19 x 7 x 1.75	36.50
1RU10	19 x 10 x 1.75	38.75
1RU12	19 x 12 x 1.75	42.75
1RU15	19 x 15 x 1.75	45.75
1RU17	19 x 17 x 1.75	48.75
2RU5	19 x 5 x 3.5	36.50
2RU7	19 x 7 x 3.5	38.75
2RU10	19 x 10 x 3.5	41.25
2RU12	19 x 12 x 3.5	45.25
2RU15	19 x 15 x 3.5	48.25
2RU17	19 x 17 x 3.5	51.25
3RU5	19 x 5 x 5.25	46.00
3RU7	19 x 7 x 5.25	48.50
3RU10	19 x 10 x 5.25	51.00
3RU12	19 x 12 x 5.25	54.00
3RU15	19 x 15 x 5.25	57.00
3RU17	19 x 17 x 5.25	60.00

### Dual Slope Cabinets

MODEL	DESCRIPTION W x D x H (in.)	PRICE \$
DS-1	4 x 6 x 4	62.00
DS-2	6 x 6 x 4	66.50
DS-3	8 x 6 x 4	70.75
DS-4	10 x 6 x 4	75.00
DS-5	12 x 6 x 4	79.75
DS-6	18 x 6 x 4	85.00
DS-7	4 x 8 x 6	72.50
DS-8	6 x 8 x 6	76.50
DS-9	8 x 8 x 6	82.00
DS-10	10 x 8 x 6	86.75
DS-11	12 x 8 x 6	92.25
DS-12	18 x 8 x 6	105.75

## BOX-IT SYSTEM™

A NEW MODULAR SYSTEM FOR FAST AND EASY CONSTRUCTION WITH NO TOOLS

- OVER 180 PREPUNCHED ALUMINUM FRONT AND REAR PANELS TO MIX AND MATCH
- PANELS SUPPLIED WITH MARKING DECALS
- FULL RANGE OF BOXES AVAILABLE IN FULL AND HALF RACK WIDTHS; RACK MOUNT OR TABLE TOP STYLES
- ASSEMBLES WITH ONLY A PHILLIPS SCREWDRIVER
- ELECTRONIC COMPONENTS ALSO AVAILABLE
- THREE COLORS ; CLEAR, BLACK AND GOLD



### HEAVY DUTY RACK CHASSIS

PANELS ARE .080" ALUMINUM AND ARE FIELD REMOVABLE; STANDARD FRONT & REAR PANELS ARE CLEAR ANODIZED, BLACK PANELS AVAILABLE FOR ADDITIONAL \$15.00

### Metal Cabinets

MODEL	DESCRIPTION W x D x H (in.)	PRICE \$
MC-1A	4 x 3 x 2	17.25
MC-2A	6 x 3 x 2	20.00
MC-3A	8 x 3 x 2	22.00
MC-4A	4 x 4 x 3	20.00
MC-5A	6 x 4 x 3	22.00
MC-6A	8 x 4 x 3	24.25
MC-7A	4 x 7 x 4	22.00
MC-8A	6 x 7 x 4	24.25
MC-9A	8 x 7 x 4	27.00

### Heavy Duty Rack Chassis

MODEL	DESCRIPTION W x D x H (in.)	PRICE \$
3RU7 HD	19 x 7 x 5.25	120.75
3RU10 HD	19 x 10 x 5.25	127.00
3RU14 HD	19 x 14 x 5.25	140.75
4RU7 HD	19 x 7 x 7.0	127.00
4RU10 HD	19 x 10 x 7.0	135.50
4RU14 HD	19 x 14 x 7.0	140.75
5RU7 HD	19 x 7 x 8.75	132.25
5RU10 HD	19 x 10 x 8.75	139.75
5RU14 HD	19 x 14 x 8.75	150.25



DUAL SLOPE CABINET  
PANELS ARE .063" ALUMINUM



RF SHIELDED BOXES  
HOT TIN-PLATED STEEL

### RF Shielded Steel Boxes

MODEL	DESCRIPTION L x W x H (inches)	PRICE \$
SB-1	2.1 x 1.9 x 1.0	4.50
SB-2	3.3 x 1.9 x 1.0	6.00
SB-3	4.2 x 1.9 x 1.0	9.00
SB-4	6.3 x 1.9 x 1.0	10.50
SB-5	3.3 x 2.7 x 1.1	9.50
SB-6	4.8 x 2.7 x 1.1	11.50
SB-7	6.4 x 2.7 x 1.1	13.20
SB-8	2.6 x 2.7 x .63	7.00
SB-9	3.2 x 2.7 x .63	8.25
SB-10	4.8 x 2.7 x .63	9.00
SB-11	6.3 x 2.7 x .63	10.75
FTS-1	1000 pF/50VDC SOLDER TYPE	.85
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- Date & time of each call.
- Length of the call.
- What number was dialed.
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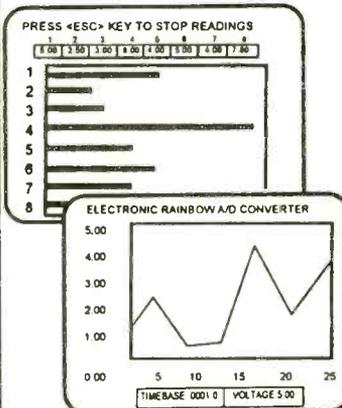
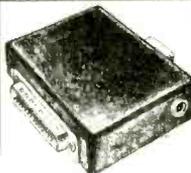
All software included!

TM-1 ONLY **\$99<sup>95</sup>** KIT

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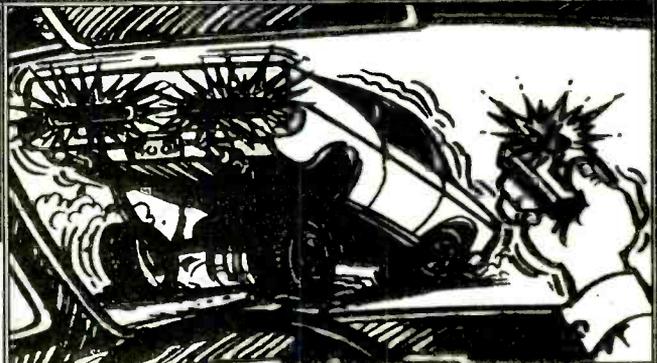
## 8 CHANNEL A to D CONVERTER KIT

Complete with Software. Over 20 DOS programs provided!



- Connect your computer to the outside world through a parallel port!
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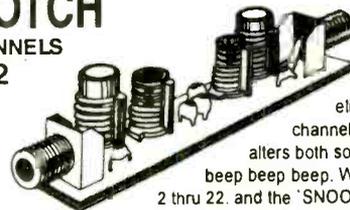


**THE ZAPPER** activates any radar detector within 3/4 of a mile. Check the brake lights of that sports car that just went by 90 miles an hour. Back off that 18 wheeler trying to eat your back bumper. Put the fun back in driving. THE ZAPPER is a 10GHz amateur transmitter the size of a cigarette pack, operates on a 9v battery, when the button is pushed, brake lights and radar detector light the skies. Complete with the rules of the new ROAD WARRIOR GAME...TROLLING FOR TAIL LIGHTS, Americas fastest growing highway participatory sport.

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Kit **\$39<sup>95</sup>**

## TV NOTCH

FOR CHANNELS  
2 thru 22  
ONLY

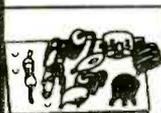


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Our TV filters eliminate unwanted TV channels or interference that alters both sound and video with a beep beep beep. Works on cable channels 2 thru 22, and the 'SNOOPER & BULLET.

NOTE: All TV Filter Kits are sold for educational purposes only. You must obtain permission from your local cable company before using these filters on your cable system.

DF-222 Kit **\$14.95**



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Small but mighty, it fits anywhere. Phone line powered, never needs batteries. Transmits both sides of a phone

conversation loud and clear, wireless, to any FM radio at great distances. Variable tunes from 70MHz to 130MHz FM. You can also use it as a speaker phone. SIZE 5"x1".

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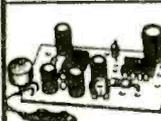


## WIRELESS FM MICROPHONE

Small but mighty this little jewel will out perform most units many times its price. It really

stomps out a signal. The WM-1 kit is a buffered wireless mike that operates from 80MHz to 120MHz FM, the frequency of any broadcast FM radio. Includes a mini-electret mike. SIZE: 8"x1" 6 to 12vDC

WM-1 **\$14.95**



## SUPER SNOOPER BIG EAR

Listen through walls, hear conversations across the room. Add a parabolic reflector and hear blocks away. The BIG EAR can be hidden about anywhere. Makes an ultra sensitive intercom. Can be used as a 1.5W AMP. We supply a mini-electret mike in the kit. SIZE: 1"x.75" 6 to 12vDC.

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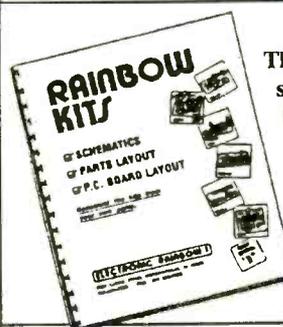


## 5.0mW Laser Diode

Great for making a gun sight, use as a transit, makes a super

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LDM-5 **\$89.95**



This Manual contains all schematics, parts lists & P.C. board layouts for all of the Rainbow Kits. Use your own parts to construct any of our kits.

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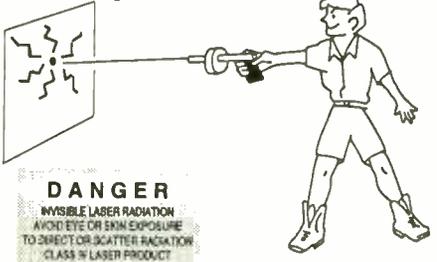
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Remember War of the World? Objects float in air and move to the touch. Defies gravity, amazing gift, conversation piece, magic trick or great science project.

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## Laser Ray Gun



**DANGER**  
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Advanced project produces a burst of light energy capable of burning holes in most materials. Hand-held device uses rechargeable batteries. 500 joules of flash energy excite either a neodymium glass, yag or other suitable 3" laser rod. This is a dangerous CLASS IV project (individual parts/assemblies available). LAGUN1 Plans ..... \$20.00  
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Neat little device allows you to make hand and shock balls, shock wands and electrify objects, charge capacitors. Great payback for those wise guys who have wronged you!

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Pocket-sized wand produces 100,000 watts of power for personal defense, field and lab use, etc. BLS3 Plans ..... \$10.00  
BLS3K Kit / Plans ..... \$69.50

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Beeper device, 3 mile range.  
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## Listen Through Walls, Floors

Highly sensitive stethoscope mike.  
STETH1 Plans ..... \$8.00 STETH1K Kit/Plans ..... \$44.50



## NEW! INFINITY TRANSMITTER++ Room Monitor / Phone Line Grabber

ALL NEW! The Ultimate in Home or Office Security & Safety! Simple to Use! Call your home or office phone, push a secret tone on your telephone keypad to access either: A. On premises sounds and voices; or B. Existing telephone conversation with break in capability for emergency messages. CAUTION: Before assembly or use, check legalities with your state Attorney General's office as you may require "beepers" or other 3rd party alerts. TELEGRAB1 Plans Only ..... \$10.00  
TELEGRAB1K Kit / Plans ..... \$99.50

## Visible Beam Laser

Easy to build, RED Beam, visible for miles. Use for light shows, window bounce holography, cloud illumination and much more! LAS1KM Kit w/1mw Laser Tube, Class II. .... \$69.50  
LAS3KM Kit w/2.5mw Laser Tube, Class IIIA ..... \$99.50

## 100,000V Intimidator / Shock Wand Module

Build an electrical device that is affective up to 20 feet. May be enclosed for handheld, portable field or laboratory applications.  
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## Ion Ray Gun

Projects charged ions that induce shocks in people and objects without any connection! Great science project as well as a high tech party prank. IOG3 Plans ..... \$8.00  
IOG3K Kit/Plans ..... \$69.50

## Invisible Pain Field Generator

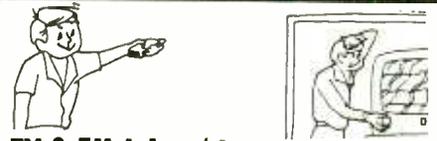
Shirt pocket size electronic device produces time variant complex shock waves of intense directional acoustic energy, capable of warding off aggressive animals, etc.  
IPG7 Plans ..... \$8.00 IPG7K Kit/Plans ..... \$49.50  
IPG70 Assembled ..... \$74.50

## 1000 Ft++ Potato Cannon

NOT A TOY. Uses electronic or piezo ignition. CAUTION REQUIRED!  
POT1 Plans ..... \$10.00  
(Dangerous Product)

## FireBall Gun

Shoots flaming ball - two shot capacity  
Great for special effects and remote fire starting. CAUTION REQUIRED!  
FIREBALL Plans (Dangerous Product).....\$10.00



## TV & FM Joker / Jammer

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Utilizes our touch power control!  
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Easy-to-Install 4-Tube Kit for Cars, Trucks, Vans! Available in Pink, Purple, Blue or Green - please specify color when ordering.  
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Flash-To-Music Option for above kit FMU1 ..... \$29.50  
License Frame Kit (Specify Color) LIC1K ..... \$29.50

## 3 Mi FM Wireless Microphone

Subminiature! Crystal clear, ultra sensitive pickup transmits voices and sounds to FM radio. Excellent for security, monitoring of children or invalids. Become the neighborhood disk jockey!  
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## Telephone Transmitter - 3 Mi

Automatically transmits both sides of a telephone conversation to an FM radio. • Tunable Frequency • Undetectable on Phone • Easy to Build and Use • Up to 3 Mile Range • Only transmits during phone use. VWPM7 Plans ..... \$7.00  
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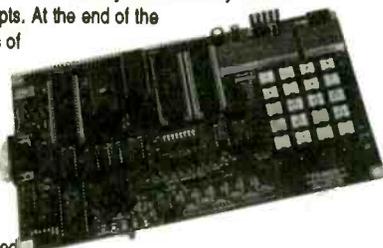


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- Up to 1 mile range.



**LONG RANGE PHONE TRANSMITTER**

Similar to our very popular XSP250, the XTT100 is battery powered for greater range. It plugs into any phone jack and transmits both sides of conversations on that line.

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- Use with any FM broadcast receiver.
- Hear every sound in an entire house!
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- Use with any modular phone.
- 16 levels of voice masking.
- Connects between handset and phone.



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- Works with most any scanner.
- 10 TO 1000 MHz.
- 10 dB typical gain.
- 3 dB typical noise figure.



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# CircuitMaker® vs. Electronics Workbench®

## A NEW STANDARD HAS JUST BEEN SET!

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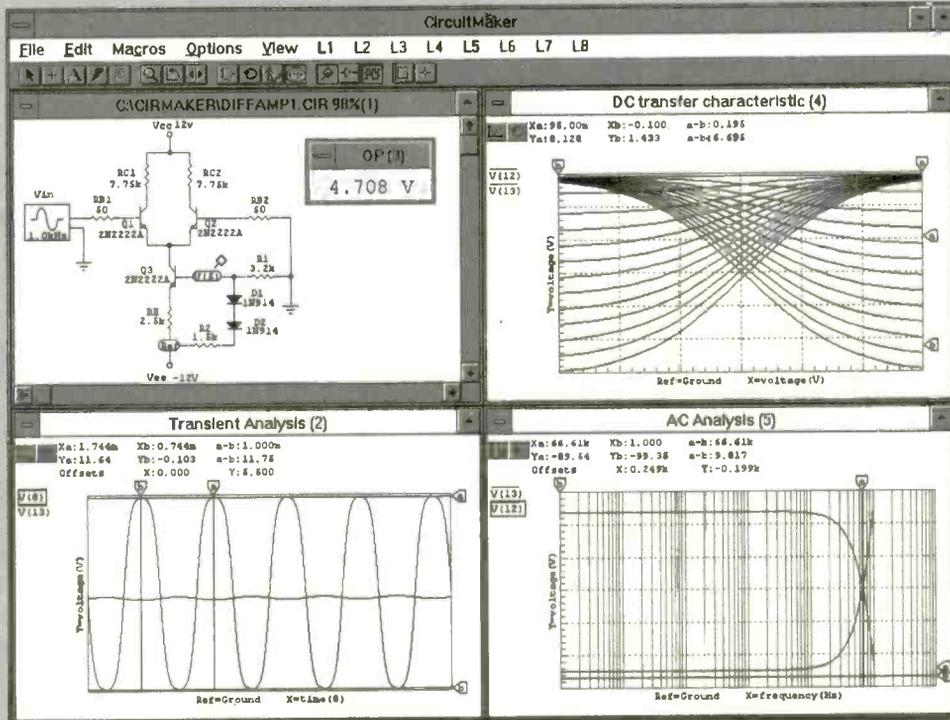
CircuitMaker's analog simulation results are shown in graph windows that provide powerful, interactive analysis options. You can plot multiple waveforms by clicking on the desired nodes and can select linear or logarithmic axes. Horizontal and vertical cursors facilitate quick and accurate measurements. You can also zoom in on any portion of the graph to obtain additional detail.

Electronics Workbench offers a single, small scope or Bode plot instrument window. The windows are not sizeable and only two waveforms can be plotted at a time. EWB has a single measurement cursor and provides no direct way to read results from the instruments.

### Superior Digital Simulation

CircuitMaker has an exclusive Trace feature where the state of every node is indicated in color as the simulation runs. You can monitor as many waveforms as your screen will allow, set edge or level breakpoints for analysis, and interactively see the state of any node by touching the logic probe to it. The data sequencer provides 1024 words of pattern data. Additional digital instruments include ASCII and HEX input keys and an ASCII display. CircuitMaker includes tri-state devices and devices have programmable propagation delays.

Electronic Workbench has no interactive logic probe or Trace capability and no Hex or ASCII keys. Their "word generator" is limited to 16 words. EWB does not have tri-state devices and digital devices do not have programmable propagation delays.



### Comprehensive Device Libraries

CircuitMaker includes libraries containing programmable, TTL, CMOS, generic analog and digital devices, and many powerful I/O devices. With CircuitMaker's macro function you can quickly and easily create your own functional devices and symbols. Now that's giving you the tools you need to get the job done right!

Electronics Workbench ships with only 17 digital devices. If you want additional devices you pay extra.

### High-Performance Schematic Capabilities

CircuitMaker puts you in control of your schematic with SmartWires™, bussing, page connectors, and rubberbanding. You can label devices and pins, add fully stylized multiline text, and create a parts list or netlist. With the Macro feature you can add user defined symbols to your device library.

Electronics Workbench dictates wire placement to you. EWB limits your overall "workbench" layout to 1 x 2 pages. EWB has no bussing, page connectors, pagebreaks, print scaling, labeling, free text fields, netlisting, zoom, undo, and no Toolbar or Toolbox.

### Competitive Upgrade Offer

You deserve the best. Upgrade from any competing product for only \$99. New users can purchase CircuitMaker for a limited time at a special introductory price of just \$269. Suggested Retail Price \$299.

### Technical Support

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Comparison based on CircuitMaker 2.0 for Windows and Electronics Workbench 3.0 for Windows. All product and company names are trademarks of their respective owners.

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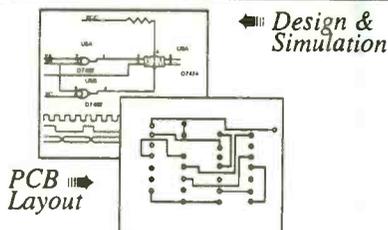
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**Frequency Resolution:** .005 Hz (.007 Hz w/ opt-5)  
**Frequency accuracy:** ± 25 ppm (± 2 ppm w/ opt-1)  
**Pulse:** Single Burst, Neg. or Pos.  
**Pulsewidth Range:** 200 s to 125 ns  
**Pulse width resolution:** 5 sec to < 1 ns  
(consult factory)

**Sine modes:** CW, AM, FM, Sweep

**Square modes:** CW, Sweep and Burst

**Triangle modes:** CW

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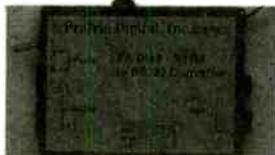
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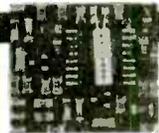
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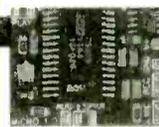
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### What are Muscle Wires?

Muscle Wires are highly processed strands of a nickel-titanium alloy called *nitinol*. At room temperature they are easily stretched by up to 5% of their length. When conducting an electric current they return to their original "unstretched" shape with a force *thousands of times* their weight.

### How strong are Muscle Wires?

This varies with the wire's size. A single wire can lift from 35 to 930 grams (over 2 lbs)! For more strength, use several wires in parallel.

### How fast can Muscle Wires activate?

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Flexinol Muscle Wire Specifications				
Wire Diameter (µm)	50	100	150	250
Resistance (Ω/m)	510	150	50	20
Contract Force (grams)	35	150	330	930
Typical Current (mA)	50	180	400	1000

### How much power do Muscle Wires need?

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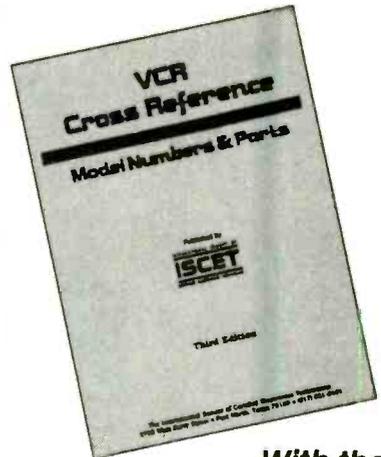
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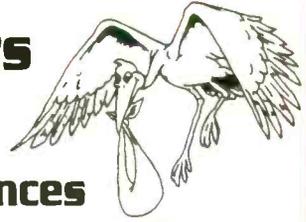
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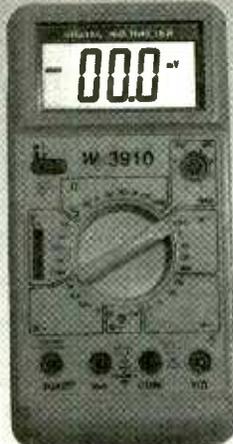
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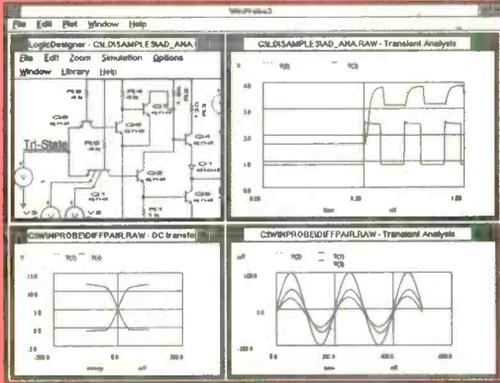
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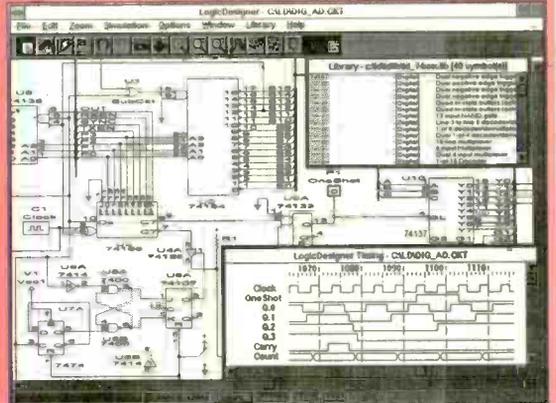
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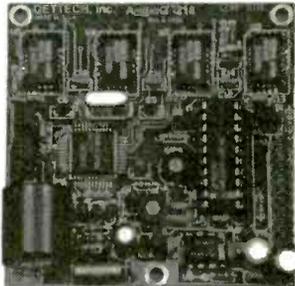
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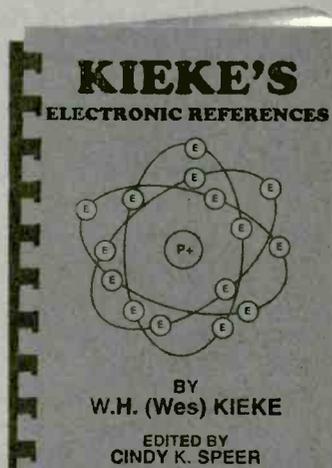
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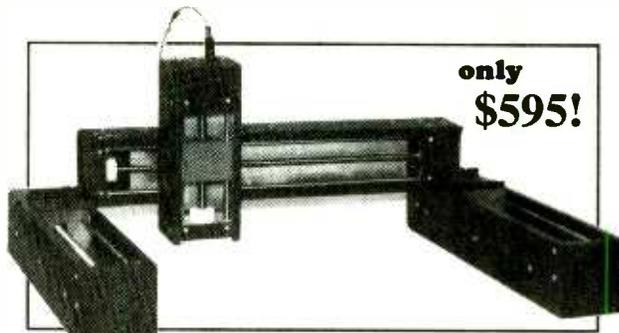
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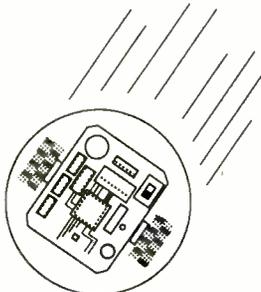
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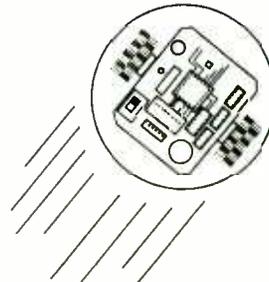
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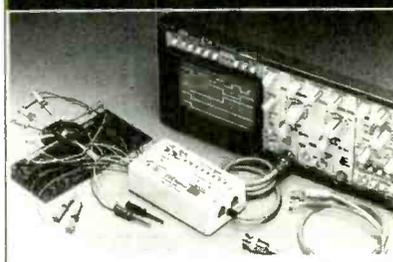
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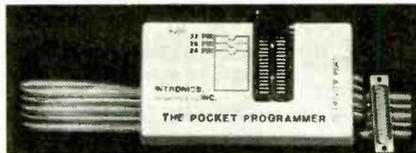
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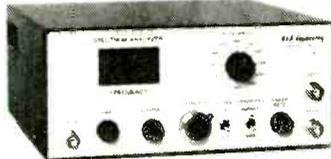
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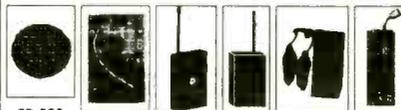
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**BP61—Beginners Guide to Digital Techniques...\$5.00.** Covers the basics of digital techniques—decimal, binary, octal and hexadecimal numbering systems are covered plus insights on weighted and non-weighted binary-coded-decimal codes and alpha-numeric codes. The basic building blocks of circuit logic, the common AND, OR, NAND, NOR and EXCLUSIVE-OR gates and bi-stables, are thoroughly covered.



**BP285—A Beginners Guide to Modern Electronic Components...\$6.50.** It is easy for newcomers to electronics to become confused. There are a great many different types of components available often with numerous variations of each type. This book presents the reader with a vast amount of invaluable parts information to enable the right component to be selected every time for repairs and projects.



**PCP103—Practical MIDI Handbook...\$9.95.** The Musical Instrument Digital Interface (MIDI) is surrounded by a great deal of misunderstanding. This book is aimed at musicians and technicians who want to explore the vast capabilities of MIDI. It covers MIDI-based equipment you can use: keyboards, drum machines, sequencers, effects units, mixers, drum pads, guitars. There's also a section on computer music.



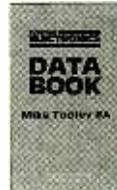
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# Scanners/CB/Ham/Shortwave

**COMMUNICATIONS ELECTRONICS INC.**  
Emergency Operations Center

**25th Anniversary Special**  
**Save \$30.00**  
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Celebrate our 25th anniversary with special savings on your choice of a new Bearcat 8500XLT or Bearcat 2500XLT radio scanner. This coupon must be included with your prepaid order. Offer valid only on orders mailed directly to Communications Electronics Inc., P.O. Box 1045 - Dept. PE1194, Ann Arbor, Michigan 48106-1045 U.S.A. Coupon expires November 30, 1994. Limit one coupon per item. Coupon may be photocopied. Coupon may not be used in conjunction with any other offer. Credit cards are excluded from this offer. Void where prohibited.

## Bearcat Scanners

### Bearcat 2500XLT-K Radio Scanner

List price \$649.95/CE price \$338.95/SPECIAL  
400 Channels • 20 Banks • Turbo Scan  
Rotary tuner feature • Auto Store • Auto Sort  
Size: 2-3/4" Wide x 1-1/2" Deep x 7-1/2" High  
Frequency Coverage: 25,000 - 549,950, 760,000 - 823,995, 849,0125 - 868,9950, 894,0125 - 1,300,0000 MHz.

Signal intelligence experts, public safety agencies and people with inquiring minds that want to know, have asked us for a world class handheld scanner that can intercept just about any radio transmission. The new Bearcat 2500XLT has what you want. You can program frequencies such as police, fire, emergency, race cars, marine, military aircraft, weather, and other broadcasts into 20 banks of 20 channels each. The new rotary tuner feature enables rapid and easy selection of channels and frequencies. With the AUTO STORE feature, you can automatically program any channel. You can also scan all 400 channels at 100 channels-per-second speed because the Bearcat 2500XLT has TURBO SCAN built-in. To make this scanner even better, the BC2500XLT has AUTO SORT - an automatic frequency sorting feature for faster scanning within each bank. Order your scanner today from CEI.

A modification sheet with instructions to restore full 800 MHz. coverage for our Bearcat 2500XLT or Bearcat 200XLT may be ordered for \$8.00. To order any Bearcat radio product call 1-800-USA-SCAN.

### Other Bearcat Scanners

- Bearcat 8500XLT-K base/mobile \$368.95
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### Bearcat 8500XLT-K Radio Scanner

List price \$689.95/CE price \$368.95/SPECIAL  
500 Channels • 20 banks • Alphanumeric display  
Turbo Scan • VFO Control • Priority channels  
Auto Store • Auto Recording • Reception counter  
Frequency step resolution 5, 12.5, 25 & 50 KHZ.  
Size: 10-1/2" Wide x 7-1/2" Deep x 3-3/8" High  
Frequency Coverage:  
25,000 - 28,995 MHz. (AM), 29,000 - 54,000 MHz. (NFM),  
54,000 - 71,995 MHz. (WFM), 72,000 - 75,995 MHz. (NFM),  
76,000 - 107,995 MHz. (WFM), 108,000 - 136,995 MHz. (AM),  
137,000 - 173,995 MHz. (NFM), 174,000 - 215,995 MHz. (WFM),  
216,000 - 224,995 MHz. (NFM), 225,000 - 399,995 MHz. (AM),  
400,000 - 511,995 MHz. (NFM), 512,000 - 549,995 MHz. (WFM),  
760,000 - 823,9875 MHz. (NFM), 849,0125 - 868,9875 MHz. (NFM),  
894,0125 - 1,300,000 MHz. (NFM).

The new Bearcat 8500XLT gives you pure scanning satisfaction with amazing features like Turbo Scan. This lightning-fast technology featuring a triple conversion RF system, enables Uniden's best scanner to scan and search up to 100 channels per second. Because the frequency coverage is so large, a very fast scanning system is essential to keep up with the action. Other features include VFO Control - (Variable Frequency Oscillator) which allows you to adjust the large rotary tuner to select the desired frequency or channel. Counter Display - Lets you count and record each channel while scanning. Auto Store - Automatically stores all active frequencies within the specified bank(s). Auto Recording - This feature lets you record channel activity from the scanner onto a tape recorder. You can even get an optional CTCSS Tone Board (Continuous Tone Control Squelch System) which allows the squelch to be broken during scanning only when a correct CTCSS tone is received. 20 banks - Each bank contains 25 channels, useful for storing similar frequencies in order to maintain faster scanning cycles. For maximum scanning enjoyment, order the following optional accessories: P5001 Cigarette lighter power cord for temporary operation from your vehicle's cigarette lighter \$14.95; PS002 DC power cord - enables permanent operation from your vehicle's fuse box \$14.95; MB001 Mobile mounting bracket \$14.95; BC005 CTCSS Tone Board \$54.95; EX711 External speaker with mounting bracket & 10 feet of cable with plug attached \$19.95. The BC8500XLT comes with AC adapter, telescopic antenna, owner's manual and one year limited warranty from Uniden. Order your BC8500XLT from Communications Electronics Inc. today.

## CB/GMRS Radios



A National Weather Service (NWS) receiver with automatic emergency broadcast activation has been added to the legendary Cobra 29 CB radio. The integrated NWS receiver in the Cobra 29LTDXW will automatically activate to receive emergency announcements about severe weather and travel conditions. A special tone-alert signal broadcast by the NWS activates the weather receiver and overrides any CB radio reception for monitoring the warning message. Cobra 29LTDXW-K CB/Weather Alert.. \$129.95  
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Cobra HH40-K CB 40 ch. Handheld ..... \$99.95  
Uniden GMR100-K GMRS Handheld ..... \$159.95  
Uniden WASHINGTON-K SSB CB Base. \$189.95  
Uniden GRANTXL-K SSB CB Mobile ..... \$139.95  
Uniden PRO538W-K CB & Weather ..... \$59.95



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## Weather Stations

Now you can be your own weather reporter with the Davis Weather Monitor II. Our top-of-the-line weather station combines the most advanced weather monitoring technologies available into one incredible package. Glance at the display, and see wind direction and wind speed on the compass rose. Check the barometric trend arrow to see if the pressure is rising or falling. Push a button, and read indoor and outdoor temperature, wind chill, humidity and barometric pressure. Our package deal includes the new ultra high resolution 1/100 inch rain collector part #7852-K, and the external temperature/humidity sensor, part #7859-K. The package deal is order #DAVI-K for \$479.95 plus \$15.00 shipping. If you have a personal computer, when you order the optional Weatherlink computer software for \$139.95, you'll have a powerful computerized weather station at an incredible price. For the IBM PC or equivalent order part #7862-K. Apple Mac Plus or higher including PowerBook, order part number 7866-K.

The Weather Monitor II (7440-K) comes complete with anemometer with 40 feet of cable, external temperature sensor with 25 feet of cable, junction box with 8 feet of cable, AC power adapter, detailed instruction booklet and one year limited factory warranty.



- Davis Weather Monitor II 7440-K ..... \$334.95
- Davis Weather Wizard III 7425-K ..... \$154.95
- Davis Remote Display Unit 7815-K ..... \$84.95
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- SNR ID200-K Bouncer name/number caller ID, call reject, forward to machine ..... \$89.95
- ICOM GP22-K handheld global positioning system (GPS) ..... \$599.95
- WL200-K weather radio with National Weather Service storm alert ..... \$359.95
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- RELM BH3600-K VHF 25 watt, 16 channel synthesized transceiver ..... \$289.95
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## Buy with confidence

It's easy to order from CEI. Mail orders to: Communications Electronics Inc., Emergency Operations Center, P.O. Box 1045, Ann Arbor, Michigan 48106 U.S.A. Add \$15.00 per radio for U.P.S. ground shipping and handling in the continental U.S.A. unless otherwise stated. Add \$8.00 shipping for all accessories and publications. Add \$8.00 shipping per antenna. For Canada, Puerto Rico, Hawaii, Alaska, P.O. Box, or APO/FPO delivery, shipping charges are two times continental U.S. rates. Michigan residents add state sales tax. No COD's. No returns or exchanges after 31 days. 10% surcharge for net 10 billing to qualified accounts. All sales are subject to availability, acceptance and verification. Prices, terms and specifications are subject to change without notice. We welcome your Discover, Visa, American Express or MasterCard. Call 1-800-USA-SCAN to order toll-free. Call 313-996-8888 if outside the U.S.A. FAX anytime, dial 313-663-8888. For technical assistance to solve your communications problem, call the Communications Electronics technical support hotline for \$2.00 per minute at 1-900-555-SCAN. Order your new electronic equipment from Communications Electronics Inc. today. Scanner Distribution Center and CEI logos are trademarks of Communications Electronics Inc. Sale dates 9/15/94 - 11/30/94. AD #915549E Copyright © 1994 Communications Electronics Inc.

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# OPTOSCAN456

## 50 Channels Per Second!!!

OptoScan 456 costs less than any other computer aided scanning system and is supported by all the best software packages including Scan Star™ and Scan Cat™. OptoScan 456 uses the highly regarded Radio Shack Pro 2005 and Pro 2006 VHF/UHF scanners. These popular receivers with the OS456 package installed becomes:

### The New Standard—The OptoScan 456.

- CTCSS & DCS Controlled Scanning and Logging
- DTMF Decode & Log with Channel and Time
- PC Software for computer Log, Scan & Search
- RS-232C & CI-V Interface
- No Drill or Solder Installation
- Output for signal level and spectrum display

**Why Computer Controlled Scanning?** The computer makes the scanner perform, simply and effortlessly. Even when you are not around, the computer can continue to search out frequencies you want and record them—virtually unlimited numbers.

**Why Decode CTCSS tones and DCS codes?** The OS456 decodes tones, codes and touch-tone characters to provide the Radio Monitoring Enthusiast with a powerful new tool in sorting out who is talking, and accessing a repeater. **Optoelectronics has produced the OptoScan 456 to make the PRO-2006 family radios perform to a new standard that no one else can match for any price!**

**Complete Installation Kit, Model OS456,** includes the assembled and tested controller board, mounting hardware (no soldering or drilling required), cables, OptoScan 456 basic software for the PC and the installation video.....\$299.

Complete Optoscan 456 and modified Pro-2006 are available from our distributors:  
Grove Ent., 1-800-438-8155, NC; Marymac Ent., Inc., 1-800-231-3680, TX; E.E.B., 1-800-368-3270, VA.

# A NEW STANDARD FOR SCANNING!!!!



# OPTOELECTRONICS

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ALL NEW  
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ALL NEW

## Model 25 Scout Electronic Equivalent of Forward Reconnaissance

The Remarkable New Frequency Scout automatically finds and records frequencies for later use and will tune a receiver.

The Scout is pocket size—ready to go anywhere, and, unlike a frequency counter, the Scout can differentiate between random noise and coherent RF transmissions.

It is ideal for surveillance walk-by situations with a built-in vibrator to alert you a frequency was recorded.

For drive-by applications, a beeper lets you know when a new frequency is found or an already recorded frequency is hit. Up to 250 hits can be counted on each of the 50 frequency memories.

Reaction tunes VHF/UHF receivers equipped with CI-V serial communications interface.

- Exclusive Optoelectronics Digital Filter/Capture Technology (pat. pend.)
- 50 Memory Locations for unique frequencies
- 250 Hit Counter for each frequency in memory
- Reaction tunes OptoScan 456 CI-V Communications receivers
- Selectable annunciators include vibrator, beeper and EL back lit display
- Can be interfaced to a PC for data logging using OptoLog Software
- 16 Segment RF signal level bargraph for relative signal level detection
- 10MHz to 2.8GHz single frequency range.
- Six+ hour battery life—one hour rapid charge
- Pocket Sized: 3.7" H x 2.75" W x 1.2" D

**The Scout Model 25 with rapid Charge and high capacity NiCad batteries.....\$399.**

Scout is pictured with optional DB32, dual band, VHF/UHF miniature antenna.....\$ 29.

## DC440 Decoder (pictured above) with New CI-V Interface

If you are into UHF/VHF communications monitoring then you will want to add a DC440 to your system. This popular decoder has been upgraded with a new communications interface port that is CI-V compatible. Now you can take advantage of the new scanning software that supports tones and codes if you are using an R7100 or R7000 receiver then the DC440 will connect to either the CT17 or CX12 RS-232C Converter for single serial port use.

- Simultaneous off the air detection of 50 CTCSS tones, 106 DCS codes and 16 DTMF characters
- Six measurement modes for maximum flexibility
- Scrollable ten character display of up to 127 stored DTMF characters
- Convenient front panel controls for Power, Mode and Recall

**The DC440 with CI-V Interface.....\$259.**  
NiCad 44 (Optional Internal NiCad battery pack).....\$ 39.

## CX12 CI-V to RS-232C Interface Converter



Low cost convertor for CI-V logic level data to RS-232C for connection to a Personal Computer serial port. The CX12 is fully equivalent to the Icom CT-17 convertor.

The CX12 is an accessory for the Optoelectronics DC440 and Model 25 Scout. Price: \$89.

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## Optoelectronics, Inc.

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TEST GEAR YOU CAN BUILD

November 1994

# Popular Electronics

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**POPULAR**



## Autorange Frequency Counter

With a range of up to 50 MHz, it's a great addition to any bench

## Build An Autoranging Capacitance Meter

It rivals the performance of commercial units costing many times more!

## The "Gate-Dip" Meter

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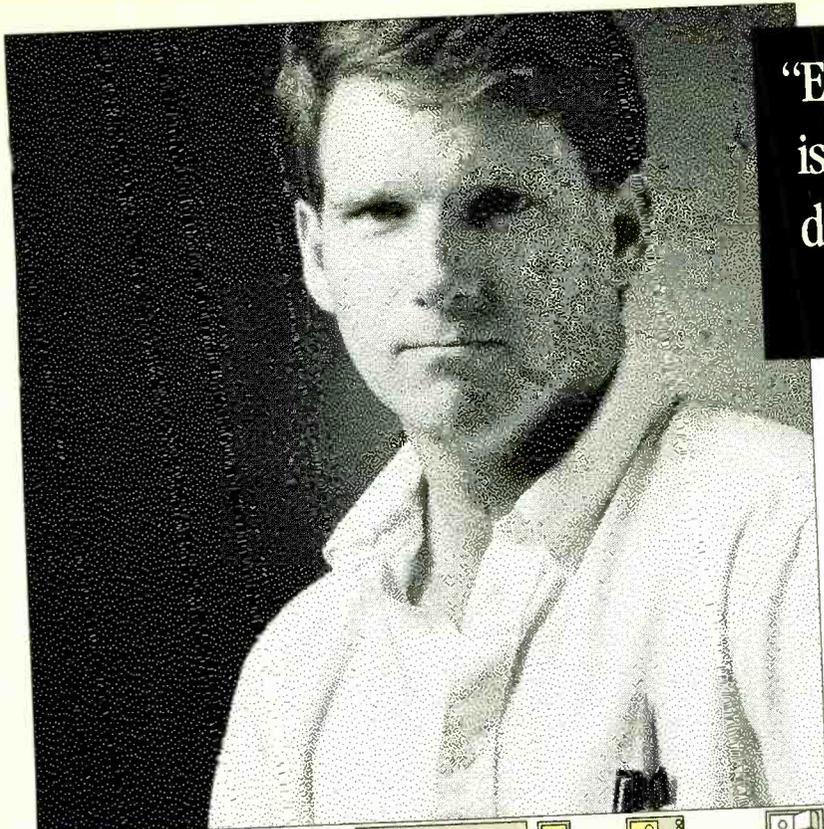
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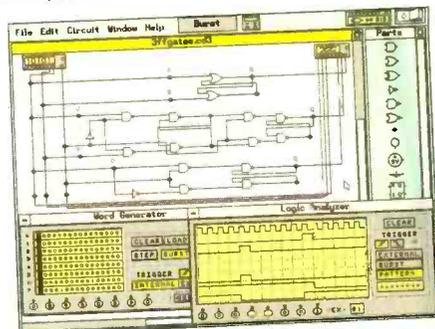
is the best simulation

design and verify

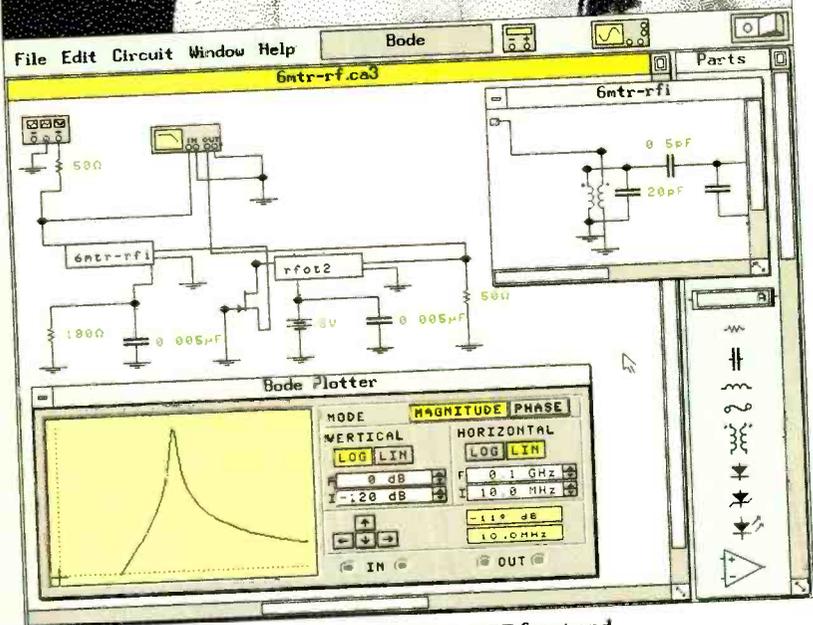
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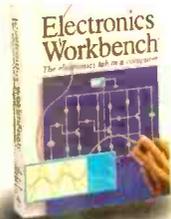
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