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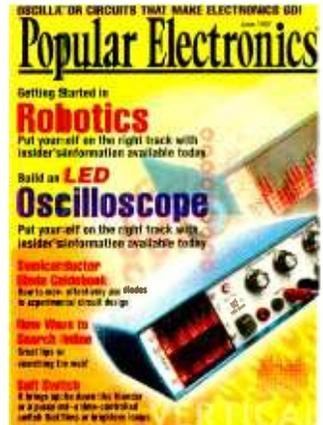
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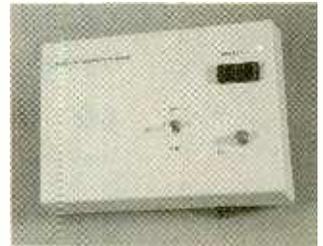
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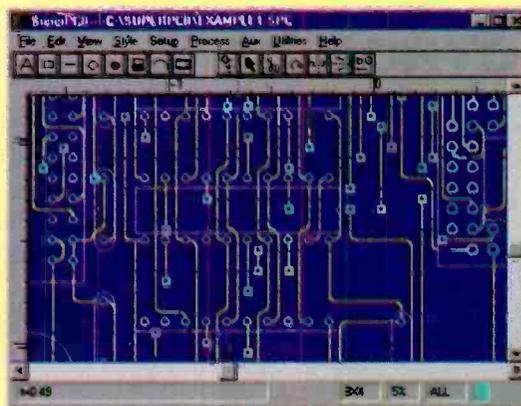
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Because of our association with McGraw-Hill in producing the **Encyclopedia of Electronic Circuits** CD ROM (available separately for \$99), the SuperCAD schematic editor is fast becoming a standard for schematic entry. The Encyclopedia includes 1000 SuperCAD schematics in 142 different categories (audio, radio, etc) that can be used as a starting point for designs.

Mixed Mode SPICE Simulator

For simulating purely analog circuits or circuits with some digital components, mentalMAX includes mentalSPICE. This simulator is based on the Berkeley SPICE 3F5 simulator and allows you to do timing analysis, frequency analysis, DC curve analysis and others. It comes with over 350 semiconductor and 250 IC models. Signals can be introduced into a circuit using a virtual function generator, and the resulting waveforms can be viewed in the Oscilloscope window.

Digital Simulator

For heavy-duty analysis of computer interfaces, timers, state machines, controllers, and others, mentalMAX provides the digital simulator SuperSIM. This comes with 150 common TTL and CMOS models. You can stimulate circuits with a built-in virtual pattern generator and view results in a logic analyzer window. You can also single-step a circuit and monitor its progress using virtual LEDs and displays.

Circuit Board Layout Software

mentalMAX comes with the popular SuperPCB program for doing layouts on printed circuit boards up to 32" x 32". SuperPCB features 1 mil (.001") resolution, 2 signal layers, silk-screen, paste and solder mask layers. It includes industry-standard Gerber and Excellon outputs, and you can also print your artwork on laser and other printers. SuperPCB comes with 150 package parts for both through-hole and surface-mount devices; you can add your own parts.

In many cases SuperPCB can automatically build a circuit board from just a SuperCAD schematic input, using the built-in autorouter and auto-placement tools. You can also layout or edit circuit board artwork using SuperPCB's intuitive, easy to learn editing features.

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EDITORIAL

Do you fit into this scenario?

In 1957, Charles Colby, a 15 year old high school student, invented the Satellite Direct Broadcast System. Charles built a working DBS demo system in his father's garage in Fresno, California and showed it as his high school Science Fair project. The rest is a marvelous 40-year history.

Probably, Thomas Alva Edison is the greatest American gadgeteer tinkerer of all time.

There are many examples of children and young men who, with the application of their minds and the dexterity of their hands, developed and built devices that eventually became successful products that we use today. Most of us started with small home-brew contrivances that effected only our own lives, launching us into a hobby arena from which we derive great pleasure. I remember my first project. It was a spark coil made from scrap telephone wire, a bolt from an old Reo truck, and a steel strap from a packing case. The wood base came from an apple crate.

Whatever it is that started us on this hobby's path must be somewhere in our genes. Don't look for it; just be grateful there's something in us that gives us the impetus to continue forward in our hobby activities.

With this last thought in mind, the publisher and editors of **Popular Electronics** bring forth another issue of their magazine that's dedicated to the electronics hobbyist. No, you probably won't become another Charles Colby or Thomas Edison, but you will probably have as much fun as they did.

There's one other bonus. Every time I vaporize rosin as I get the solder to flow, I become a kid again. The spirit of that same boy who assembled his first spark coil rejuvenates. The joy of building projects is eternal!

Julian Martin
Editor

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LETTERS

We Get Letters

BUILD A HIGH-EFFICIENCY LIGHTING SYSTEM

Your "power sa\$ing" circuit in the past May issue and your conclusions are as close to outright fraud as I have ever read in a technical publication. It is certainly competing with the 100-mpg automobile carburetor modifications that still show advertisements every so often.

A heat radiating body operating at a constant temperature and under identical surrounding radiative, conductive and convective thermal environments will consume identical rms power for an identical output regardless of the wave form applied. DC, AC, or chopped AC, it makes no difference. The only difference would be if the wave form is slow enough to cause significant temperature swings. (A well known physics law: conservation of energy.)

*Ake Hellstrom
Principal Engineer
ABB Industrial Systems
Columbus, OH*

I used the high-efficiency, lighting-system lamps to run my solar cells. I used the solar cells to drive a DC-AC converter to generate 60 Hz and connected its output to my electric company's circuit. By April 1st I expect a nice refund from the electric company!

*Richard F. Gillette PE, W9PE
Gillette Inc.
Palatine, IL*

What can be said by the Popular Electronics staff other than "If you can be hoodwinked, it's best for it to happen in the month of April."

We try hard each issue to get out a finely-tuned and edited magazine. This past issue we rushed a bit too fast when we should have stopped and asked a significant question, "Are the facts in this article correct?" Rest assured that the editors will do so in the future.

By the way, where can we get those 100-mpg automobile carburetor modifications?—Editor.

FM STEREO TRANSMITTER ENHANCEMENTS

Thank you for your February 1995 article about building an FM stereo transmitter. It fulfilled a dream of mine that I had as a boy about 40 years ago.

I built the transmitter and have been using it for more than a year. It works very well. I have found ways to improve the sound quality even more, and I would like to share them with others.

The low bass audio frequencies were a little weak. Apparently, the audio coupling capacitors were not quite large enough. I replaced the 10- μ F ones with 100- μ F capacitors, and that made a noticeable improvement. (In the FM-10, they are C2 and C5. In the FM-25, they are C17 and C25.)

I also noticed a slight 60-cycle (60-Hz) power-line hum in quieter portions of the audio. Additional filtering didn't seem to help very much. But I found the answer! A *regulated* 12-volt AC adapter did the trick. Stancor makes one: Its model STA-300R is available through electronics supply houses.

Now my FM transmitter sounds great! Solid bass response, and absolutely no background hum.

*Steve Keller
Cedar Rapids, IA*

20-WATT STEREO AMP UPDATE

The 20 watt stereo amplifier article by Gary Clifton in the February 1997

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issue of **Popular Electronics** was interesting and well written. However, it was slanted towards use in automobiles, and no mention was made of other applications. The amplifier can also be used for home stereo.

I constructed the amplifier from a kit supplied by DC Electronics, Scottsdale, Ariz. The kit number is S1554 and costs \$19.95: a real bargain since it includes all the parts, a precision drilled PC board, a huge heat sink and assembly manual.

After constructing the amplifier, I installed it in a Radio Shack enclosure (#270-274). The enclosure leaves plenty of room for the amplifier and power supply. Due to the large amplifier heat sink, it was mounted horizontally in the base of the cabinet, supported by two 1/4 inch spacers.

The power supply must be capable of at least 2 amperes at about 12- to 14- volts DC. To control input levels, a dual 10K pot works fine. The TDA1554 has enough internal gain so no additional pre-amp is needed when used with the line outputs of most tape recorders. The amplifier works well with 8 ohm speakers too. Perhaps other readers will find this application useful.

*Robert O. Barg
Rochester, NY*

AUTHOR WANNA-BE

Greetings and congratulations on your updated web page. You made it even better than before. I love it! Keep up the good work!!

I'm interested in sending you some articles that you can publish as mentioned in your Web site. I would like to know how to get the sample issue you mention there, so I can get a good idea of how I'm going to edit my work.

*Carlos Eduardo Corpeno Dubon
Comayaguella, Honduras*

We got the message. You get the free copy. Remember, only one issue to a customer.

(Continued on page 77)

Patented microelectronic antenna converts your home's wiring into a giant signal-grabbing magnet!

This little box uses your home's electrical wiring to give non-subscribers, cable subscribers and satellite users better TV reception on your local broadcast networks!

Until recently, the only convenient way to guarantee great TV reception was to have cable installed or place an antenna on top of your TV. But who wants to pay a monthly cable fee just to get clear reception, or have rabbit-ear antennas that just don't work on all stations? Some people just aren't interested in subscribing to cable. Or they may live in an area where they can't get cable and TV-top antennas

aren't powerful enough. And what about those people who have cable or satellite systems but still can't get certain local stations in clearly?

Now, thanks to fifteen years of microelectronics research, a new device has been developed that actually makes conventional antennas a thing of the past. It's called the Spectrum Universal Antenna/Tuner!

Advanced technology. If you live in a rural area, you may have resigned yourself to accept the fact that your local TV reception is poor. (This may be true even if you don't live in a rural area!) Now imagine watching TV and seeing a picture clearer than before. Simply plug the Spectrum Antenna into a standard AC outlet and plug your TV into the Spectrum. Get ready for great reception because your TV will display a clearer, focused picture, thanks to Spectrum's advanced signal controls.

Uses your home's electrical wiring. The Spectrum Antenna is a sophisticated electronic device that plugs into a standard wall outlet. Basically, the outlet interfaces the Spectrum with the huge antenna that is your home wiring network. Simply put, it turns the electrical wiring in your house or apartment into a multi-tunable TV reception antenna that will improve your TV's overall tuning capability.

How it works. Broadcast TV signals are sent out from the local broadcast station. Those signals interface with your home's AC power line system, creating an aerial antenna network of wiring as large as your home itself. When the Spectrum Antenna connects to the AC line, the signal is sent to its signal processing circuit. It processes and separates the signal into 12 of the best possible antenna configurations. These specially-processed signals route themselves into 12 separate circuits. A 12-position rotary tapping switch, the "Signal Switch" control, gathers 12 of the best antenna configurations resulting in improved picture quality.

Spectrum Antenna

Parallel 75 ohm resistance

For minimum loss of signal

Signal search control

For selecting multiple antenna configurations

Resonant fine tuner control

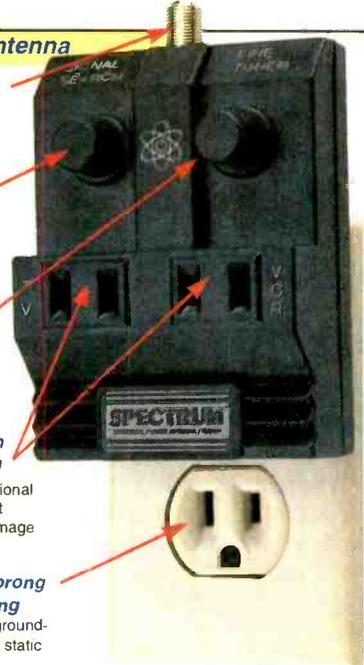
For dialing in crisp, clear TV/stereo reception, eliminates ghosting

Dual outlets with surge protection

For plugging in additional TV/stereo equipment guarding against damage and surges

Polarized three-prong plug for grounding

For optimum signal grounding to stop noise and static



Why don't conventional antennas work as well as the Spectrum?

Bandwidth of TV Signal

1 2 3 4 5 6



When TV signals are tuned at the TV channel's center frequency, optimum tuning has been achieved.

Other antennas can't offer center frequency tuning like the Spectrum Antenna can. They only offer such tuning up to the edge of the center frequency. As a result your TV picture remains snowy.

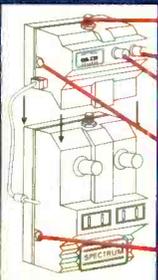
Other systems Non-precision tuning

Acting Antenna



The Spectrum Antenna "activates" the giant antenna that already is in your home. It uses all of the wiring throughout your home's walls and ceilings to make an antenna as large as your house for unbelievably clear reception of local broadcasting.

Spectrum with Gain Booster Features



Parallel 75 ohm resistance

Resonant fine tuner control

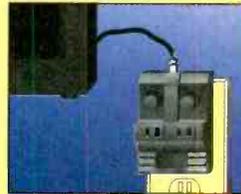
Spectrum gain control

Spectrum auxiliary jack

Spectrum Gain Booster Jack

Who can use Spectrum?

- **Cable users-You have cable but you can't get certain local stations in clearly.**
- **Non-cable users-You don't have cable and want the stations to come in more clearly.**
- **Satellite users-You have a digital satellite system but can't get local stations clearly.**



The Spectrum Antenna gets plugged into a three-prong outlet and can accommodate two additional plugs in its surge protected ports.

The "Signal Search" offers varying antenna configurations for you to select from the best signals of all those being sent. The signal then passes through the Spectrum Antenna's special "Fine Tuner" circuit for producing more clear reception.

Rural areas. Most TV signals in rural areas are weak, making them harder to fine tune. The "Gain Booster" is a high-frequency signal booster designed to increase the output level of the signal entering your television. It delivers a 10-fold greater signal which will bring richer color and a noise-free picture. By using the Gain Booster, Spectrum's fine tuning controls will function better, giving it a stronger signal to tune. It also works in conjunction with your outdoor antenna!

Risk-free. The Spectrum Antenna/Tuner comes with our 90-day risk-free trial as well as a 90-day manufacturer's warranty. Try it yourself, and if you're not satisfied, return it for a "No Questions Asked" refund.

Limited time offer! We realize that most people have more than one TV in their home. That's why we're offering a special discount on additional Spectrum Antennas so you get great reception on all your TVs!

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MULTIMEDIA WATCH

Sometimes I'd Be Lost without Removable Media

MARC SPIWAK
TECHNICAL EDITOR
WINDOWS MAGAZINE

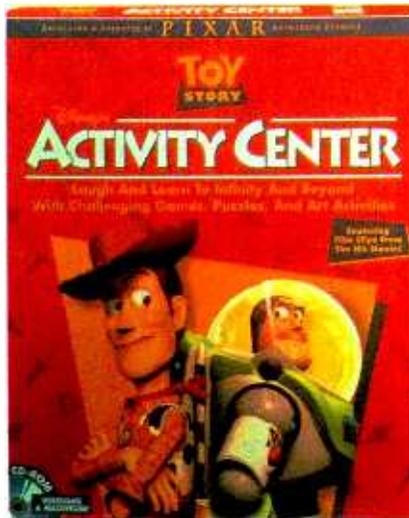
Every time I set up a new computer system at home, I'm reminded of how useful removable-media drives are. When I'm at work, and close to a network port, I can store stuff on the network in between systems. But, at home, it can be difficult to transfer files that are too big to fit on floppies. I use whatever is most convenient or on hand at the time, and at times this has been a CD-R drive. Then I simply burn a CD containing everything I want off an old system. But I don't really need a permanent recording of the stuff—just something temporary to pass between systems. More recently I used an Olympus magneto-optical, or MO drive. Everything I wanted to transfer fit on a single 230-MB disk.

An MO drive uses a laser-to-heat special magnetic media on an MO disk to the point where a magnetic field can rewrite the data. When the laser is removed and the material cools, the data is fixed. The laser is not used when reading data. The *Olympus SYS.230* packs 230 MB without compression onto \$10 cartridges. The price is \$359 for a portable SCSI model. SCSI is the way to go if you have a SCSI adapter in your computer. While it's not nearly as fast as a hard drive, I like this drive because it's very portable and 230 MB is plenty enough space for most things I want to move.

The Fujitsu *DynaMO 230* is an internal IDE MO drive that uses the same cartridges as the Olympus drive. The internal *DynaMO 230* can be installed in a standard 3-1/2-inch external drive bay, and mounting hardware is included for it to fit in a 5-1/4-inch bay as well. It's not portable, but it gives you ever-expanding storage space and disks that can be read on other compatible drives. This one sells for \$449.

Toray's *Phasewriter Dual* combines a 6X CD-ROM drive and a 650-MB optical media drive in a single 5-1/4-inch internal package. Blank 650 MB data cartridges cost about \$40 each, or about 6 cents per megabyte. This drive

costs around \$400. The *Phasewriter Dual*, or PD drive, is not a magneto-optical drive, or even magnetic at all. The media has a crystal layer that changes its reflectivity when exposed to laser light. The drive has a SCSI interface and looks just like a regular CD-ROM drive on the outside. Windows 95 automatically detects both the CD-ROM drive and the PD drive, and provides separate drive icons for each.



Disney's *Activity Center: Toy Story* features games, puzzles, arts and crafts, and film clips from the hit movie.

The motorized disc tray accepts a regular CD without a caddy or a 650 MB rewritable data cartridge.

The Pinnacle Micro *Apex 4.6 Gigabyte* is a *biggie*, both in price and capacity. It costs \$1895, but its cartridges can hold 4.6 GB apiece. The cartridges are double-sided, with 2.3 GB on each side. Cartridges cost \$169 each. That works out to 4 cents per megabyte. As a comparison, CD-R discs, at \$8 each, cost 2 cents per megabyte. This drive is great for backing up huge hard drives.

Then there's Iomega's *Jaz* drive, another of my favorites. It uses removable hard-disk cartridges. For around \$400 you get a removable-media drive

that packs 1 GB onto each cartridge, and the cartridges cost around \$125 each. The great thing about it is its speed, which approaches that of a conventional hard drive.

With so many different types of removable storage drives on the market, you must seriously consider your needs before you plunk down money on one of them. Each drive offers things that others might not, and you'll find that you purchase more useful drive if you put some thought into making your decision.

NEW STUFF

I've got two new titles from Voyager: *Dracula: Truth and Terror*, and *A Night to Remember*. *Dracula: Truth and Terror* is being released in anticipation of the 100th anniversary in 1997 of Bram Stoker's horror novel *Dracula*. *Truth and Terror* is chock full of vampire trivia and it reveals the facts behind the fiction. Learn about the man many consider to have been the "real" *Dracula*—Vlad the Impaler. The disc contains *Dracula* stories totaling over seven hundred pages, including Bram Stoker's novel *Dracula* and the complete film *Nosferatu*, the first faithful adaptation of Stoker's book. The disc has a suggested retail price of \$39.95.

On April 14, 1912, at 11:40 p.m., the *Titanic* struck an iceberg in the North Atlantic. It sank in less than three hours, taking with it 1,500 of its passengers. *A Night to Remember* is a CD-ROM that takes an in-depth look at the classic British *Titanic* movie. The disc contains the complete 123-minute, 1958 film with an additional commentary track by *Titanic* experts Don Lynch and Ken Marschall. A search tool lets you quickly locate dialogue, scenes, or images. You also get a detailed blueprint of the ship that contains hot-links to corresponding scenes, a passenger log featuring the real victims and survivors, a time line tracking the course of the ship from its launch to the rescue of the survivors, and a bonus disc featuring Ray

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Valid for new members only, subject to acceptance by EEBC. Canada must remit in U.S. funds drawn on U.S. banks. Applicants outside the U.S. and Canada will receive special ordering instructions. A shipping/handling charge & sales tax will be added to all orders.

PP1F697



In *Pie Jackers*, pizza deliverers race to pizza-obsessed customers who have to have it while it's hot.

Johnson's 60-minute 1993 documentary, *The Making of "A Night to Remember,"* and the original British trailer. It has a suggested retail price of \$29.95.

If you're into the country lifestyle, or would like to get into it, two new titles from Books That Work might just be for you. *Country Living Style* is loaded with ideas to help you decorate your country house in proper country style. The disc includes photos, video demonstrations, detailed instructions, and diagrams showing country living at its best. Much of the stuff comes right out of the pages of *Country Living* magazine. *Country Living Gardener: Great Home Gardens* is a similar title, except that it tells you how to go about treating the outside of your country home. There's a huge database of information on all kinds of plants, so you know beforehand which ones will do well where you live. You can also meet the nationally renowned gardeners responsible for ten of the most stunning gardens. These country titles sell for approximately \$30 each, or \$50 for both bundled together.

Philips Media is now offering *Fighter Duel—Special Edition*, which lets you fly one of 16 classic World War II dog-fighters in wild, realistic air battles. The special edition now allows two-player modem duels, or up to nine players can compete on a local area network. You can even face up to eight computer enemies at once—if you're good enough, that is. This one has an esti-

mated street price of \$49.95.

Another flight game this month, one from Activision, is *A-10 Cuba!* for Windows 95. This one puts you in the cockpit of one of the toughest, most versatile aircraft in the United States arsenal: the Fairchild A-10 Warthog. You're an airborne tank killer, out to destroy the rebel forces that have infiltrated the U.S. air base at Guantanamo Bay, Cuba. You have to be on your guard to avoid the Mig and Sukhoi fighters and surface-to-air missiles constantly coming at you. If you have to ditch the plane while flying over the Cuban terrain, you might just parachute into the outlying cigar factories. Test your flight skills in the exciting game for \$39.95.

Two other titles from Activision this month include *MechWarrior 2: Mercenaries* and *Hyperblade*. If you've enjoyed playing *MechWarrior 2* and all the expansion packs, you'll no doubt want to check out *Mercenaries*. This one features new missions, Mechs, worlds, and darker, more desperate realms of the universe. *Hyperblade* is a fast-action sports game that combines hockey, lacrosse, and extreme skating in a 3-D arena with a concave surface. You're armed with a throwing device and projectile, and protected by a custom armor suit. You have to penetrate the opposing team's zone and score goals. Both of these titles will sell for around \$49.95.

Apparently it's now common prac-

tice for big movie studios to release a companion CD-ROM for every movie that's released—at least that's what Disney seems to be doing. I've got three new titles from Disney Interactive, all for children, and all related to a children's movie. *Disney's Animated StoryBook, The Hunchback of Notre Dame* is an interactive reading adventure based on the full-length animated feature film. The disc features the full story, along with six challenging games and activities, lots to click on, and the entire celebrity voice cast from the film. *Disney's Animated StoryBook, 101 Dalmatians* is a similar title, except that you read along with Pongo, Perdy, and all of their spotted pups. There are also four interactive learning activities, six sing-alongs, and lots of surprise animation. *Disney's Activity Center, Toy Story*, is based on the movie, but it's actually eight new activities including games, puzzles, arts and crafts, and film clips from the hit movie. All of the above Disney titles sell for around \$35 to \$40 on the street.

I have many more children's titles this month. Three new games from Broderbund are intended for preschoolers, ages 2 to 5. All three sell for \$29.95.

My Very First Software is loaded with fun and games, but its main purpose is to teach the skills kids will need to use more advanced software. These skills include such things as pointing and clicking with the mouse, double clicking, and using the keyboard.

My Very First Art Studio is packed with activities that allow coloring, drawing, painting, and more, but with an interface that's easy for kids to use and even easier to enjoy.

My Very First Storybook is an interactive adventure game for very young people, about a gorilla that gets bored at the zoo and decides to explore life in the big city.

Blizzard's Holiday Jamboree is full of fun holiday activities for kids ages 3 and up. Kids can dress up Santa at the North Pole tailor shop, create custom greeting cards, play snowball games, listen to holiday songs, and more. This one's \$19.95.

Simon & Schuster Interactive's *Richard Scarry's Best Reading Program Ever* is targeted to children ages 3 to 6. The game lets kids help Mr. Fixit fill his new storymobile with stories. As

(Continued on page 75)

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

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

by Phil Jones



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

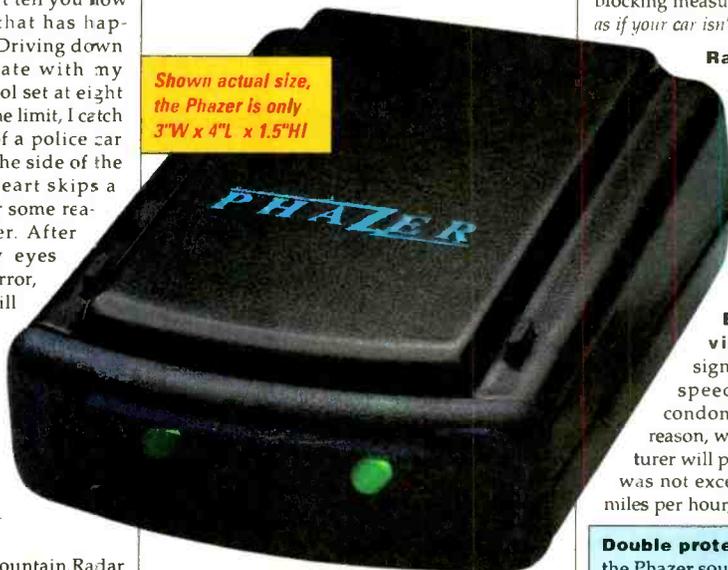
If your heart doesn't skip a beat when you drive past a speed trap—even if you aren't speeding—don't bother reading this. I can't tell you how many times that has happened to me. Driving down the interstate with my cruise control set at eight miles over the limit, I catch a glimpse of a police car parked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

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

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

The radar component works by mixing an X, K or Ka radar signal with an FM "chirp" and bouncing it back at the squad car by way of a

waveguide antenna, effectively confusing the computer inside the radar gun. The laser component transmits an infrared beam that has the same effect on laser Lidar units.



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

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

HOW TO MAKE YOUR CAR DISAPPEAR

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

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

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



How it scrambles radar.

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

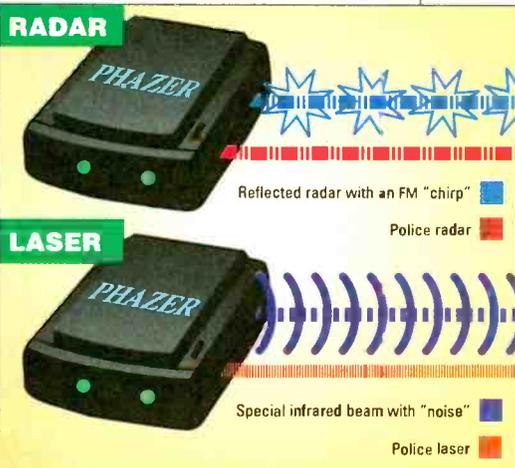
Works with laser, too! The Phazer also protects your vehicle from Lidar guns that use the change in distance over time to detect a vehicle's speed. The Phazer uses light-emitting diodes (LEDs) to fire invisible infrared pulses through the windshield. Laser guns interpret those pulses as a false indication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

Range up to three miles.

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

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

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



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

The Phazer \$199 \$14 S&H
The Phantom \$349 \$18 S&H
Please mention promotional code 1906-10621.

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comtradindustries
2820 Waterford Lake Drive, Suite 102 Midlothian, VA 23113

NET WATCH

New Ways to Search Online

DAN KARAGIANNIS

Search engines. If you've spent any time at all online, chances are you have used more than one. In fact, a search site is usually the first place you go your first time on the Web. After all, when the Net's new to you, you don't have favorite URLs.

In my opinion, when it comes to searching for a string of text and where it's found on the Web, the best choices are the Big Three: Excite (<http://www.excite.com>), InfoSeek

layout of these features is somewhat daunting. It feels as if you're just looking through more lists of search results, and not reviews.

This month we'll look at a couple of other options to find sites of interest on the Web. While the reviews found on these search pages don't go as in depth as, say, *Net Watch*, does, they're great places to visit for a brief look at what you're hunting for at the moment.

easy to use because it was created by the types of people it is designed for—busy executives, college and high-school students, parents, and even kids. By utilizing such a non-standard development team, NetWerks was able to deliver a directory that appeals to people who know what they want to find on the Net, but don't want to waste time searching through hundreds or thousands of results in a word search. The 10,000 plus websites found here were screened for their overall quality, consumer appeal, and ease of use.

While this large directory might seem just as intimidating as the search engines it's supposed to replace, it's actually quite manageable. The information is classified under the following familiar headings: Arts & Humanities, Business, Career, Computers, Consumer Products, Education, Entertainment, Government, Health, Home & Family, Internet, Kids, Media & News, Reference, Science & Nature, Society, Sports, and Travel & Weather.

There are subcategories under each of EZ Connect's headings; for example, Education has under it Colleges & Universities and Libraries. This type of layout will help you find what you're looking for. Once you find a category and subcategory you're interested in, click on it for a list of relevant websites. Each site has a brief review of what you'll find there.

For instance, if you're looking for car information simply click on the Autos button under Consumer Products & Shopping. From there, you can directly launch dozens of websites—from AutoSite, which provides automotive buying information, to Auto Jumble, a website for antique auto parts and gas-station collectibles.

Looking to change careers? You might want to check out the sites under Directories & Listings found in the Careers & Employment category.

FINDOUT

There's no doubt that the Information Superhighway has paved the road



EZ Connect might well be one of the simplest fastest ways to find a site on the Web.

(<http://www.infoseek.com>), and Yahoo (<http://www.yahoo.com>). Chances are if you're looking for terms as crazy and disjointed as "alien sausage factory" at one of the Big Three, you'll find a few thousand pages that mention these terms! No doubt about it, these sites are very powerful when it comes to brute-force searches.

But what if you'd like to find a good computer hardware site? Try entering "computer hardware" in one of those search lines and you'll most likely get a few hundred million results! Of course the Big Three also have searchable categories of "reviewed" sites, but the

AS EASY AS EZ CONNECT

If you've ever been frustrated with using standard word search engines, you'll want to immediately bookmark our first site. Called EZ Connect, this new website directory gives you quick and easy access to more than 10,000 of the most popular websites with only three clicks or so of the mouse. The information is intuitively organized under 16 major topics with subcategories, allowing you to quickly identify the places you want to visit.

According to NetWerks, a Southern California-based website design and management company, EZ Connect is

iC an Reaction Tune Another Receiver !

Reaction Tune the
NEW
ICOM IC-R10

Use the OptoLinx
for computer controlling
the ICOM IC-R10
\$129.00



Computer Not Included

Another radio to tune, another reason to purchase the Scout.

Until now the AOR AR8000/2700 were the only hand held scanners to take advantage of the *Scout's* Patented Reaction Tune function. The Scout can now tune the new ICOM IC-R10 hand held scanner (shown below). Connection is easy: No modifications required - No custom cables to buy - Just plug and play.

Scanner hobbyists and communication professionals benefit from the *Scout's* unique functions. Whether you're searching for new frequencies in your neighborhood, or testing for interference, the *Scout* is the ultimate communications tool.

Armed with a 400 frequency memory register, the *Scout* does not record duplicate frequencies, instead it coordinates repeated frequencies into a hit register storing up to 255 hits per frequency. Attach it to your belt and begin your day, the *Scout* will alert you when a signal is received by its beeper or vibrator function.

You won't miss a thing with Reaction Tune. The *Scout's* CI-V compatible output allows it to interface to the AOR AR2700/AR8000, ICOM R7000, R7100, R8500, R9000 and now the new IC-R10 (shown opposite). The *Scout* captures the frequency, then sends the serial data to the receiver and tunes the scanner to the frequency for instant monitoring in less than one second. Recorded frequencies can be downloaded to a PC using the optional OptoLinx universal interface.

SPECIFICATIONS

- ▶ 10MHz - 1.4GHz frequency coverage
- ▶ Stores and records 400 frequencies in memory with 255 hits for each
- ▶ Interface to a PC for frequency download using optional OptoLinx PC interface
- ▶ Distinctive beeps indicate frequency hits, pager style vibrator for discreet recording
- ▶ Automatic EL backlight for night operation
- ▶ 16 segment RF signal strength bargraph
- ▶ Frequencies are automatically saved when unit is turned off
- ▶ Reaction Tune the ICOM R7000, R7100, R8500, R9000, IC-R10, and AOR AR2700, AR8000, and the Radio Shack Pro 2005/6 using the Optoelectronics OS456, Radio Shack Pro 2035/42 using the Optoelectronics OS535

U.S. Patent No. 5,471,408



Radio Not Included

Scout with ICOM IC-R10
Mono Cable required (shown)

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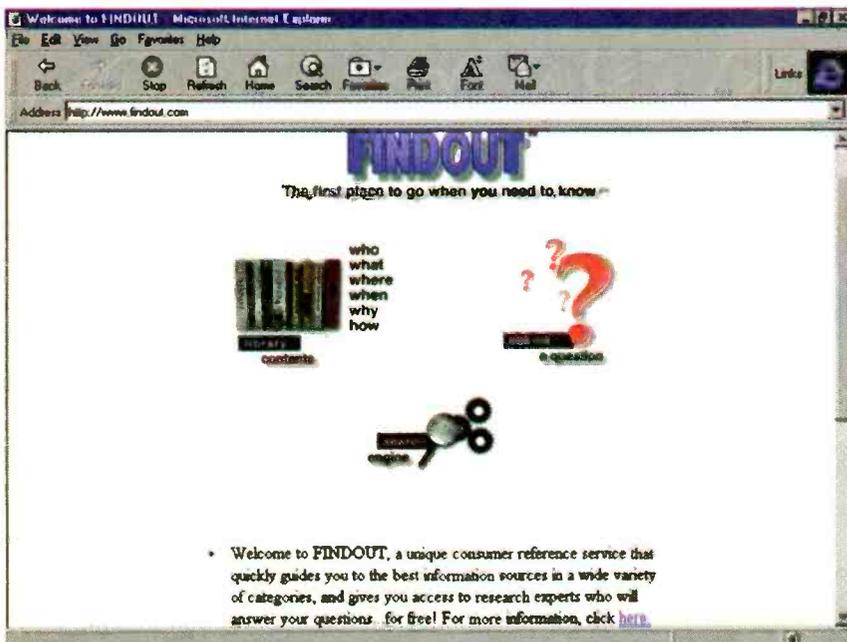
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FINDOUT lets you access information that companies have been paying big bucks for.

for countless jobs. New companies are forming all the time as a result of the Internet, and this is surely a phenomenon that will continue. But not every company on the Web is new.

Our second site this month is from a respected source of research expertise in the corporate market. Founded in 1969, FIND/SVP serves over 2200 corporate clients. The website of this enduring company is called FINDOUT.

Like EZ Connect, FINDOUT is not a search engine. Rather, it's a selective guide to the most useful and authorita-

tive information sources on subjects consumers want to know about. In other words, the expert advice that FIND/SVP has been providing for decades is now available for Net users.

While FINDOUT is certainly not the only site to categorize websites (obviously, we've already looked at another similar site), they claim to be unique in a couple of ways. First, they don't consider it important to rate or review sites. The fact that a site is included at all assures you, the Net user, that it's a quality location on the Web.

Second, you get more than just a list of websites when you select a category (we'll get to the categories in a moment). FINDOUT provides, in addition to website links, a roundup of relevant books, articles, periodicals, software, videos, associations, and guides. Many of the items lead to actual links on the Web. For example, you might be able to access the full online text of an article, or a site that shows you how to order a book or pamphlet. All in all, it's really quite impressive, and I think FIND/SVP has succeeded in making their site unique.

Now, on to the categories, which are called Libraries. When you first visit the site, you're given the opportunity to either search for an item or look through FINDOUT's Libraries. Select from Computers & Electronics, Money & Investments, Work & Career, Consumer & Legal Affairs, Hobbies & Interests, The Home, Travel & Transportation, Education, Family & Relationships, and Health. All of these are self-explanatory.

HOT SITES

- EZ Connect**
<http://www.ezconnect.com>
- FINDOUT**
<http://www.findout.com>

I found a pleasant surprise under the subcategory of Periodicals found under the Electronics Library. They listed **Popular Electronics** and mentioned the Gernsback website (<http://www.gernsback.com>). This proves that FIND/SVP's opinions can't be all that bad, right?

Obviously, though, the only way to really get a feel for either of these sites is to visit them and look for something you're interested in. While these two sites might share some links in common, there are thousands of places to visit on the Web that they don't list at both of these search sites.

That's it for this month. Until next time, feel free to drop me a line at *Net Watch*, **Popular Electronics**, 500 Bi-County Blvd., Farmingdale, NY 11735. Sending me e-mail at the old address will no longer work. However, I'll be setting up a new e-mailbox just for *Net Watch* correspondence. Watch for the address.

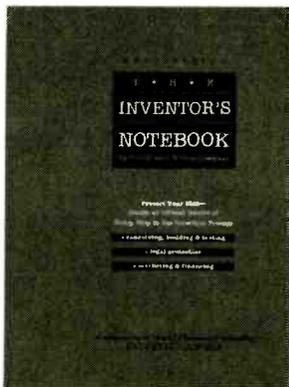


ELECTRONICS LIBRARY

THE INVENTOR'S NOTEBOOK

by Fred Grissom
& David Pressman

Your invention is your baby—and this book is the place in which to store all those memories that can be so precious when it comes time to patent it. If you don't keep careful records to document every step of the invention process, you may not be able to prove that you are the first and true inventor of your product. If your invention is ever challenged, your completed notebook can serve as the foundation of the legal protection of your idea.



The book provides all the materials you need to create an official record of your inventions. Beginning with a detailed description of the contents of a well-maintained work diary, it walks you through the four critical phases of the invention process—conception, legal protection, marketing, and financing—and offers dozens of worksheets and sample agreements along the way.

It also allows you to organize all the necessary information in one convenient location, and helps you bring your invention to the marketable stage. It explains how to assess the commercial potential of your invention and objectively evaluate and refine it during the building and testing stages. You'll learn how to calculate how much capital you are likely to need, including budget worksheets, and how to organize your search for funding to build, test, manufacture, and distribute your invention. Some of the included forms can be used to create a record of contacts who know of your invention and have signed

confidentiality agreements. That information will be crucial if a dispute arises later over inventorship or for violation of confidentiality. Recently updated to include a special section on using the Internet to develop and promote an invention, the book also includes three new agreements and a comprehensive glossary of patent terms.

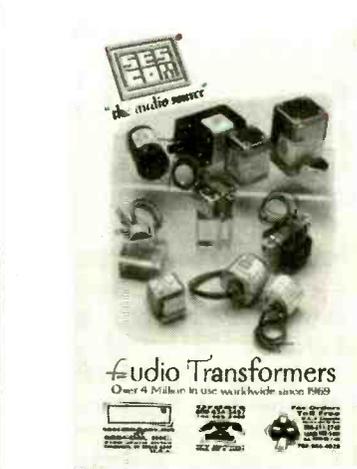
The *Inventor's Notebook* costs \$19.95 and is published by Nolo Press, 950 Parker Street, Berkeley, CA 94710; Tel: 800-992-6656; Fax: 510-548-5902.

CIRCLE 91 ON FREE INFORMATION CARD

AUDIO TRANSFORMERS CATALOG

from Sescom, Inc.

Aimed at professional users, the 1997 *MI-Series Audio Transformer Catalog* describes 59 different transformers for high-quality audio applications. The 16-



page catalog includes selection charts, mechanical information and drawings, and pinout drawings. Also included is a brief history of audio transformers, a discussion of technical issues and terms, technical data, and an explanation of mechanical shielding.

(Continued on page 72)

Turn Your Multimedia PC into a Powerful Real-Time Spectrum Analyzer

Features

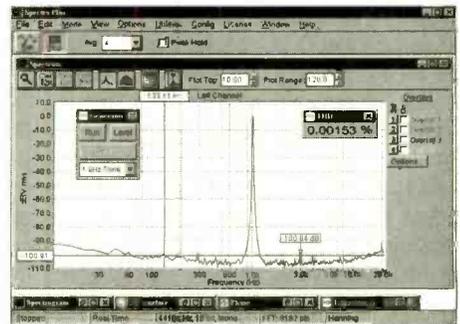
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- Triggering, Decimation
- Transfer Functions, Coherence
- Dynamic Data Exchange (DDE)
- Time Series, Spectrum Phase, Spectrogram and 3-D Surface plots
- Real-Time Recording and Post-Processing modes

Applications

- Distortion Analysis
- Frequency Response Testing
- Vibration Measurements
- Acoustic Research

System Requirements

- 486 CPU or greater
- 8 MB RAM minimum
- Win. 95, NT, or Win. 3.1 + Win.32s
- Mouse and Math coprocessor



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Options:	
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CIRCLE 175 ON FREE INFORMATION CARD

NEW PRODUCTS

GRAPHING CALCULATOR

Texas Instruments' TI-86 graphic calculator has all the power and functionality of its popular TI-85, but offers major enhancements for college mathematics, engineering, and science applications. The TI-86 boasts more math and graphing power, including a function evaluation table, deep entry recall, seven different graph styles with multiple line and shading options, and slope and direction field for exploring differential equations. It also has more than three times the available memory of the TI-85, allowing more data entry and programs.



Key locations and menus are virtually identical to those on the TI-85, and programs written for the earlier model will run on the TI-86, so the new model will be familiar to users of its predecessor. The function evaluation table shows numeric output for function, polar, parametric, and differential equation modes. A new matrix editor allows the user to view and edit a matrix in two directions, and a list editor lets users view multiple lists at the same time and attach formulas to the lists for automatic computation. New statistical features include traceable scatter plots, histograms, box and whisker diagrams, plus logistic and sinusoidal regression models.

The TI-86 is compatible with the Calculator-Based Laboratory™ (CBL™) and Calculator-Based Ranger™ (CBR™) systems. It can also use the Graphlink cable with Graphlink software, now available free for downloading on TI's Web site, and has an I/O port as well as a unit-to-unit cable for sharing data between calculators.

Users can customize the TI-86's functionality with machine language

programs downloaded from the TI Web site. The company is developing machine language extensions for inferential statistics, probability distributions, and final computations, all of which will be available later this year.

The TI-86 graphing calculator has an estimated street price of \$120 to \$130. For more information, contact Texas Instruments, Inc., Personal Productivity Products, P. O. Box 650311, M/S 3919, Dallas, TX 75267; Tel: 972-917-6278; Fax: 972-917-1592; Web site: <http://www.ti.com/calc>.

CIRCLE 80 ON FREE INFORMATION CARD

TWO-LINE PHONES

You can opt to let your personal computer *do the walking* with Panasonic's KX-TS20 and KX-TS25 two-line cordless phones. That's because both models are equipped with an external data port that allows you to connect them to a PC or laptop for on-screen dialing or Internet access. You can even carry on a conversation on one line while browsing the Web or sending or receiving e-mail via the other phone line.

Designed for use in a home or small office, the phones easily connect with existing phone lines via RJ11 or RJ14 ports. Each line has its own distinctive ring. Both models allow three-way conference calls, and a speakerphone permits hands-free conversation or phone sessions with multiple people in the room.



The KX-TS20 has eight one-touch and 20 speed-dial memory locations, while the KX-TS25 has 24 one-touch memory slots. Both phones offer automatic redial, hold, flash, and pause functions. The KX-TS25 adds an LCD readout that shows number called,

duration of the call, line in use, and other information.

The KX-TS20 and KX-TS25 two-line cordless phones have suggested retail prices of \$79.95 and \$99.95, respectively. For more information, contact Matsushita Consumer Electronics Company, One Panasonic Way, Secaucus, NJ 07094.

CIRCLE 81 ON FREE INFORMATION CARD

3-D VIEWING SYSTEM

NuVision's 3-D SPEX PC gaming system makes it possible to view PC-game graphics in dramatic stereoscopic 3-D for a richer gaming experience. The system consists of 3-D glasses with liquid-crystal shutter eyewear, three premium games, and all the necessary accessories. 3-D SPEX applies the same method used to create realistic three-dimensional images in industrial applications such as robotics control, molecular modeling, computer-aided design, and scientific visualization.



Stereoscopic 3-D works by emulating the way human vision presents images to the brain. The glasses' LCD shutters alternately open and close presenting right-eye then left-eye views. The PC monitor is synchronized with the shutters and presents slightly offset perspectives of the scene to give it any real depth. Recent improvements in 3-D graphics cards offer additional depth cues and further enhance the experience.

Unlike earlier introductions of 3-D eyewear, 3-D SPEX does not suffer from flickering images, high prices, and limited software. The LCD lenses are more than 50% larger than earlier

(Continued on page 73)

It's Not Just Training...

"I needed a refresher in fundamentals and a piece of paper that said I had a degree. CIE gave me both."

Louis P. Briant
Senior Engineer
Sentel Corp.

"CIE allowed me to use my G.I. Bill benefits and independent study allowed me to continue my studies while deployed."

Charles Hopper
Electronics Senior Chief
U.S. Navy

"The fact that I intended to continue pursuing my Associate Degree with CIE was a key factor in being considered for my current position."

Annamarie Webster
Project Engineer -
Instrumentation
Ketchikan Pulp

"My associates at work recommended CIE... The lessons were structured so they were easy to comprehend."

Vincent R. Buescher
Communications Technician
AT&T

"I reenrolled and received my A.A.S. degree from CIE because of the good experiences I had in one of CIE's career courses."

Maurice M. Henthorn, Jr.
Electronic Technician
The Denver Post

Independent study from CIE will give you the skills you need to win your own independence in a successful career.

At CIE, we pride ourselves in keeping pace with the latest developing technologies. In turn, this assures our students that upon graduation they can mesh seamlessly into a variety of exciting and rewarding technology-based careers.

Back in the 1930's, we specialized in teaching radio and television sciences. Today, it's computer technology, programming, robotics, broadcast engineering, information systems management, and the electronics behind it all.

But some things have not changed, like the desire of CIE's faculty and staff to see their graduates succeed.

That is why at CIE we teach not only the hands-on, practical aspects of electronics technology, but also delve into the "why" behind today's technology. Why does it work the way it does?

The insights to be gained from such a broad, rich and comprehensive

education at CIE matches or exceeds those gained through traditional commuter institutes while providing an education schedule to match your commitments and lifestyle.

Our patented learning program is specifically tailored for independent study and backed up by a caring team of professional educators who are at your call whenever you need their help.

At CIE, we'll match our training with your background and career goals and help you decide which of the many career courses that we offer suits you best. We offer an Associate Degree Program and through our affiliation with World College a Bachelor Degree

Program.

If you have the sincerity, the smarts and the desire, CIE can make it happen. CIE is already the institute of choice for many Fortune 1000 companies. Why shouldn't you be next?



Computer Programming



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...It's an Education.



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YES! Please send me more information on:

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- CIE's Career Courses
- World College's Bachelor Degree Program

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AH94

DX LISTENING

Shortwave Broadcasts Speak with Many Tongues

DON JENSEN

There are, linguists have counted, at least 2,796 different spoken languages. And this number doesn't include the virtually countless dialects, which are local forms of a language.

spoken in their American home by their first generation immigrant parents.

In these DX LISTENING columns, I often focus on English language programming that can be heard on short-

Lithuanian and English. Another frequency to try is 9,560 kHz.

For others of you who are looking for non-English programming from "the Old Country," whichever it may be, maybe this partial listing will help.

ARMENIAN—0000 UTC, Voice of Armenia on 9,965 kHz. Also try at 2000 or 2115 UTC.

CROATIAN—0000 to 0200 UTC, Croatian Radio on 5,895, 7,165 or 7,370 kHz.

DANISH—0230 UTC, Radio Danmark on 7,465 or 9,560 kHz.

FINNISH—0100 UTC, Radio Finland on 9,790 kHz. Also try at 1130 UTC on 11,700 and 15,365 kHz.

GREEK—0330 UTC, Foni tis Helladas on 6,260 or 9,935 kHz.

HEBREW—0000 UTC, Reshet Bet on 7,495 or 9,388 kHz.

ITALIAN—0130 UTC, Radio Roma on 6,005, 9,645 or 9,675 kHz.

ROMANIAN—0600 UTC, Radio Romania on 9,570 or 11,940 kHz.

UKRAINIAN—0100 UTC, Radio Ukraine on 7,150 or 9,735 kHz.

Republica Populară Română
Radiodifuziunea Romina
București Casa nr. poștală 111

	15250	
	11937	
Short waves	9.570	Kc/s
	9.254	"
	4.218	"
	5.980	"
Medium waves	1.484	"
	1.457	"
	1.151	"
	1.052	"
	854	"
	755	"
Long waves	155	"

THESE RECORDS CALLING

Bucharest's shortwave service broadcasts Romanian language programs for listeners abroad.

There are more than 100 languages which are spoken by more than a million people each. Thirteen of these have over 50 million speakers; Chinese, English, Hindustani, Spanish, Russian, German, Japanese, Indonesian, French, Italian, Portuguese, Arabic and Bengali. All of the "Big 13" can be heard on shortwave, and scores more of the other languages of the world.

For most of us, English is our native, and perhaps our only, tongue. But among our readers there also is a significant number who grew up with some other language, perhaps because they were born abroad, or because it was

wave radio in North America. But there are also many SWLs among us who prefer, or would if they knew where and when to tune them, programs in other languages.

A recent letter from reader Pete Kavaliunas of Miami Beach, FL, added some emphasis to this point.

"I've been listening to SW for nearly a year now," writes Nick, "and have managed to hear stations in quite a few countries, from Australia to Holland. But every time my great uncle—he came to America from Lithuania a few years ago—visits my home, he asks why can't I tune in some programs in Lithuanian? Can you help?"

Maybe, Pete. Try 6,120 kHz, around 0030 UTC for Lithuania's Radio Vilnius. The station beams SW signals in our direction with programming in both

TUNING BUDAPEST

Maybe you, or someone you know, would like to hear shortwave programs in Hungarian. If so, it's Hungary's Radio Budapest you want.

At this writing, Radio Budapest airs its Hungarian language broadcasts to North America from 0100 to 0200 UTC on 5,905 and 9,8840 kHz, and from 0230 to 0330 UTC on 6,195 and 9,840 kHz.

Other Hungarian language programming, primarily intended for audiences in Europe and other parts of the world, is broadcast at 1900 UTC on 9,710 kHz; 2100 UTC on 9,840 kHz; and 2300 on 9,835 and 11,660 kHz.

Radio Budapest's two powerful 250-kilowatt shortwave transmitters at Jaszbereny usually put good signals into North America. At two other sites, Szekesfehervar and Diosd, the station operates four more transmitters ranging from 20 to 100 kilowatts of power. Radio Budapest also broadcasts in

eight other languages, including English. English programs for listeners in the U.S. and Canada can be found at 0200 UTC on 5,905 and 9,840 kHz, and at 0330 UTC on 6,195 and 9,840 kHz.

Among the programs worth tuning are the musical features aired during the Sunday night (because of the time difference, that's actually 0200 UTC Mondays) transmission.

On successive weeks, you can hear a range of Hungarian music on Peter and Pop, Kata Chooses Folk, Balint and the CD and Take One.

MORE MAIL

Harris Arch, Huntingdon Valley, PA, writes this month with a couple of questions.

"About a month ago, I bought a shortwave radio at a garage sale for only \$2, just to get a taste of international listening. Now I want to hear many more stations from many more foreign countries.

"I'm 14, and I'm considering buying the Realistic DX-375 from RadioShack for \$70. Is that a decent radio? In a shortwave book I read, it referred me to *Passport to World Band Radio*, but the most recent issue my library has is 1993, so I cannot find a review for this model."

Hey, Harris, good job! You're approaching SWling in the right way. Start out inexpensively, and then, as you can afford it, move up to better listening equipment. And the receiver reviews in the annual *PWBR* can be a very useful guide when buying a shortwave radio. But I think its time you began bugging your librarian to get a 1997 edition.

The latest *PWBR* calls the Realistic DX-375 an "excellent value" and "a sensible choice" if you "absolutely, positively don't want to spend more than \$100." Don't expect performance equaling one of the more costly SW receivers, but you'll find it a big step up on performance from your \$2 Bon-Sonic H1180, which, by the way, isn't even listed in *PWBR*.

Harris' second question has to do with International Reply Coupons (IRCs), which some SWLs include with their reception reports to help the stations cover their costs of mailing QSL card replies.

"How many IRCs are needed for a reply? I usually send one when my post office has them, which is rare."

In this day and age, with many SW stations struggling with tight budgets, it seems a decent thing to include return postage if you are requesting a QSL verification card for your reception report. But, obviously, U.S. postage can't be used overseas. So that's where IRCs come in. Your locally purchased are exchangeable in many foreign countries for local postage stamps sufficient to send a letter by regular surface mail—not airmail—back to you. One IRC ought to be enough, unless you hope for an airmail, then send two!

And I should point out that a number of the larger international broadcasters still will send you a QSL even if you don't, or can't, help with the return postage.

IRCs should be, but clearly aren't always, available at the stamp counter of your local post office. Nag your postmaster to keep a supply on hand!

DOWN THE DIAL

What are you hearing? Why not drop me a note with your reception notes. Send your letters in care of **DX Listening, POPULAR ELECTRONICS**, 500-Bi-County Blvd., Farmingdale, NY 11735-3931

In the meantime, here are some goodies to try.

ISRAEL—7,465 kHz, KoL Israel was heard with an economic commentary in English at 2010 UTC.

JORDAN—11,970 kHz, Radio Jordan has been reported on this frequency from 1500 UTC with interview and feature English programming.

MONACO—6,230 kHz, Trans World Radio, Monte Carlo, was logged on this frequency, and parallel 7,160 kHz, with German language programs at 0830 UTC.

ROMANIA—7225 kHz, R. Romania International was noted with a jazz music program and Romanian announcements at 2320 UTC. A parallel frequency is 6,105 kHz.

SAO TOME—4,750 kHz, Voice of America's English language morning program, "Daybreak Africa" is heard here at 0330 UTC, relayed by a transmitter on this West African island nation.

SYRIA—12,085 kHz, Radio Damascus was heard with popular Arabic music at 2015 UTC, but the station was experiencing sporadic transmitter difficulties. ■

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#166—By Hugo Gernsback. Here is a collection of 21 April Fools Articles, reprinted from the pages of the magazines they appeared in, as a 74-page, 8 1/2 x 11-inch book. The stories were written between 1933 and 1964. Some of the devices actually exist today. Others are just around the corner. All are fun and almost possible. Stories include the Cordless Radio Iron, The Visi-Talkie, Electronic Razor, 30-Day LP Record, Teleyeglasses and even Electronic Brain Servicing. Get your copy today. Ask for book #166 and include \$16.00 (includes shipping and handling) in the US and Canada, and order from **CLAGGK Inc., P.O. Box 4099, Farmingdale, NY 11735-0793**. Payment in US funds by US bank check or International Money Order. Allow 6-8 weeks for delivery. MA05



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Alaska

Frigid North Co.
1207 W. 36th Avenue
Anchorage, AK 99503

California

California Electronics
221 N. Johnson Ave.
El Cajon, CA 90202

Ford Electronics
8431 Commonwealth Avenue
Buena Park, CA 90621

All Electronics
14928 Oxnard Street
Van Nuys, CA 91411

Gateway Electronics of CA
9222 Chesapeake Drive
San Diego, CA 92123

Mac's Electronics
191 South "E" Street
San Bernardino, CA 92401

Electronics Warehouse
2691 Main Street
Riverside, CA 92501

Orvac Electronics
1645 E Orangethorpe Ave.
Fullerton, CA 92631

Sav-On Electronics
13225 Harbor Blvd.
Garden Grove, CA 92643

JK Electronics
6395 Westminster Blvd.
Westminster, CA 92683

Marvac Dow Electronics
980 S. A Street
Oxnard, CA 93030

Kandarian Electronics
1101 19th Street
Bakersfield, CA 93301

Whitcomm Electronics
105 W. Dakota #106
Clovis, CA 93612

Marvac Dow Electronics
265-B Reservation Road
Marina, CA 93933

Minuteman Electronics
37111 Post St., Suite 1
Fremont, CA 94536

HCS Electronics
6819 S. Redwood Drive
Cotati, CA 94931

Halted Specialties Co.
3500 Ryder Street
Santa Clara, CA 95051

Metro Electronics
1831 J Street
Sacramento, CA 95814

The Radio Place, Inc.
5675-A Power Inn Road
Sacramento, CA 95824

HSC Electronics
4837 Amber Lane
Sacramento, CA 95841

Colorado

Gateway Electronics of CO
2525 Federal Blvd.
Denver, CO 80211

Connecticut

Signal Electronics Supply
589 New Park Avenue
W. Hartford, CT 06110

Cables & Connectors
2198 Berlin Turnpike
Newington, CT 06111

Electronic Service Prod.
437 Washington Avenue
North Haven, CT 06473

Georgia

Norman's Electronics, Inc.
3653 Clairmont Road
Chamblee, GA 30341

Illinois

Tri State Elex
200 W. Northwest Hwy.
Mt. Prospect, IL 60056

Maryland

Mark Elec. Supply Inc.
5015 Herzel Place
Beltsville, MD 20705

Amateur Radio Center
1117 West 36th Street
Baltimore, MD 21211

Massachusetts

U-Do-It Electronics
40 Franklin Street
Needham, MA 02194

Michigan

Purchase Radio Supply
327 East Hoover Avenue
Ann Arbor, MI 48104

The Elec. Connection
37387 Ford Road
Westland, MI 48185

Minnesota

Acme Electronics
224 Washington Avenue N.
Minneapolis, MN 55401

Missouri

Gateway Electronics Of MO
8123-25 Page Blvd.
St. Louis, MO 63130

William Elec & Ind Supply
803 Davis Blvd.
Sikeston, MO 63801

New Jersey

Lashen Electronics Inc.
21 Broadway
Denville, NJ 07834

New York

Sylvan Wellington Co.
269 Canal Street
New York, NY 10013

R&E Electronics
4991 Rt. 209
Accord, NY 12404

Unicorn Electronics
Valley Plaza
Johnson City, NY 13790

Ohio

Philcap Electronic Suppliers
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Akron, OH 44308

Oregon

Norvac Electronics
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Beaverton, OR 97005

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Business & Computer Bookstore
213 N. Easton Road
Willow Grove, PA 19090

Texas

Mouser Electronics
2401 Hwy. 287 N
Mansfield, TX 76063

Tanner Electronics
1301 W Beltline
Carrollton, TX 75006

Electronic Parts Outlet
3753 B Fondren
Houston, TX 77063

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GIZMO®

The Latest and Greatest

A look at some of the hot new products highlighted at this year's Consumer Electronics Show

Every year, the Consumer Electronics Manufacturers Association (CEMA) presents Innovations Awards to honor products that stand out for being exceptionally well-designed and -engineered. The Innovations Awards, which are endorsed by the Industrial Design Society of America, are the most prestigious awards in the consumer-electronics industry.

Last month, we covered some of the new technologies demonstrated in January at the Consumer Electronics Show in Las Vegas. In this month's *Gizmo*, we present a sampling of the cutting-edge products featured in the Innovations exhibit at the show. Keep reading for hands-on evaluations of a few award-winners.

Innovative Video

Digital dominates the newest crop of video gear

Projectavision's Digital Home Theater might look like a typical rear-projection TV—but looks can be deceiving. In fact, it's anything but typical, for several reasons. The Digital Home theater is a 100% digital television that combines a 60-inch rear-projection television with a front-projection system that delivers images up to 260 inches in diameter. In either front- or rear-projection mode, the set can deliver either VGA or SVGA computer images, as well as standard NTSC video fare. It uses Texas Instruments' Digital Light Processing™ projection technology, built around an advanced microchip that allows both video and computer-generated images to

be reflected onto a screen with their full color spectrum intact.

"This is accomplished by digitally controlling the impact of light on projected images," explained Martin Holleran, president and CEO of Projectavision. "The result is true-to-life picture quality whether you're watching your favorite team ... on the 60-inch rear-projection TV, or surfing the Internet with an image the size of your family-room wall."

While traditional rear-projection sets weigh in at around 300 pounds, and require intricate wiring and frequent convergence adjustments, the Projectavision Digital Home Theater is relatively portable. The system—which weighs a total of 100 pounds—comes in three boxes that can be carried home from the retailer. The projector, which can be moved about for portable use, is placed into the base of the cabinet, and all connections are made with the company's proprietary docking-station design. All functions are accessed through a remote control when the drawer is closed, and there is never a need to adjust the convergence.

The Digital Home Theater has a suggested retail price of \$7999.



Projectavision's Digital Home Theater

Samsung's CompacTheater Model TXE2759 provides instant home theater right out of the box. The 27-inch television is enhanced by a powerful, front-firing, six-speaker sound system. Its ultra-flat screen offers edge-to-edge clarity and 800 lines



Samsung CompacTheatre Model TXE2795

of horizontal resolution. The sound system delivers 30 watts of total RMS power and three surround-sound modes (concert, stadium, and simulated stereo). The CompacTheater features dual front-panel stereo headphone jacks to allow two people to enjoy its dual-tuner picture-in-picture mode. It also offers three preset audio modes, front and rear S-video inputs, and access to the on-screen menu from the front panel as well as the remote control.

The CompacTheater TXE2759 has a suggested retail price of \$999.99.

Did you know that your subscription to DSS satellite programming is good wherever you (and your receiver) happen to be? You can take your receiver with you easily enough, but you're not likely to climb up to the roof to disconnect your 18-inch dish to take along on your two-week vacation to the shore.

RF-Link Technology's Portable Direct Broadcast Satellite (PBDS) Model SKD 10-014 lets you enjoy DirecTV/USSB DSS programming, as well as EchoStar DISH Network programming, via a 14-inch dish, from anywhere—campground, ski house, RV, or tailgate party. The PBDS system includes a suction-cup mount for



RF-Link Portable DBS 14-inch Dish

smooth surfaces, a C-clamp for rough surfaces, a proprietary alignment system (compass/level/wedge) to quickly orient the dish, a 25-foot length of coaxial cable, a 6-foot length of A/V cable, and a sturdy carrying case. No tools are needed for installation. A universal mounting kit is available as an option.

The pizza-sized dish delivers large-dish performance thanks to something called Pseudo-morphic High Electron Mobility Transistor (PHEMT) device technology, and the entire system meets airline regulations for carry-on luggage. (It is not a Hughes-certified DSS product however, because its 31.5-dBi gain does not meet Hughes' 33.5-dBi specification.)

The PBDS Model SKD 10-014 has a suggested retail price of \$229.95.

According to *Toshiba*, its 40-inch *TheaterWide Model TW40F80* is the first widescreen TV whose cabinet is less than 16 inches deep. For viewing versatility, the set's 16:9 aspect-ratio screen can be split in two. The Double Window feature divides the screen vertically into two equal-sized areas in which users can view sepa-



Toshiba 40-inch Widescreen Rear-Projection TV

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rate programs from the two built-in tuners or from external video sources. A multi-window search function lets viewers scan through and monitor nine individual broadcast channels on one side of the screen while viewing a separate program in the other window.

The TW40F80's 7-inch CRT system delivers a picture with more than 600 foot-lamberts and 800 lines of horizontal resolution. "Dynamic Quadruple Focus" circuitry continuously adjusts the focus of the electron beam to compensate for varying distances to the surface of the screen. The resulting image is sharp even at the edges and corners. Convergence adjustments can be made via the remote control instead of directly at the set.

The *Video ToolKit 3.0* from *Videonics* is the first edit-control package capable of including video story boards (edit decision lists or EDLs)—complete with video "snap" of in and out edit points for users with a video capture card—into fully functional HTML Web pages. It allows video producers to collaborate on video projects from anywhere in the world.



Videonics Video ToolKit 3.0

Aimed at post-production professionals, corporate and communications training departments, independent videographers, and high-end consumers, Video ToolKit 3.0 turns a PC (with Windows 95 or NT 4.0) into a powerful edit controller. Its intuitive graphical interface makes it easy to build on-screen edit decision lists, rearrange scenes, and automatically assemble finished productions with the click of a mouse or standard joystick. Productions can be assembled from multiple sources, including virtually any controllable consumer or professional VCR and camcorder.

The included AV/Net Universal Module lets users create fully integrated multimedia editing studios by linking up to seven separate controllable post-production devices—including mixers, titlers, special effects generators, audio devices, VCRs, and camcorders—through one computer serial port. Video ToolKit 3.0 also offers enhanced, on-screen computer control of the Videonics MX-1 Mixer.

The Video ToolKit 3.0 has a suggested retail price of \$279.

With *Matsushita's Panasonic PV-L606 Palmcorder*, you can watch your subject through a traditional viewfinder, or on its DisplayMate 3.2-inch color LCD screen with built-in speaker. The LCD rotates 270 degrees vertically and 180 degrees horizontally, for creative, unusual camera angles and for flexible viewing during playback. When not in use, the screen folds against the body of the camcorder. The image has more than 100,000 pixels, and color and tint are adjustable.

The MotionSensor feature automatically switches the camcorder from standby to record mode as soon as the lens detects movement in the field of view, and stops recording 30 seconds after the movement stops. That feature makes it easy to capture unexpected events, and also makes the PV-L606 well suited for security applications.



Panasonic DisplayMate Palmcorder

The compact VHS camcorder features a 16:1 optical zoom that goes up to 22:1 with digital enhancement. A digital electronic image-stabilization system compensates for the shakiness that tends to creep into the picture as the zoom ratio is increased. Other picture-quality enhancers include a VCR-sized head cylinder, four recording heads, and a color-enhancement light that comes on automatically in low lighting conditions. Digital effects include seven fade patterns and a negative/positive reverse feature that can be used to convert photo negatives into video.

The PV-L606 has a suggested retail price of \$1099.

DVD DEBUTS

After all the hoopla and anticipation, it's not surprising that several DVD players won Innovations '97 Awards. Here's a look at just a few that have just become available. (Keep in mind that many of the capabilities mentioned depend upon the content of the DVD discs as they become available—the DVD players can allow you to select different story lines, subtitles, or languages only if the software providers have included such options.)

Samsung's DVD705 offers "multi-video stream capability," which allows viewers to select different camera angles in such programs as recorded concerts or story lines in films. Dolby Digital optical and coaxial



Samsung DVD 705 DVD Player

terminals provide 5.1-channel surround sound for output to a Dolby Digital decoder. Two sets of stereo audio terminals and two composite video terminals are provided, as well as an S-VHS video output. The DVD705 can provide stereo playback of up to eight different languages and can display as many as 32 possible subtitles. The DVD player has 500 lines of resolution and a host of special effects capabilities including clear fast-forward, slow-motion, still-frame, and single-frame advance playback. It accurately reproduces a variety of aspect ratios, such as letterbox, widescreen, and pan-and-scan. The DVD705 has a suggested retail price of \$699.

From *Toshiba*, the *Model SD-3006* offers all of the above, including component video outputs—with a difference. “Color-difference” outputs allow users to route a component video signal directly to line-scanning converters (doubblers or quadruplers, for instance), bypassing the set’s comb filter and NTSC decoder. By retrieving the signal before it is converted to composite form, typical NTSC artifacts such as dot crawl and moire are virtually eliminated. In addition to Dolby Pro Logic and HiFi stereo, the SD-3006 supports Dolby Digital; however, an external Dolby



Toshiba SD-3006 DVD Player

Digital decoder (or an amplifier equipped with one) is required to enjoy 5.1-channel audio. DVD PCM audio surpasses the standards of today’s best CDs with 24-bit quantization, 96-kHz sampling frequency, and a dynamic range of up to 138 dB. The DVD player’s remote control can also be used to operate a TV, VCR, and cable box. The SD-3006 will carry a suggested retail price of \$699.

Targeting audiophiles as well as videophiles with its *DVP-S7000* DVD player, *Sony* is promising incomparable CD sound as well as digital video playback. The player features current-pulse D/A converters and a 45-bit “Full Feed Forward” digital filter for high music resolution. The front panel and chassis are crafted to suppress even subtle distortion-causing vibrations, and twin monaural audio circuitry is mounted on a separate glass epoxy board



Sony DVP-S1000 DVD Player

for protection from video interference. A Dual Discrete™ optical pickup incorporates both 650-nm red laser and 780-nm infrared laser diodes for accurate tracking of different substrate thicknesses and pit sizes in CD and DVD discs.

As for DVD playback, Sony’s own MPEG IC accurately decompresses MPEG2 video signals, and a 10-bit video D/A converter minimizes digital artifacts. A 32-bit RISC processor allows the deck’s Smooth Scan feature to operate smoothly, frame-by-frame, in either fast forward or reverse.

The DVP-S1000 has a suggested retail price of \$1000.

Award-Winning Audio

Innovative personal-, home-, and car-audio products

Pioneer is offering a relatively affordable consumer CD recorder (CD-R), the *Model PD-R04*, which allows users to make digital copies of prerecorded CDs, putting up to 74 minutes of audio onto blank recordable CDs. “The PD-R04 is the only consumer model on the market for under \$1000,” noted Matthew Dever, *Pioneer* senior brand manager. The write-once format is completely compatible with all existing CD players.

The under-\$1000 price tag was achieved by eliminating a sampling-rate converter (found on *Pioneer*’s pricier CD-R models) needed to make digital recordings from DAT decks or satellite signals. Those signals can still be recorded to blank CDs, but will have to pass through the unit’s analog inputs in the process.

The PD-R04 features *Pioneer*’s Stable Platter CD mechanism to reduce disc-surface vibrations, as well as Automatic Dig-



Pioneer PD-R04 Compact Disc Recorder

ital-Source Syncro Recording (both one-track and all-track recording) with automatic level control and a table-of-contents writer.

The PD-R04 CD recorder has a suggested retail price of \$999.

Built to withstand the rigors of everyday use, *Matsushita*’s *Panasonic RQ-SX40* personal cassette stereo offers long life in terms of both design and playback. For durability, it features a rubberized body, a thick aluminum lid, and a buckle lock to keep the cassette secure inside. For extended performance—up to 40 hours of



Panasonic RX-SX40 Personal Cassette Player

continuous play—the personal stereo uses both the included rechargeable battery and one AA alkaline battery (not included). Convenience features include a wired remote control with backlit LCD readout that allows users to play, rewind, or fast-forward a tape without touching the stereo itself. Tape Program Search lets them skip to a desired song using the remote. The SXBS Super Extra Bass System (and matched “insidephones”) provides deep bass response even when the volume is turned down.

The RX-SX40 personal cassette stereo has a suggested retail price of \$169.95.

For music lovers who still consider speakers to be focal points in their homes, *NHT*’s *Focused Image Geometry Series* speakers, including the *Model 1.5* shown here, are now available in sycamore and mahogany laminate finishes, as well as high-gloss black and white. The sycamore finish lends a light, airy feel to rooms with Scandinavian or other light-wood decorating schemes, while the rich mahogany complements more traditional cherry or rosewood furnishings. The 1.5 is a two-



NHT Model 1.5 Speaker

way, compact speaker with a one-inch, fluid-cooled aluminum dome tweeter and a custom-designed 6.5-inch long-throw polypropylene woofer. Focused Image Geometry technology, which directs sound into the listening area and away from room boundaries, is said to ensure precise, accurate imaging and an overall detailed soundstage.

The Model 1.5 speakers have a suggested retail price of \$675 per pair.

Proton's AS-2600 preamplifier is designed to deliver superior home-theater audio and video processing today, and to meet the needs of tomorrow's evolving A/V standards. Its multi-channel surround processor handles Dolby Pro Logic as well as Dolby Digital AC-3. It reproduces six independent audio channels—left, right, center, left and right surround, and sub-woofer.

The unit's remote control allows the user to make over-all system adjustments, which can be monitored with an on-screen display. Advanced speaker-modulation controls help match speaker tone and timbre. The AS-2600's master volume control has a range of 85 decibels, adjustable in discrete single-decibel increments. And each of the six separate channel levels can be stepped up or down one decibel at a time with a range of ± 9 dB. Rear-channel delay can be set from 0 to 30 milliseconds. A built-in six-channel crossover delivers ac-



Proton AS-2600 Dolby Digital and Pro Logic A/V Preamp

curately reproduced soundtracks without the telltale dropouts or slurring common in some traditional processor systems.

The AS-2600 has a suggested retail price of \$999.

SoundTube Entertainment set out to "create an extraordinary sounding, yet affordable speaker that can be enjoyed from anywhere in a room ... a speaker that can be visually customized to fit any environment or decor without compromising sound quality." The resulting *SoundTube Visual-Audio™ Speaker System* brings a whole new look to audio while eliminating the small, limited "sweet spot" produced by conventional speakers. SoundTube speakers combine 360° sound dispersion with an efficient and accurate flexible tubular enclosure. Those enclosures are available in an array of stock and custom colors and patterns, with interchangeable "Sound-Sleeve" coverings available.



SoundTube Visual-Audio Speaker System

The tube enclosure acts as a passive radiator that is said to actually improve bass response and eliminate standing wave distortion. Proprietary "Lens-Direct Technology" expands the sweet spot, allowing the SoundTube to energize an area with "Omni-Dynamic" sound that can be equally enjoyed from virtually any location. Lens-Direct uses a series of computer-optimized acoustic lenses to smoothly deflect and disperse low, mid, and high frequencies in a 360° area.

Available in two-way and three-way full-range systems, SoundTubes are priced starting below \$450.

The *Bass Shaker Plus* from *Aura Systems* is a fully integrated car-audio bass-enhancement system, complete with a pair of Pro Bass Shakers, a remote level control, and a highly efficient digital amplifier. "This system will allow customers to purchase one package containing all the



Aura Systems Bass Shaker Plus

components necessary for a successful installation, eliminating the guesswork of selecting the proper amplifier," said Bob Goodman, *Aura's* vice president of sales.

The amplifier has a small footprint that enables under-seat installation, is rated at 100 watts continuous, and is optimized for the bass-enhancement system. The Pro Bass Shakers, which hook up like speakers to the amplifier and also fit under the seats, are designed to respond to all low frequencies of music from 100 Hz down. When properly installed, they make the car's interior resonate with bass, without the damaging effects of high sound-pressure levels.

The Bass Shaker Plus has a suggested retail price of \$329.

Pioneer has introduced "the last tape deck you'll ever buy." No, the *CD-W616DR* won't last forever, but it has what it takes to bring your extensive, but aging, cassette library into the future—until the format becomes totally obsolete. Its Digital Processing System (DPS) examines the high-frequency content, level, and noise content of the audio, and digitally processes the signals for the best results. It allows very little signal degradation compared with standard analog circuitry, and suppresses the tape hiss better. DPS separates the music signals from the hissing sound, and passes the music through directly. The hiss is fed through bandpass filters and removed.



Pioneer Digital Processing System Cassette Deck

"Now those people who still enjoy listening to tapes in their home or car can enjoy digital quality sound, either when the tape is recorded on the deck, or when played back on it," said Matthew Dever, *Pioneer* senior brand manager.

The resulting signal-to-noise ratio is 90 dB—quite impressive when you consider that tapes played on decks with no noise reduction circuitry activated have a 57-dB

S/N, and with Dolby C it's about 73 dB. We heard a demo in which a tape was played with no noise reduction, and then with each of the CT-W616DR's NR circuits (Dolby B, Dolby C, and DPS) switched on in turn. The audible results were dramatic.

Tape-duplication noise suppression and CD-deck synchronization make it easy to create digital-sounding copies of CDs. The dual-cassette deck also offers FLEX (frequency level expander) for accuracy in recreating high-frequency sounds, and allows level EQ testing and adjustment to be performed separately.

The CT-W616DR has a suggested retail price of \$300.

We're not sure why its Innovations award was granted in the home-theater category, but JVC's F3000 Super Digifine mini-component system offers superior sound quality, attractive champagne-gold front panels, compact size, and ease of use. The system consists of the AX-F3000 integrated amplifier, the FX-F3000 tuner, the XL-F3000 CD player, and the TD-F3000 cassette deck. The SX-F3000 speaker system is available separately. The amplifier features a power output of 35 watts per channel into 4 ohms and JVC's proprietary "Advanced Super-A" technology with "Constant Current" circuitry. It provides six audio inputs: phono, CD, tuner, tape, auxiliary, and MD. The tuner has 40 station memories and a programmable timer. The



JVC F3000 Super Digifine Mini System

magnetically shielded, two-way bass-reflex speakers feature 5/4-inch corrugated cone woofers and one-inch dome tweeters. Hooking up the components is easy with the included ribbon cable connectors, and "Compu Play" allows for instant playback performance with the simple touch of any source button.

The F3000 Super Digifine system has a suggested retail price of \$830; the SX-F3000 speaker system costs \$420.

An even more unlikely home-theater award winner is Matsushita's Panasonic SL-650 portable CD player. The player is notable for its ability to play for almost two days straight with four AA alkaline batteries (not included), as well as for its "Anti-Shock Memory." The SL-650 delivers up to 45 hours of continuous play time—when the anti-shock memory feature is not engaged. That feature uses extra battery power as it spins discs faster than normal, allowing the player to store up to ten sec-



Panasonic SL-650 Portable CD Player

onds of music in its memory reserve. If rough conditions cause a skip, the CD player continues to play music from that buffer, so there is no audible interruption.

The included wired remote control with backlit LCD display can be used to control the unit and monitor information such as track number and elapsed time. The slim unit's thickness is less than that of two CD jewel boxes, and a heat-resistant polycarbonate shell helps protect the player's inner mechanisms, as well as the loaded disc, from warping and other heat-related problems. The SL-650 uses Panasonic's MASH 1-bit digital-to-analog converter, said to provide excellent signal integrity, and the XBS Extra Bass System for improved bass response. Also included are XBS inside-the-ear headphones and an AC adapter.

The SL-650 has a suggested retail price of \$199.95.

THE BEST OF THE REST

Consumer electronics covers a lot more than just audio and video gear. The following award-winners represent the broad scope of today's consumer-electronic marketplace.

Based on the Windows CE platform, the Velo 1 handheld computer from Philips Mobile Computing Group is a lightweight, portable solution for mobile computing, communications, and information management. Microsoft Windows CE is a familiar, easy-to-learn user interface modeled after Windows 95. It comes with Microsoft Pocket Word, Pocket Excel, Inbox, and Pocket Internet Explorer, which allows the user to access the Internet, browse the World Wide Web, and send and



Philips Velo 1 Handheld Computer

receive e-mail.

"For many people, the Velo 1 will provide the equivalent functionality of a con-

ventional notebook PC, without the weight, inconvenience, and high price," said Alan Soucy, general manager of the Philips Mobile Computing Group. "The Velo 1 is configured with everything a busy professional needs, right out of the box. To achieve this, we have gone well beyond the base Windows CE applications and added extensive communications capabilities and expansion options that will keep the Velo 1 useful for years to come."

In addition to the basic functions of Windows CE, the Velo 1 has a built-in 19.2-Kbps modem, fax-send capability, access to corporate cc:Mail and Microsoft MS mail systems, a low-profile RJ-11 jack, and an integrated voice recorder called the Velo Voice Memo. The built-in data/fax modem and dual "Miniature Card" expansion slots allow users to expand the unit's memory and upgrade its operating system without sacrificing communications capabilities—or using PC cards. (However, recognizing the PC cards are the current industry standard, Philips developed an add-on module that supports the use of PC cards for wireless communications, global positioning systems, and other applications.)

Other advantages to the Velo 1 are multiple power options, a high-speed chipset, and easy transfer of information to and from a PC equipped with Windows 95. Available power sources include AA batteries, an optional nickel-metal hydride rechargeable battery, and an AC adapter. The PR31500 processor, based on a MIPS 3910 RISC core, "moves at the speed of work, determined not to slow a user down." And the Velo Dock (included) provides PC connection, synchronizes all the personal information management (PIM) functions of Windows CE, and charges the optional battery pack.

The Velo 1 with 2MB of memory costs \$599; with 4MB, it costs \$699. A 4MB unit with the rechargeable battery pack costs \$739.

Intended for consumers and business users, Motorola's Wordline FLXTM word message pager features a backlit, one-line, continuous scrolling display and a 2000-total-character memory. When messages are received, the pager alerts the user with a standard beep, one of eight musical alerts, or a standard vibration.

"We have found that people prefer to receive pages that are complete messages rather than just phone numbers," said Jennifer Hansard, senior marketing manager of Motorola's North American Paging Subscriber Division. "The Wordline FLX pager's word messages are valuable time-savers, frequently eliminating the need to call back for a more detailed message."

The pager is equipped with Motorola's FLEX technology, a high-speed, high-volume paging protocol that moves messages more quickly through the paging system,



Motorola Wordline FLEX Pagers

at up to 64,000 bits per second. FLEX technology also improves message reliability and battery life.

The Wordline FLX has the memory capacity to receive two information services, such as news, weather, sports, traffic, or financial updates. It receives and stores up to 16 personal messages, which are retained even when the device is turned off and when the battery is changed.

Private Time allows users to turn off all pager alerts at pre-selected times. A Bookmark feature enables users to interrupt reading an information service update and mark their place so that the message, when resumed, will begin again at the exact point. Three built-in alarm clocks can be programmed.

The Wordline FLX, in cranberry ice, smoke, willow green, or black, has a suggested retail price of \$169; add \$10 for Motorola's Cybersplash™ "Monet Mystique" pattern.

Bringing the Internet into America's living rooms, *Philips' Magnavox Internet TV Terminal*, a.k.a. *WebTV™*, is a set-top box that provides Net access via a standard TV and phone line. A computer, and computer literacy, are no longer required for surfing the Net or sending e-mail.

"Our research shows that while American consumers have a general awareness of the Internet, the cost of hardware is perceived to be prohibitive," said Ed Volkwein, Philips Consumer Electronics Company senior vice president and general



Philips Magnavox WebTV

manager of marketing and sales. "Priced at \$329, the Philips Magnavox WebTV is the user-friendly, affordable option for consumers who want accessibility to the Internet without investing in a home computer or for families who want to experience the Internet in the living room at an affordable cost."

Family-friendly WebTV has a built-in parental-control feature as well as a "Kids" icon for connection to interactive field trips, reference resources, and other youth-oriented sites. Its plug-and-play setup requires no technical knowledge, and a familiar remote control is used to operate the device. Yet WebTV provides full Internet access via a 33.6Kbps V.34 modem and WebTV Browser. It also offers CD-quality sound; an ISO smartcard slot that supports ISO-compliant Visa/MasterCard, cash card, and ATM smartcards for online shopping; patent-pending image-enhancement technology to eliminate interlace flicker without blurring; and an industry-standard, PC-compatible keyboard port.

WebTV™ has a suggested retail price of \$329.00.

Consumers who already have a multimedia PC, a soundcard, and an Internet provider can use *InterAct Accessories' WorldTalk Internet Phone* to have two-way voice conversations with other Net surfers around the world. "With the WorldTalk Internet Phone, making phone calls on the Internet is as easy as calling Grandma," said InterAct president Todd Hays.



InterAct WorldTalk Internet Phone

The Internet Phone connects to the user's existing sound card and features adjustable microphone sensitivity and automatic switching between speakerphone and handset functions. It comes bundled with Microsoft Internet Explorer and Microsoft NetMeeting for Windows 95.

The WorldTalk Internet Phone has a suggested retail price of \$39.95.

Jet-skiers and users of other high-speed water crafts will like the *HH 940* from *Uniden*. It's the first wearable, waterproof two-way VHF marine radio. Weighing in at just 8.8 ounces, the radio has been proven to withstand high-velocity water-impact



Uniden HH 940 Wearable Marine Radio

tests of up to 50 mph. Its waterproof construction reduces the possibility of salt-water corrosion and protects against the harshest marine conditions. The radio can even be worn attached to a life jacket while waterskiing.

The HH 940 is equipped with all U.S. and international marine channels. Its triple watch feature allows users to continually observe emergency channels 16 and 9 while monitoring a third selectable channel. Users can also simultaneously activate the weather-alert feature, which periodically refers to the NOAA weather service to monitor inclement conditions. The radio has a waterproof electronic touch keypad, a backlit Super Twist LCD readout, a drop-in charger, a flexible rubber antenna, all-channel scan feature, and keypad lockout to prevent accidental reprogramming.

The HH 940 has a suggested retail price of \$239.95.

According to *Cobra*, its *HH-45WX*, which measures 5¼×2½×1½ inches, is the world's smallest full-featured handheld CB radio. The diminutive radio provides convenient, affordable communications and vital weather information for those involved in outdoor sports and recreational activities. It is equipped to receive ten National Weather Service channels for up-to-the-minute local weather, emergency, and disaster information 24 hours a day, seven days a week, across the United States. Four-watt power capabilities ensure maximum range.

"It's the only unit on the market small enough to fit into a shirt pocket that can



Cobra Family Radio Model HH-45WX

still offer maximum range capability and features usually found only in much larger CBs," said Don Wisniewski, Cobra marketing manager. "No matter where you go—whether camping, biking, boating, or hiking—this CB provides you with an affordable security network, serving as a reliable form of communication, a weather guide, and emergency aid."

The radio's dual-watch feature provides simultaneous monitoring of any two channels, while its full scan feature allows scanning of all 40 channels at the push of a button. It provides instant access to emergency channels 9 and 19 as well as an eight-channel memory setting for easy access to favorite channels. The HH-45WX comes with a removable battery pack and offers power-saving features that dramatically increase battery life. A 12-volt power adapter is included.

The HH-45WX CB radio has a suggested retail price of \$149.90.

Time On Your Side

THE TIME MACHINE MODEL RM-116E. From Oregon Scientific, 18383 South West Boones Ferry Road, Portland, OR 97224. Tel: 1-800-853-8883; Fax: 603-684-8883. Price: \$99.95.

Most of us are pretty good when it comes to time. Sure, we might press the snooze button a few too many times on cold Monday mornings, or arrive at the dentist a couple of minutes past our scheduled appointment time. But, barring unforeseen emergencies, we get to work or school when we're supposed to, we don't leave

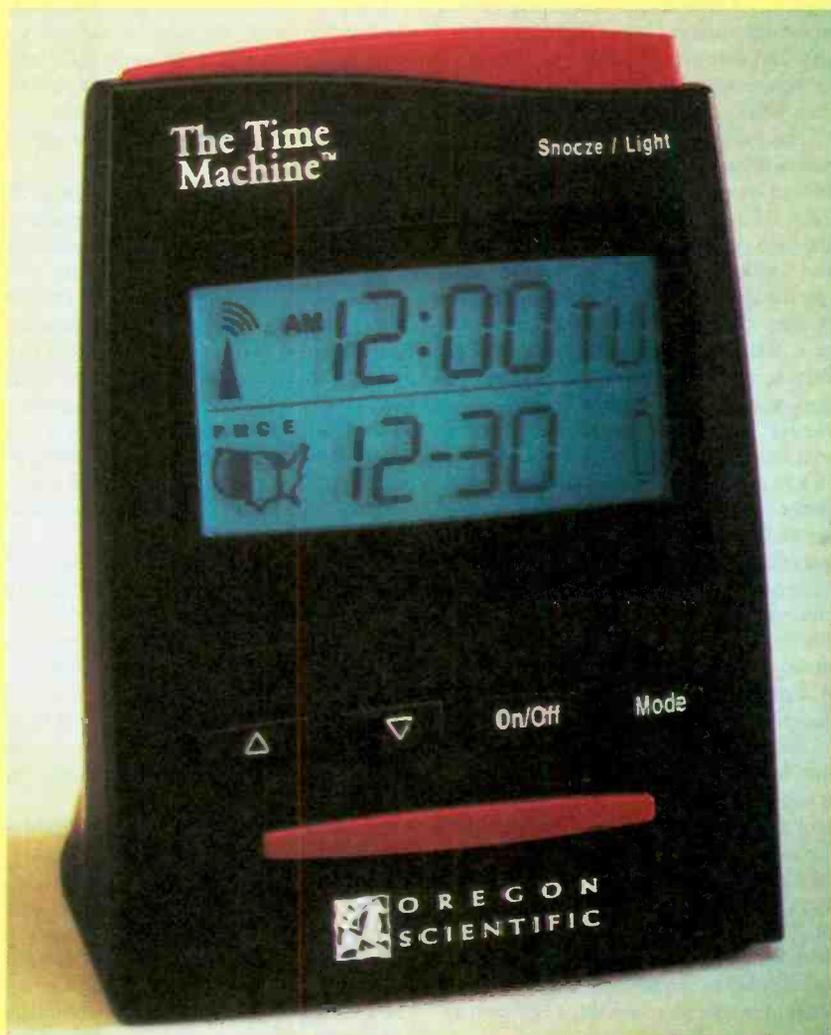
our friends or spouses waiting for hours in restaurants, our kids aren't left standing outside the daycare center after everyone else's have been picked up, and we get to the movies early enough to buy popcorn and see the coming attractions.

There are, however, two separate groups of time extremists: We'll call them the punctually-challenged and the time-obsessed. Everyone knows someone who seems to live in a time warp. We quickly learn never to count on such a person to show up anywhere near the expected time. For instance, we have a friend who held up the bus for so many of her ski club trips that the rest of the group learned to lie about the departure time, telling her the bus left at 6 AM instead of the actual 6:30. And a close relative actually had his mother call him every morning for all four years of college—from 700 miles and one time zone away—to wake him up in time to get to his first class. As an adult, he is routinely two hours late for any social appointment. Whether habitual tardiness is caused by some cerebral glitch or simply bad manners, dealing with the punctually-chal-

lenged can cause severe aggravation.

So, also, can dealing with the time-obsessed—those people who never say it's a quarter past six when they can say 6:13. Not as numerous, nor as obvious, as the punctually-challenged, they get on your nerves by expecting everyone to be as prompt as they are, and by being a little too perfect. They never leave their VCR and coffee-maker clocks blinking 12:00 after a power outage. They set their clocks ahead and behind each spring and fall before they go to bed, not the morning following Daylight Savings Time changes. They can tell you if the Times Square ball drops a second too early or too late on New Year's Eve, and if the local fire house blasts the noon whistle at 11:59. They might never keep you waiting—but they're not likely to put up with any lateness on your part, no matter the cause. They can even tell you the frequencies of all broadcasts that contain time signals derived from atomic clocks, because they synchronize their watches and clocks (right down to the ones on the stove and the car dashboard) to them.

Oregon Scientific has come up with an



Innovations '97 award-winner that the compulsive clock watcher will love. *The Time Machine (Model RM-116E)* is an alarm clock that automatically sets itself, using the radio signals transmitted by WWV, which broadcasts the time of day as determined by the U.S. Atomic Clock.

The U.S. Atomic Clock is one of the most accurate timepieces in the world. Located in Boulder, Colorado, and run by the U.S. Department of Commerce's National Institute of Standards and Technology (NIST), its signal has been used for years in commercial and industrial applications requiring precise time-keeping, such as aircraft and ship navigation, television and radio broadcasting, and scientific facilities. Civilians equipped with a shortwave radio can pick up the signal on 2.5, 5, 10, 15, and 20 MHz, and then manually set their clocks and watches to match it.

Or, they can buy *The Time Machine* and never have to worry about setting the clock again. An internal radio receiver allows it to pick up the Atomic Clock signals six times each day—at 2, 3, 4, and 9 AM, and 3 and 8 PM. The included external T-bar antenna can be draped behind a desk or night stand to facilitate reception anywhere in the continental United States. The time, day, and date are set automatically, as are adjustments for daylight-savings time and leap years.

The palm-sized, wedge-shaped clock stands 4½ inches tall. Its front panel is dominated by an oversized (approximately 2½ × 1¼-inch) LCD readout that displays the time (in hours and minutes) and day of the week on the top line, and the date (month/day) below it. Alternately, the time display can show the time in hours, minutes, and seconds, with the seconds display displacing the day of week. The day can appear in English, French, or Spanish. To the left of the time is a radio-tower icon that indicates reception strength. Below it is a map icon, divided into the four time zones of the continental U.S., with the user-selected time zone highlighted. The LCD is backlit with Oregon Scientific's bright-blue electroluminescent HiGlo illumination, making it easy to read at night. The backlight is activated by pressing a red bar at the top of the clock. The light bar is also used to activate the clock's 8-minute snooze function while the alarm is ringing.

Below the LCD is a row of buttons—up arrow, ZONE, ON/OFF, and MODE—that serve a variety of purposes. They are used to select the time zone, set the alarm time, turn the alarm on or off, and change the top line of the display to show seconds instead of the day of the week. A press of the red alarm bar replaces the date line on the LCD with the alarm time; a second press returns the display to month and date. (When the alarm function is activated, a bell icon appears on the display.)

It is possible to manually set the time, day, and date, but we can think of only one reason why you might want to—impatience. Although it should take only three to seven minutes to set itself, *The Time Machine* does not always receive a signal right away. Like any radio device, it is subject to propagation conditions and interference;



The Time Machine's LCD displays more than just time, day, and date. The radio tower icon indicates excellent reception, and the map shows that the time zone is Mountain Standard Time.

for that reason, the best reception generally occurs late at night.

The manual suggests that you give the *Time Machine* a full 72 hours to set itself before becoming concerned. It includes advice on how to orient the antenna for best reception (near a window, away from TVs or PC monitors, and preferably not in a heavily reinforced concrete or steel structure).

The signal-strength indicator on the LCD lets you know how good your reception is. A full-strength indicator (a radio tower with four waves beaming from it) means that signal reception was excellent for the last signal broadcast and that synchronization has occurred. If reception is poor, and you need to reposition the clock, the LCD shows instead a radio tower with just two waves, with a curved arrow next to it. No radio tower at all means that radio reception is nonexistent; a tower with no waves shows that the displayed time has been manually set.

In our suburban New York setting, the *Time Machine* took more than two days to synchronize itself to the U.S. Atomic Clock. That's really not too bad, especially considering that we are right in the middle of the northeastern seaboard—an area "where urban interference or signals from the United Kingdom's radio control tower may distort or delay the time setting signal," according to the manual.

If, for whatever reason, the *Time Machine* fails to pick up the Atomic Clock signals for an extended period of time, its quartz clock movement should maintain a precise time. We did not have to put it to the test; after the initial setup, it continued to synchronize itself several times each day, and we couldn't have set it more accurately ourselves.

The Time Machine has actually saved us some time. After a brief power interruption, we had to reset quite a few clocks around the house, from the VCR to the bread-baker. Setting them using the time machine as our reference was far quicker than tuning into WWV.

No electronic product is going to improve the promptness of the punctually-challenged. But the *Time Machine* just might improve the on-time performance of the average person. And the time-obsessed will adore it. ■

Quiet Down!

NOISEBUSTER EXTREME! STEREO HEADPHONE SYSTEM. From: Noise Cancellation Technologies, Inc., 800 Summer Street, Stamford, CT 06901-1023; Tel: 203-961-0500. Price: \$69.

Silence may be golden, but it can also be rather eerie. We live in such a noisy world that it can be disconcerting to be away from the constant background hum associated with civilization.

Stop and listen. What do you hear? Maybe the roar of a distant highway, maybe a train, maybe the wind whistling outside. Even if your house is closed up tight, you'll have plenty to hear—maybe the boiler or furnace, the refrigerator, the power-supply fan on your PC, the TV in another room, the neighbors in the next apartment, or the dog across the street. Perhaps even all of the above.

Most of us ignore virtually all of the sounds we hear—we'd go crazy, otherwise. We're so adept at tuning them out that we tend to worry only about loud noises that we fear could damage our hearing. But loud noise isn't the only damaging noise. Constant exposure to noise can lead to stress, and recent studies have shown that noise can even elevate blood pressure.

Although we are not always able to control the sounds to which we're subjected, we can take some steps to reduce our exposure. In our homes we can insulate walls, close windows, and perhaps even use a white-noise generator to mask external sounds. We can wear ear plugs. (While they're essential when using power tools, lawn mowers, and other generators of excessive noise, ear plugs can also be effective just to quiet our noisy world.)

At CES, we found a new way to stifle the cacophony around us: active, electronic noise cancellation as provided by the *NoiseBuster Extreme!* from *Noise Cancellation Technologies*. Three years ago, we examined the original *NoiseBuster* system here in *Gizmo*. *NoiseBuster Extreme!* is a new update, offering more features, smaller size, lighter weight, higher perfor-

mance—and even lower cost.

NoiseBuster Extreme! is powered by two AAA batteries—another improvement over the original, which was powered by a 9-volt battery. It looks something like a small personal stereo. A pair of comfortable, on-the-ear headphones is hardwired to a plastic “audio enhancer pack” that measures about 2 × 3½ inches and contains most of the NoiseBuster circuitry. Unlike the original, the newer headphones fold flat, which makes it much easier to slip them into a briefcase. The normal appearance of the headphones is deceiving. Pull off the foam padding around each earpiece, and you’ll see the difference: Each earpiece contains not only a driver, but also a small microphone.

Those microphones listen for the offensive noise that would reach your ears, and feed the information back to the audio enhancer pack, where its level and frequency are analyzed. The NoiseBuster then creates a noise signal of its own—an “anti-noise wave” that is a copy of the original noise, but 180 degrees out of phase with it. That anti-noise wave is fed to the headset, where it is output by the speakers. You can’t hear it, though. When the anti-noise meets the offending noise, they cancel, and the noise is reduced.

The NoiseBuster Extreme! is designed to operate within the frequency range from 30 Hz to 1500 Hz, and provides better than 15 dB of cancellation between 150 and 300 Hz. The intent is to reduce or eliminate low-pitched rumbles and hums, without interfering with speech or music. The effectiveness of the device depends on how much of the ambient noise falls within its operating range. On an airplane, for example, the effect can be dramatic.

Although the NoiseBuster Extreme! can be used as a stand-alone noise-reduction device, it can accept an input from, for example, a personal portable stereo. A cable with miniature stereo plugs on each end is provided to link the output of an audio source to the input of the NoiseBuster. Also, an adapter is provided so that the NoiseBuster can be connected to airplane audio systems that require two-prong plugs.

Our first experience with the NoiseBuster Extreme! was on the way back from the Winter Consumer Electronics Show in Las Vegas. Normally, we hate the cross-country airplane flight. This flight was different for a couple of reasons. First, we watched the in-flight movie and could actually understand the dialogue thanks to the NoiseBuster Extreme!’s effectiveness. Second, we were able to fall asleep—something that we normally can’t do on an airplane, even when taking the red-eye flight back to New York.

Airplanes are incredibly loud, with noise levels in the passenger cabins somewhere around 80 decibels (dB). Typically, that

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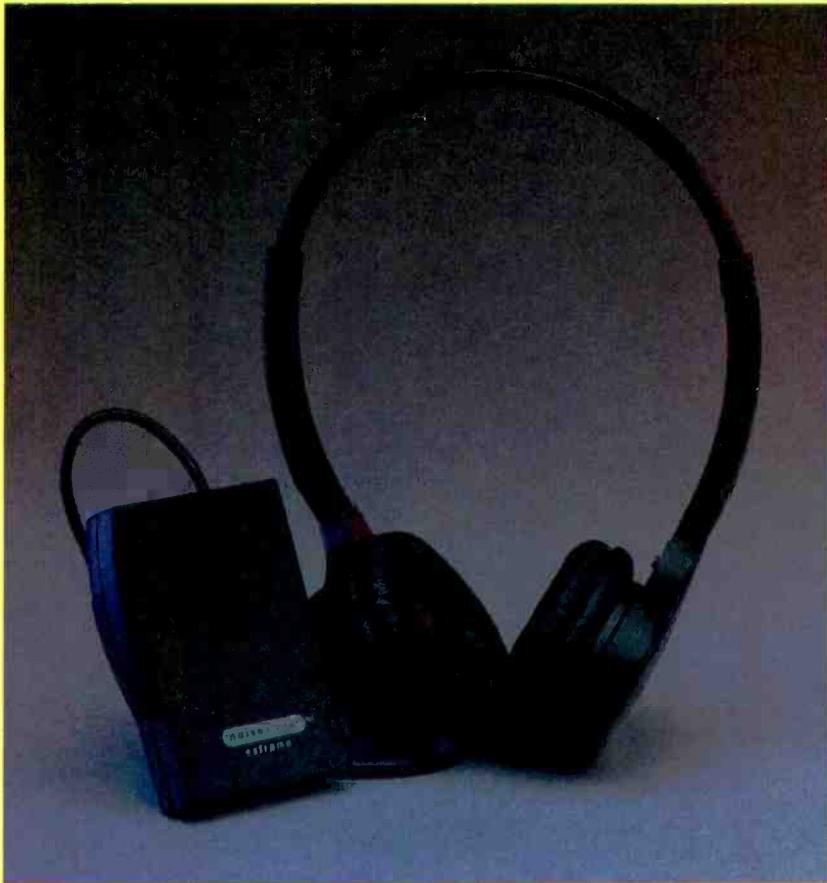
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noise—about the same as you might expect during the daytime in a busy city—makes it difficult to listen to a personal stereo, in-flight audio entertainment, or the soundtrack for an in-flight movie. To compensate for the noise, your first inclination might be to simply increase the volume—which doesn't do your ears any favors.

Of course, the airplane cabin is still a loud place even with the NoiseBuster turned on and its adjustable cancellation turned to its maximum. (The device can be varied to provide between 8 and 15 decibels of attenuation with a slide potentiometer.) But the difference with and without the headphones is nothing short of dramatic. We kept them on for the entire flight—the most restful airplane trip we've ever taken.

Back on the ground, we found a few other situations in which the NoiseBuster Extreme! proved handy. Most notably: When our boiler kicks in, you definitely know it. The resultant rumble has us reaching for the remote controls to turn up the volume on the stereo several times in the course of an evening. When using the NoiseBuster Extreme! with a personal stereo, however, we could keep the volume constant. As an added bonus, we didn't hear any complaints about the increasingly loud music from other family members—another sort of noise-busting, we suppose. ■

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CB03

BUILD AN LED OSCILLOSCOPE

Popular Electronics
JUNE 1997

BY CARL J. BERGQUIST

While thumbing through a recent catalog from "the guys from Van Nuys" (All Electronics), I encountered an item that included eight 5x7 dot-matrix displays, and a PGA style driver, all for a very reasonable price. That reminded me of a project I had been promising to try for some time, and, since I have a hard time staying away from a bargain, I placed an order. The project is an LED display oscilloscope.

While LED display scopes have been around for some time, they always make an interesting project and a practical pursuit. A major construction deterrent, however, is the tedious wiring of the display board. That's because to obtain satisfactory resolution, a minimum of about 200 LED's is necessary, and, that represents 800 tight solder joints. Perhaps, that's why I had not to this point pursued the project with more vigor, but the use of those 5x7 LED arrays would greatly simplify the construction. Therefore, I felt compelled to venture forth (or something like that).

One of the appealing aspects of this type of "solid-state" oscilloscope is its simplicity. With the absence of a cathode ray tube (CRT), the need for a high-voltage power supply, associated sync circuits, and coils are eliminated. And through the use of two integrated circuits for the vertical gain and horizontal sweep circuits, the overall configuration could be made com-

With just a handful of readily available components and a little patience, you can build a simple scope and add a new dimension to your electronics experiments!



compact as well as economical. Like CRT scopes, this unit can display sine, square, and triangular waves, as well as other commonly encountered patterns.

Circuit Operation. Figure 1 is a schematic diagram of the LED Oscilloscope. The scope revolves around the light-emitting diode, dot-

matrix display, which is used to visually illustrate the wave form of the input signal. The prototype uses twelve 5x7 LED arrays to provide 20 rows of horizontal dots and 20 columns of vertical dots. That's a total of 400 LED's. With that in mind, let's look at the vertical gain circuitry.

The circuit uses a pair of LM3914 dot/bar display drivers (IC1 and

IC2) for vertical (row) attenuation. The LM3914 has ten outputs that activate progressively as the input voltage increases. The outputs go low, on activation, thus, accommodating the LED cathode junctions, so, whenever an LED's anode is high, the diode lights.

The outputs of IC1 and IC2 can be configured in two different fash-

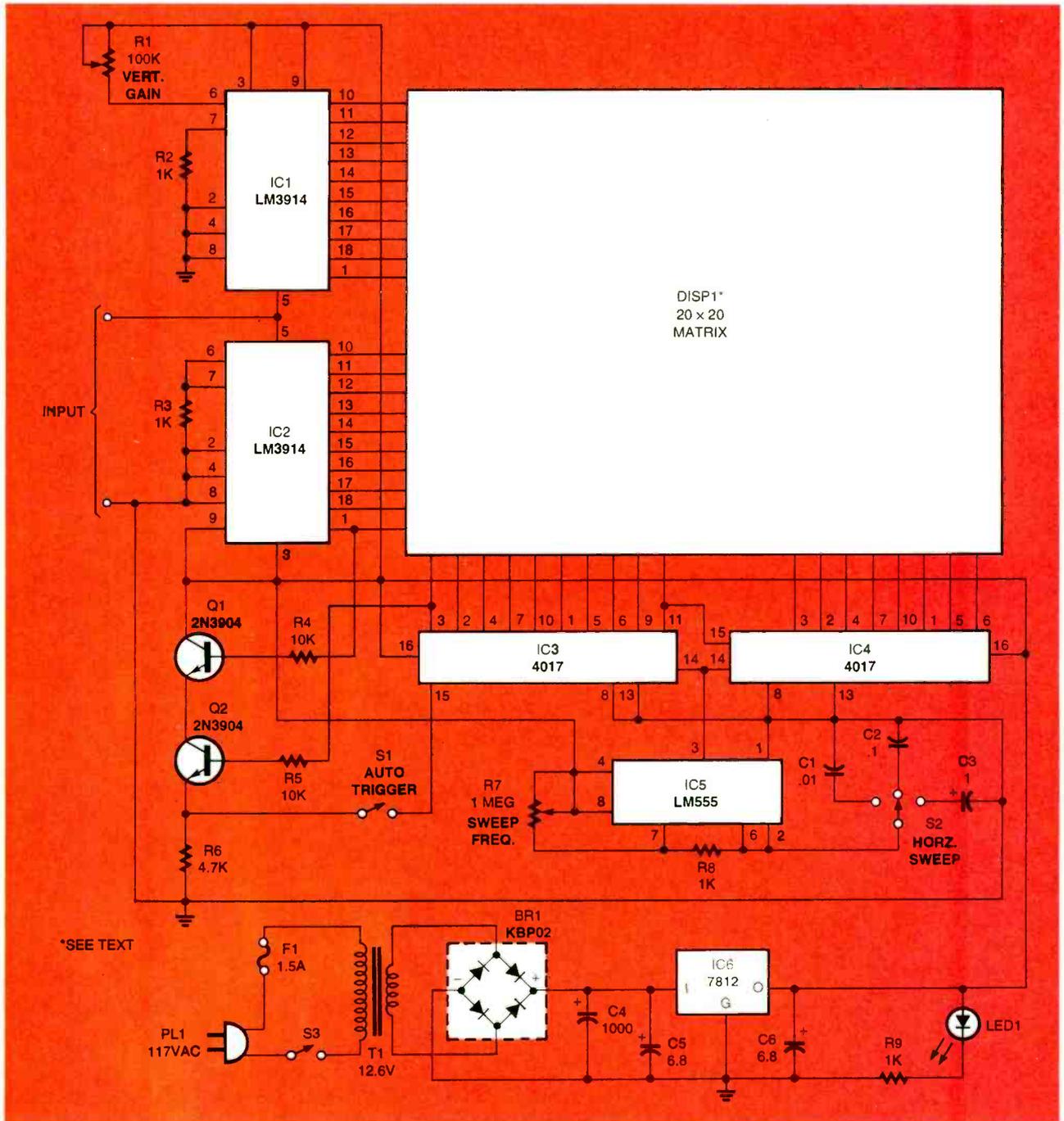


Fig. 1. The Solid-State LED Oscilloscope is built around six IC's and twelve 5x7 LED arrays that are arranged to form a 20 x 20 LED display matrix. Two of the chips, IC1 and IC2, form the vertical circuit, while the horizontal circuit is formed by two more

chips, IC3 and IC4. The clock, which provides the sweep frequency, is built around a simple 555 oscillator/timer (IC5). The final IC (IC6) is used to provide a stable power source to power the entire circuit.

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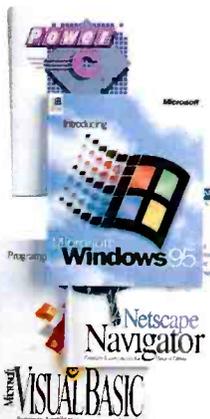
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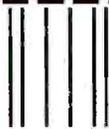
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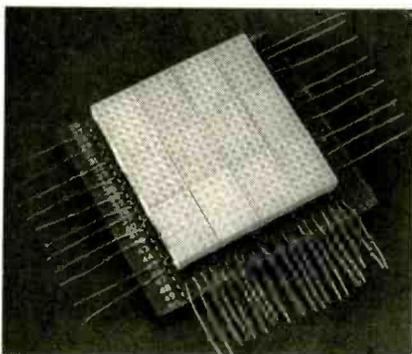
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ions. The two chips can be cascaded, as shown in Fig. 1, to form a 20-dot full-scale display for a single trace unit. Or each IC can have separate inputs to yield two 10-dot full-scale displays: i.e., forming a "dual trace" arrangement. The dual trace arrangement allows two individual signals to be viewed and/or compared at a given time. Figure 2 illustrates the wiring changes required to produce a dual-trace arrangement. Note that in the dual-trace arrangement a second vertical-gain control (R10) has been added to the circuit and pin 1 of IC1



Twelve 5x7 LED arrays were mounted on a section of perboard in a 3 by 4 configuration, as shown here, to form the oscilloscope's 20x20 display matrix.

and IC2 are connected to R4. The vertical-gain control(s) sets the parameters for IC1 and IC2.

The horizontal sweep circuit is comprised of a pair of 4017 decade counter/dividers (or Johnson counters), IC3 and IC4. Since a full horizontal sweep involves 20 columns, IC3 and IC4 are cascaded to produce 20 outputs. Thus, the display now has both vertical and horizontal control. The 4017 sequentially sends one of its ten outputs high at a frequency that's determined by sweep clock. The sweep clock is built around a 555 oscillator/timer (IC5) that's laid out in a standard astable configuration. Potentiometer R7 along with a capacitor (either C1, C2, or C3) are used to set the sweep frequency. Switch S2 is used to select one of three capacitors (C1, C2, or C3) (to provide the sweep a timing range, which is then "fine tuned" via R7. The higher the setting of R7 and/or the greater the

capacitance value selected by switch S2, the slower the sweep frequency. Conversely, lower R/C values the faster the clock speed. The clock output at pin 3 of IC5 is applied to pin 14, of both IC3 and IC4.

Finally transistors of Q1 and Q2, plus R4, R5, and R6 are configured as an AND gate. One input of the AND gate is tied to the first output of the vertical circuit (pin 1 of IC2) and the other input tied to the first

the counter, and readying it for the sweep cycle. Note that the AND gate can be disengaged via switch S1, allowing manipulation of the display, if desired.

Now let's see how those individual circuits interact as we follow the scope through its paces. When a signal of sufficient voltage is applied to the input of the circuit, the first output of the LM3914 activates, creating the AND action required to reset the 4017. For the

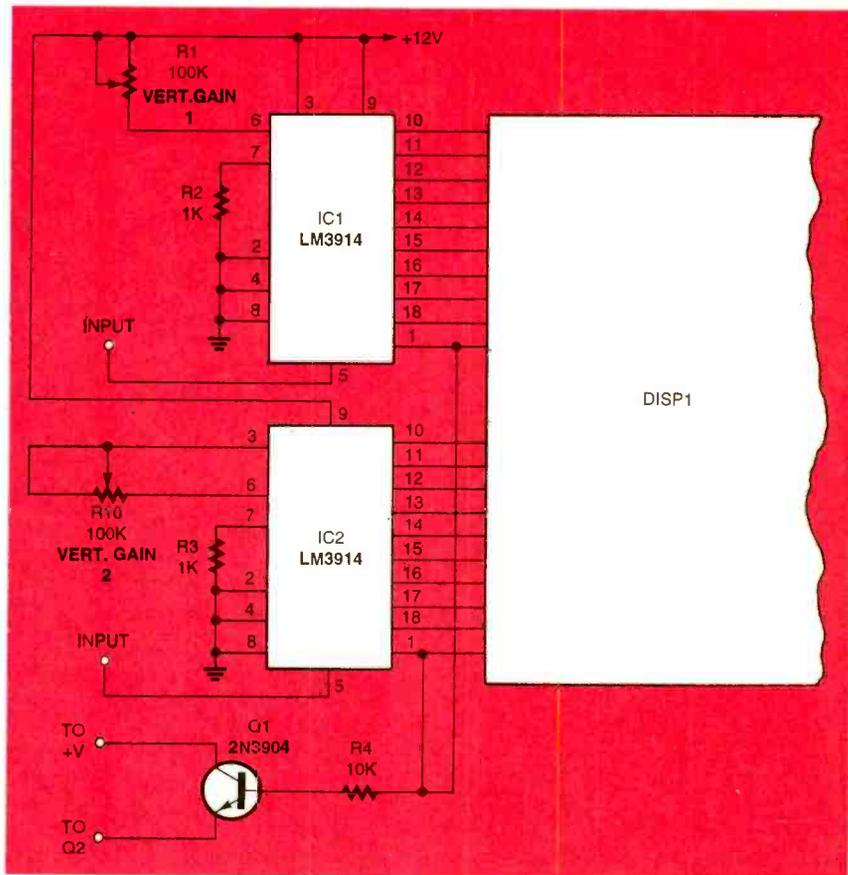


Fig. 2. By altering the input of the Solid-State LED Oscilloscope, as shown here, the single-trace circuit illustrated in Fig. 1 can be converted to a dual-trace unit. Other modifications are possible as well (see text for details).

output of the horizontal circuit (IC3 pin2). When pin 1 of IC2 and pin 3 of IC3 are activated, a high from the row 1, column 1 LED and the active low output of IC2 at pin 1 is applied to its cathode, causing it to light. That situation also results in a high at one input of the AND gate and a low at the other, forcing the AND gate output low. The low output of the AND is fed to the reset terminal of IC3 at pin 15, thereby clearing

sake of discussion, let's assume that the LM3914 is set for dot-mode operation and that signal input is initially at some low value. As the applied signal voltage increases, the first out of IC2 at pin 1 activates, producing a low. As the input signal voltage continues to rise, the next successive output of IC2 is activated, sending its output low, as the previous one is deactivated; i.e., goes high. The opposite occurs as the signal voltage decreases.

The active low output of the LM3914 is simultaneously applied to the cathodes of the all the LED's connected in that row. Thus, increases and decreases in the input voltage determine which output is activated, and, thus, the vertical height of the display.

At the same time, the horizontal sweep (which is governed by the clock, IC5) pulls the vertical image across the display, by sequentially activating the outputs of IC3 and IC4, sending them high one at a time. That sweeping action causes any LED that has its cathode pulled low via IC1 or IC2 to light, producing a corresponding waveform to appear in the display. The higher the sweep frequency, the more continuous, or solid, the pattern appears. Conversely, the image appears to "walk" across the display as the clock speed is decreased.

Construction. Since the circuit configuration isn't all that critical, perfboard, point-to-point, or printed circuit construction techniques can be used. The author's prototype was configured for dual-trace operation, with the main assembly mounted to a printed-circuit board and the display assembled on a section of perfboard. Since most tedious and demanding procedure is wiring the display board, so, let's get that out of the way first. The display was assembled on a section of perfboard and connected to the printed-circuit board through hook-up wire.

Twelve Hewlett Packard HDSP-L203, 5x7 LED arrays were used to form the 20 (20 LED display matrix. While the individual LED arrays fit standard 14-pin IC sockets, sockets are not recommended (the arrays are a 12-pin configuration, which tends to throw off the spacing if sockets are used. In addition, the individual arrays must be placed tightly together, making it necessary to solder the displays directly to the perfboard. When connecting adjacent rows of pins, take care to avoid solder bridges. Patience is the key to preparing a successful display board. Although

there are some 335 connections to make, that is a far cry from the 1,680 solder joints required if individual LED's are used.

Figure 3 shows the wiring layout for the display board; start with row 19 and work down the board. Then, go to column 20 and work across. It is best to visually inspect each row and column upon completion for possible shorts, and make the necessary corrections then and there. Once the board is complete, run a test to make sure all the LED's light,

board is shown in Fig. 4. A parts-placement diagram for the printed-circuit board is shown in Fig. 5. Assembly of this section is relatively straightforward. Begin by installing the jumpers and IC sockets first. Note that four of the jumper leads run beneath the sockets for U3 and U4. With the jumpers and sockets in place, install the discrete components (resistors and capacitors), followed by the regulator and transistors. Finally, connect appropriate lengths of hook-up wire to the

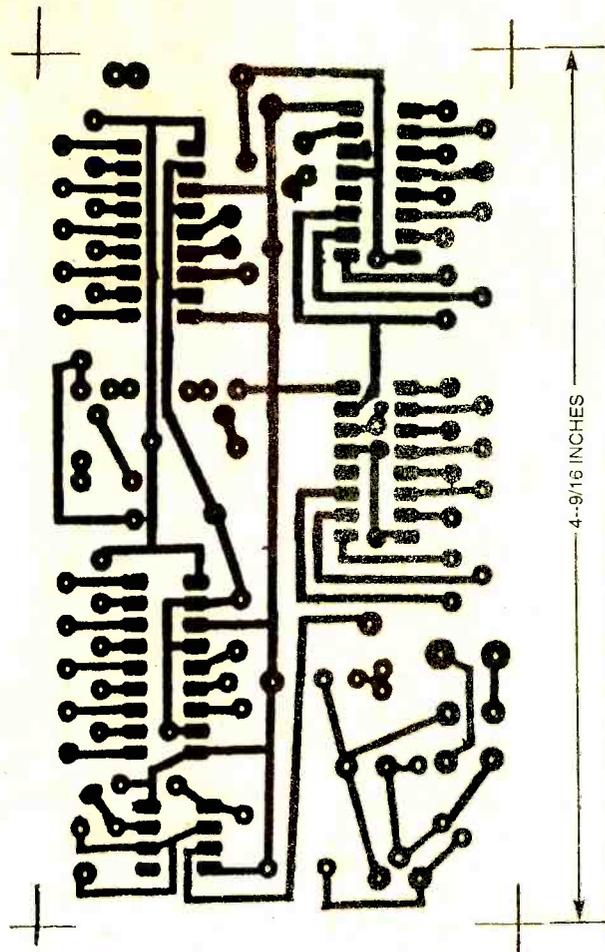


Fig. 3. The display portion of the Solid-State LED Oscilloscope is comprised of twelve 5x7 LED arrays mounted to a section of perfboard to form a 20x20 LED display matrix. The layout for that matrix is shown here.

and the assembly follows the "X-Y" configuration. If all is well, set the display aside, and move on to the control circuit.

The control circuit was built on a printed-circuit board, measuring 4-9/16 by 2-1/2 inches. A full-size template of the author's printed-circuit

points indicated for the off-board components (switches, potentiometers, input jacks, and transformer.

With that done, apply power to the circuit and check the power terminals of each IC socket (pin 9 of IC1 and IC2, pin 16 of IC3 and

IC4, and pin 8 of U5 (for +12-volts DC. If the voltage checks out, connect the display to the circuit board, paying very close attention to lead orientation. Last, solder the off-board components to the hook-up wires and install the integrated circuits, again observing proper orientation. The scope is now ready for testing.

Testing and Final Assembly. With the vertical gain control(s) and hor-

zontal sweep control set to mid range, plug the project's line cord into an AC socket and turn on switch S3. That should cause a column of dots to start moving across the display. Actually, you will see two columns about ten spaces apart. Next, introduce a stable audio-frequency signal to the input(s), and, a sinewave should appear on the display. By adjusting the vertical gain, the height of the image can be varied; similarly, the

width of the displayed waveform can be varied by adjusting the clock frequency. Increasing the clock will expand the waveform, while decreasing it will compress it.

With some experimenting, a grid can be developed to give accurate voltage and frequency readings, at various level settings. For example, let's say that an input of 10 Hz at 5 volts is applied to the circuit, and the vertical gain and clock are set at mid-range. If the waveform runs halfway up the display and halfway across, then full

PARTS LIST FOR THE SOLID-STATE SCOPE

SEMICONDUCTORS

- IC1, IC2—LM3914 dot/bar display driver, integrated circuit
- IC3, IC4—4017 decade counter/divider, integrated circuit
- IC5—555 oscillator/timer, integrated circuit
- IC6—7812 12-volt, 1-amp voltage regulator, integrated circuit
- Q1, Q2—2N3904 general-purpose NPN transistor
- BR1—KBF02 full-wave bridge rectifier
- DISP1—Twelve HDSP-L203 dot matrix display (see text)
- LED1—Light-emitting diode (any color)

RESISTORS

- R1, R10—100,000-ohm potentiometer
- R2, R3, R8, R9—1000-ohm
- R4, R5—10,000-ohm
- R6—4700-ohm
- R7—1-megohm panel mount potentiometer

CAPACITORS

- C1—0.01- μ F Mylar
- C2—0.1- μ F Mylar
- C3—1- μ F, 35-WVDC, electrolytic
- C4—1000- μ F, 35-WVDC, electrolytic
- C5, C6—6.3- μ F, 35-WVDC, Tantalum

ADDITIONAL PARTS AND MATERIALS

- S1—SPST toggle or push button switch
 - S2—SP3T rotary switch
 - S3—SPST miniature or micro toggle switch
 - S4—SPST power switch
 - T1—12.6 volt, 1-amp step down transformer
 - PL1—117-volt AC line cord with molded plug
 - F1—1.5-amp fuse
- Printed-circuit materials, enclosure, heat sink, IC sockets, panel-mount fuse holder, transparent red plastic, knobs, wire solder hardware, etc.

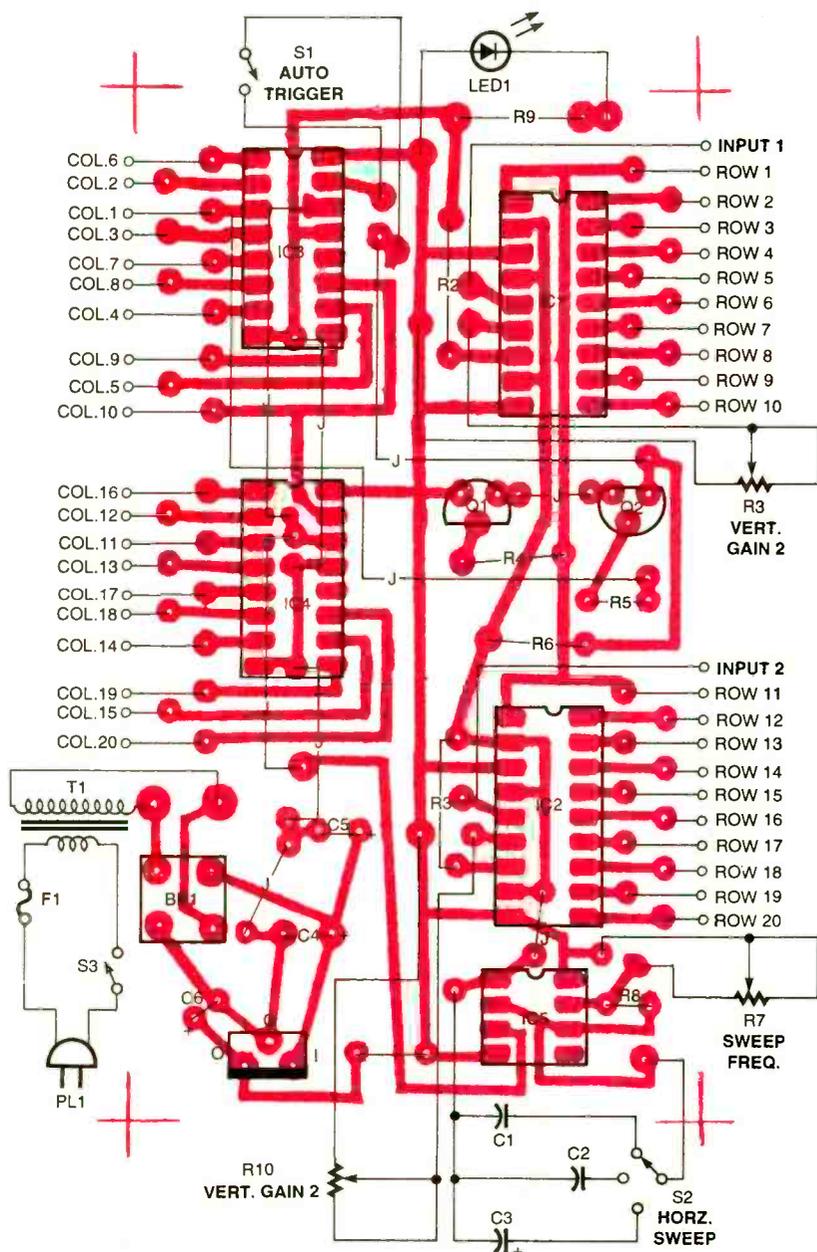


Fig. 4. The control circuits for the Solid-State LED Oscilloscope were assembled on a small printed circuit board, measuring 4-9/16 inches by 2-1/2 inches. This template can be copied and used to etch your own printed circuit board.

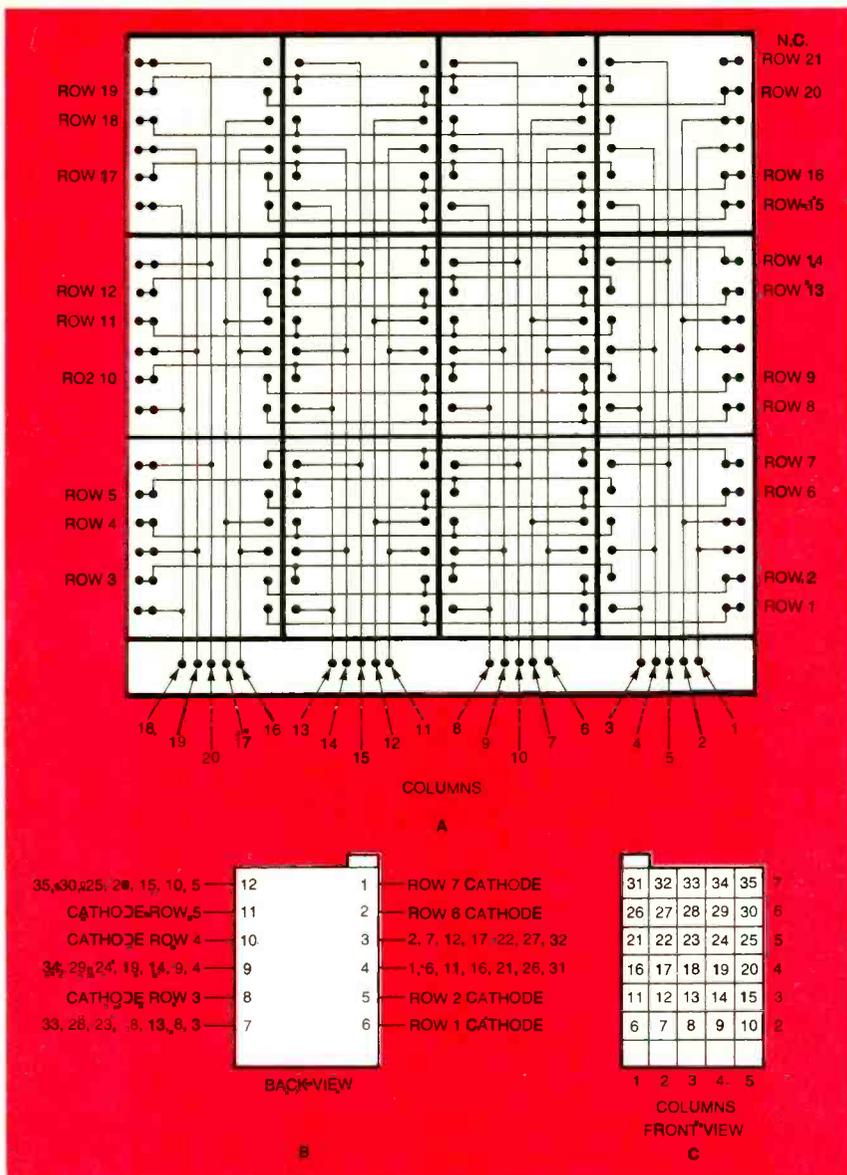


Fig. 5. Once you've etched your board, install the parts guided by this parts-placement diagram. Install the jumper connections first, as at least four of them must run beneath the IC sockets for U3 and U4.

scale for those settings will be 20 Hz, and 10 volts. By plotting several known input values references can be established.

The last step in construction is to house the unit in a suitable enclosure. The prototype was housed in a standard bench-style instrument case, measuring 2-1/2 inches high, 8-1/2 inches wide, and 6 inches deep. Those dimensions easily handle the scope and the power supply.

The front panel is 1/16-inch sheet plastic with holes drilled for the switches, jacks, and potentiometers, and a 2-x 2-1/8-inch rectangular

cutout for the display. If you choose to house your unit in a similar enclosure, the template shown in Fig. 6 can be used. Always use caution, when working with plastic to prevent cracking or chipping. After making the appropriate alterations to the front panel, it can be painted and labeled with dry transfer lettering, and then given a final spray coat of clear plastic to protect the labels. The back panel only needs holes for the power cord, and fuse holder.

Once the finish is dry, mount the display and other off-board com-

ponents to the front panel. Secure the control board and power transformer, to the bottom of the enclosure, and close up the case. For cosmetics, and greater contrast, a thin piece of clear red plastic can be mounted over the display. If more diffusion is desired, try frosted plastic sheeting (which is available in most art supply stores).

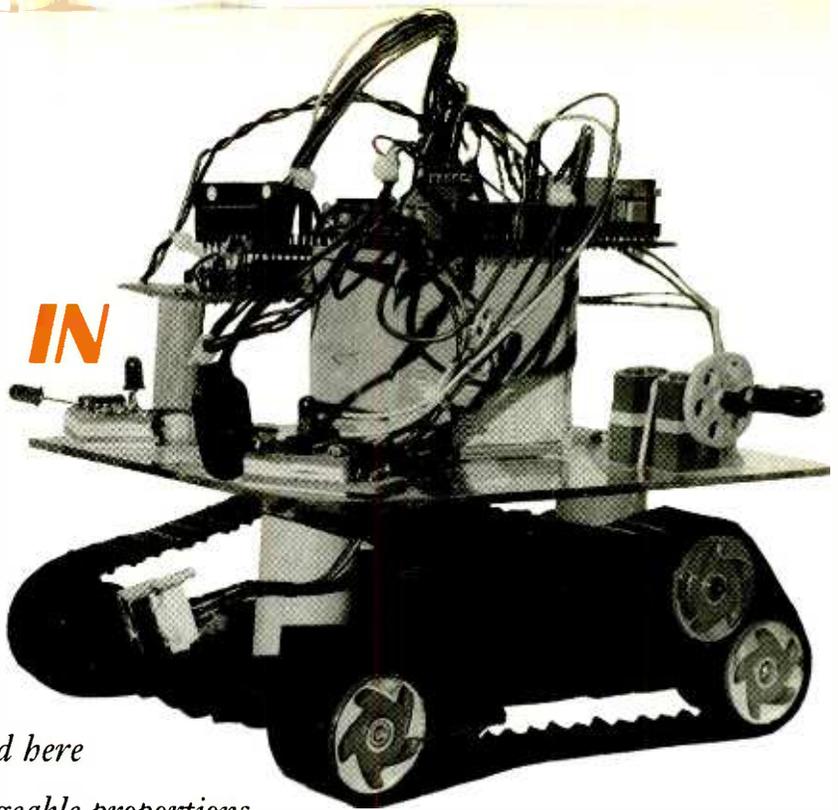
Modifications. If desired, the circuit can be modified to take advantage of the mode select terminals of IC1 and IC2 by placing a single-pole single-throw switch (let's call it S4) from pin 9 of the LM3914's. With pin 9 connected to the 12-volt supply (as shown in the schematic diagram), the circuit is set to the bar mode, causing the display to fill the inside of the waveform, thereby accentuating the shape. However, if a more traditional single-line pattern is desired, opening the switch sets the circuit to the dot mode. In the dot mode only the highest output is activate.

The author's prototype is a dual-trace unit with channel 1 configured for mode selection. However, if desired, a DPDT switch can be used to convert both channels at once, or two separate switches could be used to allow selective conversion. In each case, the dot mode results from either floating pin 9, or connecting it to ground. If the dot mode is desired, it will be necessary to alter the printed-circuit board severing pin 9's connection to +V and connecting a switch in series with the severed trace.

Conclusion. Solid-state displays have come along way since the first light-emitting diodes hit the market back in the 1960's. Both LED and LCD (liquid crystal displays) are commonly used for clocks, watches, test equipment, games, TV screens, signs, and a variety of other applications, where a visual annunciation is desired. Their popularity is due, in part, to ease of use, modest power requirements, accuracy (especially in measurements), and enhancement of appearance
(Continued on page 78)

GETTING STARTED IN ROBOTICS

Finding information on building robotic devices can be a daunting task, but with the help of the information that's presented here that task can be reduced to manageable proportions.



By the time I finished reading Mike O'Connor's article "Build a Mobile Robot" that appeared in the September 1996 issue of **Popular Electronics**, I wanted to know more about robotics so that I too could get started in this interesting and challenging hobby. My problem was that I knew nothing about robotics, nor where to turn to get information, and I knew no one who could advise me either.

After several weeks of perusing the bookshelves of my local libraries and visiting countless Web pages on the Internet, I was able to gather enough information to begin building my own robot and to endow it with a variety of robot behaviors. If Mike O'Connor's article piqued your interest in robotics as it did mine, then I hope the following information will make it just a little easier for you to begin experiencing the joy of this fascinating hobby.

My biggest startup hurdle was gaining an understanding of all that the hobby of robotics entails. An amateur robot might have a simple function with only a single behavior, as with the unit shown in Fig. 1, or it might have a complex function with multiple behaviors like the robot

WILLIAM T. BENSON

shown in Fig. 2. In every case however, a mobile robot will include, in some important way, elements of electrical, mechanical, and software engineering. Since I have no professional training in any of those disciplines, everything about this hobby was going to be a new learning experience for me.

Getting Started. My local libraries had a disappointing lack of useful information about amateur robotics. On the other hand, the Internet's World Wide Web, not surprisingly, was the richest source of information about all aspects of robotics. In fact, most of the information sources recommended in this article first came to my attention while perusing the Web.

If you don't have access to the Internet, you should get connected without delay. Too much is happening out there not to be a part of it. You can get access to the Internet by joining one of the major on-line services such as America On-line or CompuServe, or by opening an account with a local Internet ser-

vice provider (ISP). The Internet will prove to be one of your most valuable resources and research tools to help you get the most out of the robotics hobby.

The World Wide Web. The Internet offers an abundance of information sources that you will find useful. Among them are World Wide Web pages hosted by commercial suppliers of robotics related stuff, university researchers, other robotics hobbyists, and robotics clubs. In addition, you'll find robotics-related forums, called newsgroups, where subscribers interested in robotics can exchange information or ideas, and seek or offer help to other subscribers. It is not

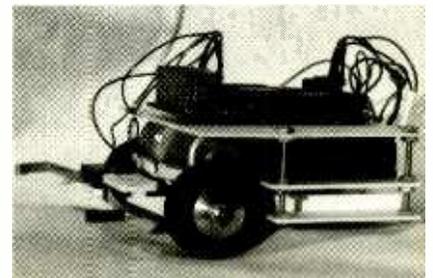


Fig. 1. This simple robot roams aimlessly, but if it hits a wall or other obstacle, its single behavior causes it to back up and turn in another direction.

possible to list all of the Web pages that have robotics content, because there are so many. So, instead, I have listed several sites, each of which contains large lists of links to other robotics sites. One of the many features that has made the Web so popular is its inter-connectivity to other Web sites via hypertext links. By clicking on one of those links, you can travel from one Web site to another. Most robotics Web sites offer at least one or two links to other robotics related Web sites. The Web site descriptions below include the site's address called a URL (Universal Resource Locator).

Portland Area Robotics Society (PARTS)—This Oregon club's members include professionals, amateurs, students, college professors, engineers, artists, hobbyists, and tinkerers. They are actively involved in learning about and building amateur robots. The club publishes a monthly newsletter featuring some aspect of robot building. You can download and file it for future references.

URL: <http://agora.rdrop.com/users/Marvin/>

Triangle Amateur Robotics (TAR)—This club serves the Raleigh-Durham-Chapel Hill area of North Carolina. Topics include news & ideas, other robotics WWW links and scheduled robotics events.

URL: <http://www4.ncsu.edu/~rnbowen/tar/>

Arrick Robotics—This site provides information of interest to robotics hobbyists. There are numerous links to suppliers, robotics clubs, designs and tools.

URL: <http://www.robotics.com/index.html>

Frequently Asked Questions (FAQ)—This list was prepared for the Internet robotics newsgroups comp.robotics.misc and comp.robotics.research. It provides answers to a variety of questions about robotics systems, organizations, periodicals, and pointers to numerous other resources on the net.

URL: <http://www.frc.ri.cmu.edu/robotics-faq/>

Internet Newsgroups—The

ROBOTICS CLUBS

Triangle Amateur Robotics (TAR)
P.O. Box 17523
Raleigh, NC 27619
Attn.: Russell Lynday, Jr.,
Club President
<http://www4.ncsu.edu/~rnbowen/tar/>

Dallas Personal Robotics Group
5112 Hardaway Circle
The Colony, TX 75056
Attn.: Eric Yundt
<http://199.1.173.112/>

The Robot Group Home Page
P.O. Box 164334
Austin, TX 78716
<http://www.robotgroup.org/>

The Rockies Robotics Group
13702-E E. Lehigh Ave.
Aurora, CO 80014
<http://www.he.net/~roundy/RRG.html>

Twin Cities Robotics Group
Computer Science Dept.
200 Union Street
University of Minnesota
Minneapolis, MN 55455
Attn.: Martin Maiers
<http://www.webconn.com/tcrobots/>

Northern New Mexico Robotics
2805-B Walnut Street
Los Alamos, NM 87544-2051
<http://www.acl.lanl.gov:80/~mwd/NNMR.html>

PARTS (Portland Area Robotics Society)
821 SW 14th
Troutdale, OR 97060
Attn.: Marvin Green
<http://agora.rdrop.com/users/marvin/>

Seattle Robotics Society
P.O. Box 6815
Bellevue, WA 98008-0815
<http://www.hhhh.org/srs/>

Connecticut Robotics Society
Hartford, Connecticut
e-mail:

jake_mendelssohn@circellar.com
Atlanta Hobby Robotics Association
P.O. Box 2050
Stone Mountain, GA 30086
Attn: John Gutmann
e-mail: jgutmann@robot4u.atl.ga.us

Robotics Society of Southern California
P.O. Box 26044
Santa Ana, CA 92799-6044
Attn: Jess Jackson
e-mail: rssc@netcom.com

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Danville, CA 94526-1205
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Homebrew Robotics Club (Santa Clara County)
561 Hyannis Dr.
Sunnyvale, California 94087
Attn: Chuck McManis
e-mail: cmcm manis@freenet.net

Nashua Robot Builders
133A Haines St.
Nashua, NH 03060
Attn: John D. Cook
e-mail: jdcook@mv.mv.com

Robotics International Student Group
University of Cincinnati
Center for Robotics Research
M.L. 72
Cincinnati, OH 45221
Attn: Bradley Matthews
e-mail: robot@uceng.uc.edu

Robotics Club of Maryland
Computer Science Department
Room 1151
A.V. Williams Bldg (115)
University of Maryland
College Park, MD 20742-3255
Attn: Stephen P. Klueter

Internet also features a huge number of newsgroups dealing with every conceivable subject. The most popular robotics newsgroup is called comp.robotics.misc. Here you can meet others who are interested in amateur robotics to exchange information and get help with problems. You can post your own personal messages for others to read simply by sending e-

mail addressed to the newsgroup. Reading this newsgroup on a regular basis helps keep you up-to-date on the latest happenings in the field of amateur robotics.

Important Reference Books. Thinking about building a robot and imagining the surprise and enjoyment of others who see it in action is easy, but often getting started is not.

While Internet resources will give you information about virtually every aspect of robotics, putting these elements together into a functioning robot can be a daunting task to the newcomer. But do not despair, there is help here too! There are two popular hobbyist books devoted exclusively to the design and construction of amateur robots: *Mobile Robots: Inspiration to Implementation* and *The Robot Builders Bonanza: 99 Inexpensive Robotics Projects*. Each book focuses on a wide range of amateur robotics topics from construction practices to the final implementation of hardware and software.

Of the two, the *Mobile Robots* book is a must have. This book is often referred to as the "robot hobbyist's bible." It probably presents the most comprehensive treatment of autonomous mobile amateur robotics that you will find in one document. If you read this book, you will not only learn how to build robots that have a variety of behaviors, but you'll also acquire the requisite skills and tools to

implement creations of your own imagination.

An added bonus of the *Mobile Robots* book is its appendices. They provide the reader with a list of over 150 suppliers and distributors of robot parts a list of magazines and trade journals, and a list of semiconductor manufacturers' data books.

A third book that you may want to consider is: *Sensors for Mobile Robots—Theory and Application*. This book consists of a collection of information about non-visual sensors. You may not need this book immediately, but it is one that you'll eventually want to have on your reference bookshelf.

Robotics Periodicals. Periodicals are probably the best way to stay up on current events in the field of robotics, to learn about new developments and to read about recent robot projects built by other hobbyists. Three of my favorites are:

Robotics Digest—Published quarterly, the *Robotics Digest* is a new magazine. Whirlwind Publications purchased an old favorite, *The*

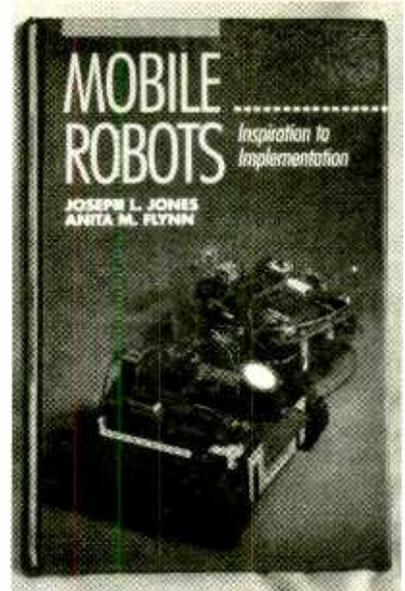


Fig. 3. Known as the robot hobbyist bible, this book—*Mobile Robots: Inspiration to Implementation*, by Joseph L. Jones and Anita M. Flynn—provides a tutorial on building autonomous robots, and covers all basic robotic technology, including sensors, actuators, power supplies, and intelligence systems.

Robotics Practitioner to consolidate it with one of their existing publications.

This publication is of interest to both the amateur and the professional, but it focuses on practical not theoretical applications.

Nuts and Volts Magazine—Published monthly, this magazine has a feature column entitled "Amateur Robotics" written by Karl Lunt. Karl is also a member of the Seattle Robotics Society.

Circuit Cellar Ink—Published monthly, this magazine focuses on microcontroller and computer applications. About every six months, it publishes a robotics edition that features a number of excellent articles about amateur robotics.

Robotics Clubs. Finally, if there is a robotics club where you live, join it. Club meetings and activities provide a wonderful opportunity to meet other hobbyists with whom you can trade information about individual projects. Knowing an expert in one of the technical fields of robotics can be an invaluable resource

(Continued on page 76)



Fig. 2. A more complex robot, such as this one, can maneuver while avoiding obstacles and can locate, identify, and retrieve designated objects by using a combination of infrared, tactile, and vision sensors.

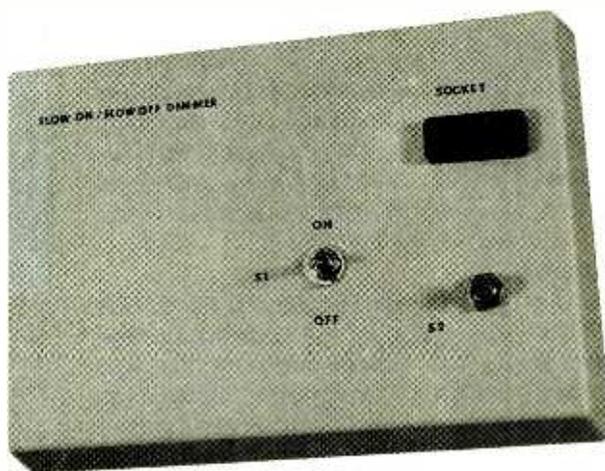
BUILD A SOFT SWITCH

Have you ever noticed that light switches are often mounted in the most inconvenient locations. If your furniture arrangement does not mate well with your light switch location, you can spend a lot of time stubbing your toes once the light goes out. In my bedroom, for instance, when I turn off the light, I usually have to leave the TV on so that I won't be tripping over things as I make my way to my bed. Then, once in bed, I use the TV's remote control to turn it off.

Perhaps you are fortunate enough to have conveniently located light switches throughout your home. But what about when you first awake in the morning? You still must contend with the strain placed on your eyes as they try to adjust to the sudden flash of light when you first turn on your lamp.

One answer to those and other of life's little inconveniences is the Soft Switch described in this article. The Soft Switch takes its sweet time coming to full brilliance, allowing your eyes to gradually adjust to the light's intensity. When turned off, the Soft Switch causes the light to gradually decrease in intensity, thereby allowing you to exit the room before darkness strikes. The gradual on and gradual off times are independently adjustable from two seconds to one hour, allowing the circuit to be custom tailored to your specific needs.

Circuit Operation. A complete schematic diagram of the Soft Switch is shown in Fig. 1. The circuit is built around four integrated circuits: IC1, a TEA1007 phase control; IC2, a 4093 CMOS quad 2-input NAND Schmitt trigger; and ICs 3 and 4,



Tired of stumbling around in the dark as you attempt to exit a room after turning out the light? Here is a device that can eliminate the problem.

RONALD A. REIS

which are 4516 CMOS binary up/down counters. Other active components used in the circuit are a Triac, Zener diode, two switching transistors, and various diodes.

The circuit is operated from a 117-volt AC source. Zener diode D6, switching transistor Q1, and associated components are used to rectify the incoming AC waveform and regulate the resulting DC output voltage to 5.6 volts. The circuit can be configured for four different operating modes —*Slow On/Slow Off, Instant On/Slow Off, Timer/Dimmer, and Slow On/Slumber Switch*—all of which have a maximum load capacity of 200 watts. Any of the four modes can be selected by

switching a few components and moving a couple of jumpers. We'll describe how to configure the circuit for the various modes later.

In describing the circuit's operation, we'll concentrate on two basic modes: the slow on/slow off modes and the timer/dimmer mode. In both modes, IC2 is used to create two clock circuits, the off-time clock and the on-time clock. The off-time clock is built around IC2-c with potentiometer R33 and capacitor C7 determining the clock's output frequency. With R33's resistance set close to zero and C7 at 1 μ F, the output frequency is at maximum. With R33 set to 500k and C7 at 100 μ F, the circuit's output frequency is at minimum. The operation of the on-time clock (which is built around IC2-d) is similar, with R34 and C8 determining its output frequency.

In the Slow On/Slow Off Mode, jumper JU1 is installed. With this configuration, closing S1 causes the input to NAND gate IC2-a (which is configured as a NOT gate) to go high, forcing its output low. That low is delivered to the input of IC2-c at pin 9. With one input to a NAND gate low, its output is always high. Hence, the off-time clock is disabled. That is not the case with the on-time clock. With pin 12 of IC2-d high, the on-time clock is "free" to generate pulses. Those pulses are passed by NAND gate IC2-b to the clock input of IC3 and IC4 (a pair of cascaded CMOS 4516 binary up/down counters). The clock inputs to the two ICs are tied together.

With S1 closed, pin 10 (up/down count select) of both IC3 and IC4 are pulled high, placing them in the count up mode. Hence, clock pulses from the on-time clock causes are

get, the Triac turns the load lamp on to full brightness.

At the same time, the input to NAND gate IC2-a goes high. Pulses from the on-time clock are fed to the clock inputs of the binary up/down counters, while clock pulses from the off-time clock are blocked. Furthermore, since S1 is open, the pin10 (U/D select) inputs to both counters are low. The coun-

ters begin counting down.

During the first half of the 256-bit down count, the most significant bit (MSB) of IC4 remains high. Therefore, the maximum voltage is applied to IC1, and the light remains at full brilliance. During the second half of the 256-bit down count, that same MSB goes low, causing two things to happen. First, the input to NAND gate IC2-a goes low, thereby allowing the off-time clock's signal to pass, while disabling the on-time clock. Second, as the binary count decreases, the voltage applied to pin 6 of IC1 also decreases, causing the lamp to gradually dim. As you can see, the on-time clock determines how long the lamp remains at full brightness, while the off-time clock determines how long it takes the lamp to go out.

seconds to one hour.

Mode 2: Instant On/Slow Off. In mode 2, pressing a normally open pushbutton switch causes the lamp to immediately light to full brightness. Releasing the switch causes the lamp to slowly dim until it is fully off. The slow off time is adjustable from two seconds to one hour, as illustrated in Fig. 2B.

Mode 3: Timer/Dimmer. In mode 3, when the pushbutton switch is pressed, the lamp lights to full brightness immediately. When the switch is released, the lamp stays at full brightness for a period that's adjustable from 1 second to 30 minutes. The lamp then dims to fully off over a time period that is adjustable from 1 second to 30 minutes. The two time periods are independent of each other. (See Fig. 2C.)

Mode 4: Slow On/Slumber Switch. In this mode, closing the toggle switch causes the lamp to slowly light to full brightness (adjustable from 1 second to 30 minutes). After the lamp reaches full brightness, it remains that way until the toggle switch is opened. When the switch is opened, the lamp then remains at full brilliance for a preset period ranging from 1 second to 30 minutes. Once that period has lapsed, the lamp begins

Operating Modes. *Mode 1: Slow On/Slow Off.* In the slow-on/slow-off mode, closing a toggle switch causes the lamp's light intensity to slowly increase until it reaches full brilliance, as illustrated in Fig. 2A. The light then remains at full brilliance for an indefinite period. Opening the switch has the reverse effect, causing the lamp to slowly dim until it is fully off. The slow on (brightening) and slow off (dimming) times are independently adjustable from two

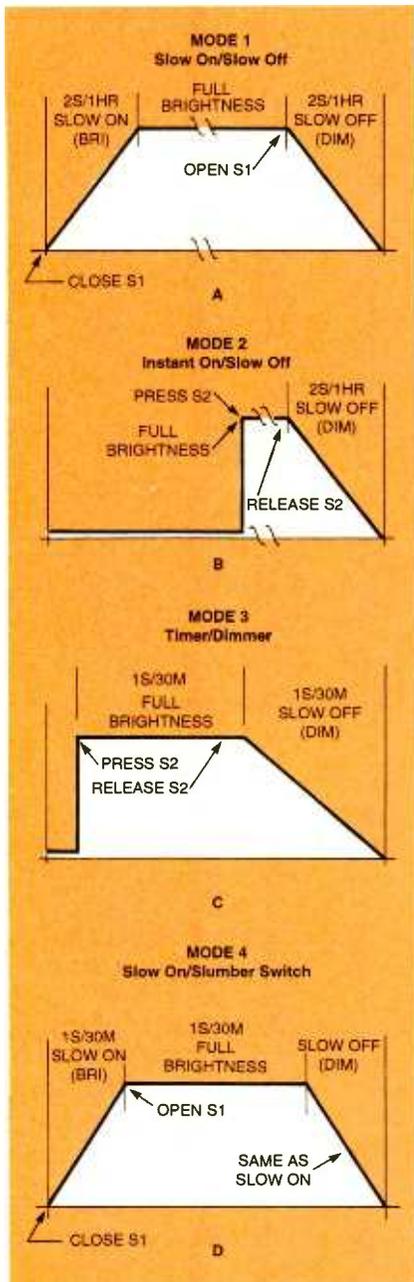


Fig. 2. The brightening and dimming sequences of the Soft Switch in its four modes are illustrated here. A little component swapping (see text for details) allows the circuit to operate in any of these modes.

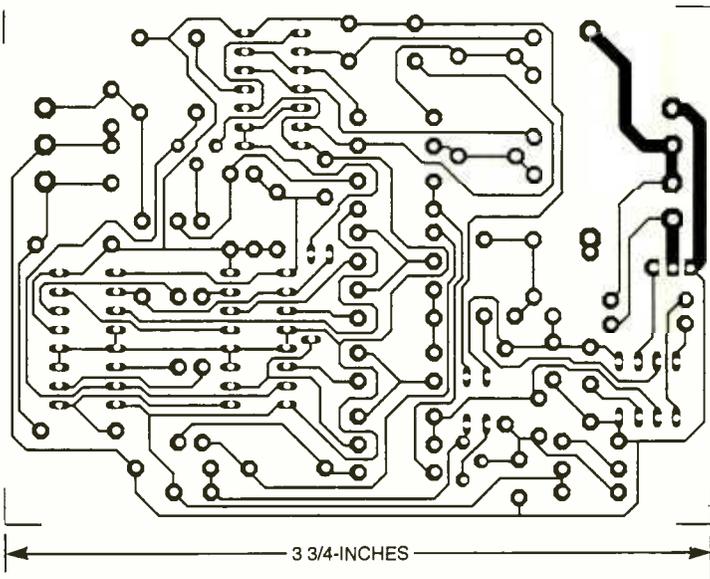


Fig. 3. If you choose to go the do-it-yourself route, this full-size, printed-circuit template, which measures 3-3/4 by 2-3/4 inches, can be copied and used to etch your own board.

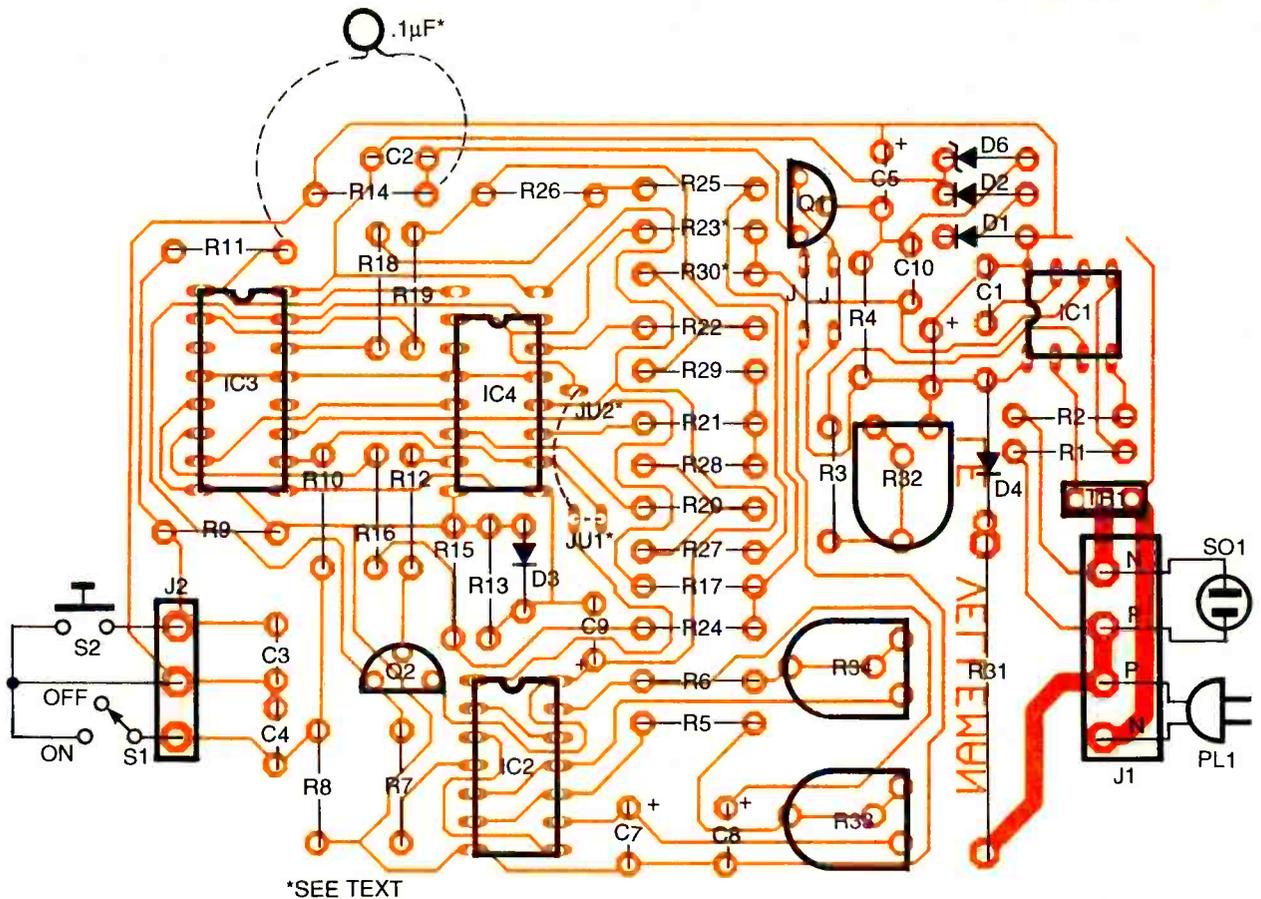


Fig. 4. Assemble the Soft Switch's printed-circuit board according to this parts-placement diagram. Note the components marked with an asterisk. Those components are either included in or left out of the circuit depending on the mode of operation that you are configuring your circuit for.

to gradually dim to fully off at a rate equal to that of its brightening rate. In other words, the brightening and dimming times are *not* independently adjustable. (See Fig. 2D.)

Construction. The author built the Soft Switch from a kit of parts, containing a pre-etched and drilled printed-circuit board. The kit is available from the source mentioned in the Parts List. But if you are a dyed-in-the-wool do-it-yourselfer, a full size template of the unit's printed-circuit board is shown in Fig. 3. Note: If you choose the do-it-yourself route, you might encounter some difficulty in finding the TEA1007 phase converter (IC1). That component is available from JAMECO for \$4.95.

Before you begin assembling the circuit, it will be necessary to select the desired operating mode. If you choose modes 1 or 2, install jumper

JU1 and resistors R23 and R30 flush to the PC board. If you choose modes 3 or 4, install jumper JU2, and omit JU1. Instead of R30, install a jumper wire JU3. And instead of R23, install D5 (either a 1N914 or 1N4148 small signal diode), paying particular attention to diode orientation.

Now, regardless of which mode you have chosen, assemble the rest of the circuit guided by the parts-placement diagram in Fig. 4. Install two jumpers, just below Q1 and to the left of R4, as shown. Then install diodes D1-D4 and D6, paying attention to their orientation. Next install all of the 1/4-watt resistors flush to the PC board. Tack solder a 0.1-μF capacitor between the right end of R11 and the right end of R14. Keep the capacitor leads as short as possible.

Install the three trimmer potentiometers, R32-R34. Install the four IC

sockets, making sure that they face in the correct direction. Install the non-polarized ceramic capacitors, C1-C4. Install the two transistors, T1 and T2. Install the six polarized electrolytic capacitors, C5-C10. Pay close attention to polarity. For C7 and C8, use 1-μF capacitors. Install power resistor R31. Do not mount this resistor flush to the board. Place it about a quarter of an inch above the board to allow for cooling. Install screw connector J1. Install Triac TR1, with the metal tab facing the screw connector J1. Using about 6 inches of #28-gauge or larger wire, connect switches S1 and S2 to J2.

Connect a two-conductor line cord with plug (PL1) to J1. Then connect a length of two-conductor line cord between the board and AC receptacle (SO1) as shown in the parts-placement diagram. Finally, place ICs 1-4 into their sockets. Be sure they are properly seat-

PARTS LIST FOR THE SOFT SWITCH

SEMICONDUCTORS

IC1—TEA1007 phase control, integrated circuit
 IC2—4093 quad 2-input NAND Schmitt trigger, integrated circuit
 IC3, IC4—4516 CMOS binary up/down counter, integrated circuit
 TR1—TIC226 Triac or equivalent
 Q1, Q2—BC557 PNP (ECG 159) or equivalent
 D1-D3, D5—1N914 or 1N4148 signal diode
 D4—1N4001, 1-amp, 50-PIV rectifier diode
 D6—5.6-volt Zener diode

RESISTORS

(All resistors are 1/4-watt, 5% fixed units unless otherwise noted.)
 R1, R10, R11—100,000-ohm
 R2—220,000-ohm
 R3—470,000-ohm

R4—4,700-ohm
 R5, R6—22,000-ohm
 R7—68,000-ohm
 R8, R9, R12-R14—10,000-ohm
 R15-R23—100,000-ohm, 1% or 2%, metal film
 R24-R30—51,000-ohm, 1% or 2%, metal film
 R31—8,200-ohm, 5-watt
 R32—1,000,000-ohm trimmer potentiometer
 R33, R34—500,000-ohm trimmer potentiometer

CAPACITORS

C1—4.7-pF ceramic disc
 C2-C4—0.1-pF ceramic disc
 C5—10- μ F, 35-WVDC electrolytic
 C6—100- μ F, 35-WVDC electrolytic
 C7-C9—1- μ F, 35-WVDC electrolytic
 C10—4.7- μ F, 35-WVDC electrolytic

ADDITIONAL PARTS AND MATERIALS

J1—4-pin screw connector
 J2—3-pin screw connector
 PL1—2-conductor AC line cord with plug
 SO1—2-conductor AC receptacle
 Printed-circuit materials, enclosure, IC sockets (8-pin, 14-pin, 16-pin), bus wire, solder, hardware, etc.

Note: The following is available from JAMECO (1355 Shoreway Road, Belmont, CA 94002-4100; Tel. 415-592-8097; Fax: 415-592-2503): kit of parts, including printed circuit board (less line cord and appliance receptacle) as part number 127589 for \$29.95, plus \$5.00 shipping and handling. California residents please add 8% sales tax. IC1, the TEA1007, is also available from JAMECO as a separate item for \$4.95.

ed and correctly oriented.

If you opted to go the kit route, don't be alarmed by the left over components. Those components fall into two categories: those used for a mode or time delay that you did not select, or those needed to operate the circuit from a 220—240-volt AC line. The former we'll discuss in a moment; the latter is of little interest here in the United States. Nonetheless, if for some reason you wish to configure your circuit for 220—240 volt operation, instructions supplied with the kit explain what components to install.

You might be asking: "If I choose a particular operational mode, am I stuck with it?" Not at all. When you desire a mode change, just switch components as described earlier.

Test and Adjustment. Regardless of which mode of operation you've decided to configure your project for, before applying power, turn all of the trimmer potentiometers to their center position. Next, plug a lamp (no greater than 200 watts) into SO1. Plug the project's line cord into a wall outlet. The lamp will come on and then dim slightly. Wait a couple of minutes to be sure that the lamp doesn't fade further. Now, slowly adjust R32 until the lamp just goes out.

The circuit is now ready for test-

ing and adjusting. How you proceed from here depends on which mode you've chosen. However, it's advisable to read over the instructions for all modes. In that way, you'll be prepared if you decide to switch modes later, plus you'll have a better understanding of the cir-

cuit's operation.

Mode 1: Slow On/Slow Off. Close S1. The lamp will begin to brighten, reaching full brightness in about 20 seconds (adjustable by R34). Leave S1 closed for a minute or so, thus keeping the light at full brilliance.

(Continued on page 76)

MODES 1 AND 2			
C7	Off-Time	C8	On-Time
1 μ F	2SEC. 30SEC.	1 μ F	2SEC. 30SEC.
10 μ F	30SEC. 5MIN.	10 μ F	30SEC. 5MIN.
100 μ F	5MIN. 1HR.	100 μ F	5MIN. 1HR.
MODES 3 AND 4			
C7	Off-Time	C8	On-Time
1 μ F	1SEC. 15SEC.	1 μ F	1SEC. 15SEC.
10 μ F	15SEC. 2.5MIN.	10 μ F	15SEC. 2.5MIN.
100 μ F	2.5MIN. 30MIN.	100 μ F	2.5MIN. 30MIN.

Fig. 5. The on and off times of the Soft Switch can be custom tailored by selecting the appropriate capacitor values for C8 and C7, respectively, to set a specific timing range, and then by adjusting potentiometers R34 and R33, respectively, to achieve the exact time period desired. The table shown here gives different timing ranges for different values of C7 and C8.

KEEP TRACK



OF



DRIVING HABITS

The automotive equivalents of the aircraft flight recorder, here are some aftermarket products that can monitor driving habits, maintain mileage records, and can even reconstruct events leading up to an accident.

BILL SIURU

Today's cars have more "computer power" than the Apollo spacecraft that put astronauts on the moon. Here are some more computers you can add to keep track of how your vehicle is used. These aftermarket computers let you monitor the driving habits of a teenage driver or your employees. Or how about at income tax time having complete mileage and other vehicle expenses on neat printouts rather than having to tediously tabulate them from scribbled entries on crumpled slips of paper? With these automotive equivalents of the aircraft flight recorder, you can even reconstruct the events leading up to a serious accident.

DriveRight. Davis Instrument's DriveRight 10, DriveRight 100, DriveRight 130AL and DriveRight Trip Computer all monitor and record how a vehicle is used, differing in details as to the type of data presented and stored. A sensor that monitors vehicle speed is mounted on the driveshaft on rear wheel drive vehicles and on the CV joint on front

wheel drive vehicles. The display unit itself can be mounted on the dashboard, console, or visor (the highway police do this, too!).

All DriveRight versions display items like current speed in mph or km/hr, time and date, acceleration/deceleration in "g's", and distance traveled in miles or kilometers. You can program in speed and acceleration/deceleration limits, and an optional alarm will sound if the limits are exceeded. To monitor the driving behavior of a teenage driver or employees, the DriveRight records on a daily basis items like maximum speed, time of maximum speed, amount of time the vehicle was driven over a set speed limit and number of times the set acceleration/deceleration limits were exceeded. By selecting another mode, you can obtain data on first and last time the vehicle was moved each day and the total time the vehicle was in motion.

A Trip Computer version aimed at

the individuals and businesses who need to track mileage can store information on 204 individual trips. That includes start, end, and total time; distance traveled; maximum and average speed; stop times between trips and whether the trip was made for business or pleasure purposes. On the Trip Computer (DriveRight 130AL), vehicle speed at each of the last 10 seconds before a sudden deceleration is stored for subsequent accident investigations.

The systems have password protection so the settings cannot be changed by a driver and there is an indicator to show if someone tries to tamper with the settings or disconnects the display. The tamper indicator will remain on until you re-enter the password. Data is also pro-



An example of one display available on Davis Instruments' DriveRight computer

tected against power failure or removal so it is never lost—even if the wires are cut and the batteries removed.

Optional software is available so information on the DriveRight computer can be downloaded into an IBM compatible PC or laptop. Prices run from \$195 for the DriveRight 10; \$245 for the DriveRight 100; and \$295 for the DriveRight 130AL and Trip Computer. The numbers indicate the number of days of logging ability—10, 100 or 130 days—and the 130AL and Trip Computer have the accident log capability.

Auto Ledger. The Auto Ledger™ offered by Transportation Recording Systems, Inc. makes record keeping

categories of expenses can be logged on Auto Ledger. Data entry procedures can be programmed to be menu-driven and TRS can custom program the Auto Ledger to match up with individual user's reporting procedures. This feature can save big tax bucks.

Once you set up the categories, a couple of button pushes will log an expense in the proper place. The buttons and display are a bit small, so don't do this while driving. The Auto Ledger stores data until it is retrieved or the memory becomes full - the capacity is about 60 days. There is a "memory full" warning on the display. Data can be retrieved in daily, weekly, bi-weekly, monthly, or year-to-date reports by plugging

when it is plugged in.

The Auto Ledger can do more than just "real-time" bookkeeping. It can serve as a security system when set-up so that the vehicle cannot be started if the Auto Ledger is not plugged in. Besides preventing theft,

FOR MORE INFORMATION

DriveRight™ Davis Instruments
3465 Diablo Avenue
Hayward, CA 94545
(510) 732-9229
Fax: (510) 732-9188

**Auto Ledger™ Transportation
Recording Systems, Inc.**
110 Orbison Street
Barneveld, WI 53507
(608) 924-3333
Fax: (608) 924-1333



Here is Transportation Recording System, Inc.'s Auto Ledger mounted and ready for easy use by the driver.

much easier and definitely more accurate. The portable, pocket-sized recorder is wired into the vehicle's electrical system so odometer readings are automatically recorded to keep track of mileage as well as stops and starts. Time and date are also recorded automatically. An alphanumeric keypad is used to input data like clients and reason for stop; whether the trip is business, personal, or a commute; and food, toll, parking, lodging, fuel, or repair payments. Indeed, over some 200

directly into a serial printer. Alternatively, you can download the data into an IBM compatible computer. Auto Ledger comes with its own DOS or Windows software, so you can generate a wide variety of complete, detailed tax reports to secure the maximum deductions allowed by law as well as for tracking vehicle and other travel expenses. Data can also be transferred via a modem using a cellular phone. A built-in charger automatically charges the battery to full charge

that feature reminds you to use the Auto Ledger to keep track of all travel. The Auto Ledger can also record up to four vehicle functions such as the use of brake lights, turn signals, seat belts and the speed of the vehicle so it can serve as a "flight recorder" for use in accident reconstruction. Or how about having the output of Auto Ledger to show you were traveling at 55 mph when fighting a speeding citation in court.

The Auto Ledger comes with a video giving operating and installation instructions. Installation of the unit's Vehicle Interface Unit (VIU) does require cutting into and attaching to many wires in the vehicle's electrical system. Unless you know your way around under the dashboard, it is probably prudent that you leave installation to a professional automotive electronics installer. With additional VIU's, a single Auto Ledger can be used in up to five different vehicles. Likewise, DriveRight units can be used in multiple vehicles.

TRS offers several versions with prices starting around \$160 and going up to \$400 for the unit with all the bells and whistles. According to TRS, documenting as few as five more miles per business day would pay for the Auto Ledger in a few months. ■



SEMICONDUCTOR DIODE GUIDEBOOK

Here's a simple guide to understanding diode characteristics and their use in circuit design.

Although diodes have been around for many years, few hobbyists truly understand how the devices operate, nor are they aware of the many applications to which these little "globs of grease" are suited and so they are ill equipped to take full advantage of their various "talents." So what we'll attempt to do in this space is set you on the road to enlightenment. We won't get into the composition of the device, but instead concentrate on biasing characteristics as they relate to circuit design. But, before we begin any discussion of diode circuit design, we must first discuss current flow. That's because semiconductor diodes are much easier to control with a *bias current*, than with a *bias voltage*.

As you already know, the electron current theory states that electrons flow from a negative point to

SKIP CAMPISI

a positive terminal. Although electron current flow is useful to understand the physics of the device, it is rather awkward when reading schematic diagrams. Ben Franklin originally theorized that current flow was from the *positive* terminal to the *negative* terminal. That theory is called *conventional* current flow. You'll notice that the arrows used in all semiconductor symbols point in the direction of conventional current flow, which we will use here, rather than electron current flow. Those facts allow us to describe a current generator circuit by its function: a current *source* would supply current from its positive output terminal to a load, which is, in turn, connected to a negative terminal. A current *sink*

would draw current to its negative terminal through a load, which would be connected to a positive source. A current *pump* could perform either function.

To properly demonstrate the characteristics of semiconductor diodes, we will require a current generator of some type. Once we have a working generator, we will be able to take an in-depth look at small-signal diodes, Zener diodes, light-emitting diodes (LEDs), and even laser diodes! The only tools required are a small solderless breadboard and a DMM.

A SIMPLE CURRENT SOURCE. The basic current source can actually be no more than a resistor connected in series with a load that is, in turn, connected to a voltage source. Such an arrangement works fine for a fixed voltage source

driving a fixed load. However, the diode characteristics that we will be observing are far from fixed. Therefore, an adjustable constant current source is required for our experiments.

To understand how the current source operates, refer to Fig. 1A as we begin our discussion. At this point, we will have to make a few simple assumptions. However, those assumptions will become clear to you after we have actually completed a few experiments using the circuit. The basic circuit shown in Fig. 1A features a single transistor (Q1) configured as an emitter follower amplifier. In that circuit, transistor Q1 (a 2N3906 PNP unit) has an input voltage that is determined by the forward voltage drop across LED1 (a standard red, light-emitting diode). Bias current (more about that later) to the LED is supplied via a 1500-ohm resistor (R1), setting bias current at about 5 milliamps (mA). At that current level, the voltage drop across LED1 is about 1.7 volts; the voltage drop across the LED varies for different units.

The forward voltage drop across the base-emitter junction of Q1 is about 0.7 volts. Since the base voltage of Q1 is fixed at +V minus V_{LED} , or 9-1.7, the voltage appearing at Q1's emitter is fixed at 7.3 volts plus 0.7 volts, or 8.0 volts. Thus, nearly 1 volt appears constantly across R2 (the sense resistor) no matter what load is connected to Q1's collector.

Neglecting Q1's finite gain and other effects, we can state that the current through the load at Q1's collector is constant and equal in magnitude to the current through R2, which is simply 1 volt divided by the value of R2. Thus, by simply changing R2's value, we can vary the magnitude of constant current that is being supplied to the load. As Q1's collector voltage can approach its emitter voltage when fully turned on; the current source's compliance, or maximum usable voltage, is about 8 volts, which can vary down to 0 volts for different loads.

CURRENT SOURCE CONSTRUCTION.

52 Assemble the circuit shown in Fig.

DIODE TYPE	VF @ 5 mA
1N4148 (silicon)	0.70 V
1N34A (germanium)	0.38 V
Infrared LED (T-1)	1.20 V
Red LED (T-1)	1.70 V
Yellow LED (T-1)	1.85 V
Green LED (T-1)	2.00 V
Blue LED (T-1)	2.70 V

1A on a solderless breadboard. Be sure to leave terminal points to accommodate various resistor values for R2, and also for various diode loads. A standard 9-volt battery is sufficient to power all of our experiments that we'll be performing. Figure 1B shows the standard current source symbol. That symbol, which can replace the entire diagram shown in Fig. 1A, will be used for the remainder of our discussion. Prepare a set of 5% resistors to be used for R2 in the following values: 100k, 10k, 1k, and 100 ohms. They'll yield currents on the order of 10 μ A, 100 μ A, 1 mA, and 10 mA, respectively. Bend their leads in a similar fashion for easy insertion into the correct points on the breadboard.

Set your DMM to the current mode and connect it from the collector of Q1 to ground. Starting with R2 at 100k, apply power to the circuit and note the current; it should be about 10 μ A. Similarly, change R2 to 10k, 1k, and 100 ohms and check the resulting current levels. Short the collector to ground, and set your DMM for voltage measurement. Check the voltages at Q1's base (which should be about 7.3V) and emitter (about 8V); the voltage across R2 should end up at about 1 volt. If everything checks out (within about 10% or so), you're ready to go!

SMALL-SIGNAL DIODES. The first experiment paves the way for all of the rest of the information you'll glean as you proceed. It demonstrates the dependence of the forward conduction characteristics of the diodes on current, voltage, and temperature. Install a 100k resistor for R2 (see Fig. 1A), and referring to Fig. 2A, install a 1N4148 silicon diode

as the load, D_X . Connect your DVM across the load diode and note the voltage; the voltage should be about 0.37 volts with a bias current of 10 μ A. Change R2 to 10k (100 μ A), 1k (1 mA), 100 ohms (10 mA) and note the resulting forward voltage drops across the 1N4148 diode.

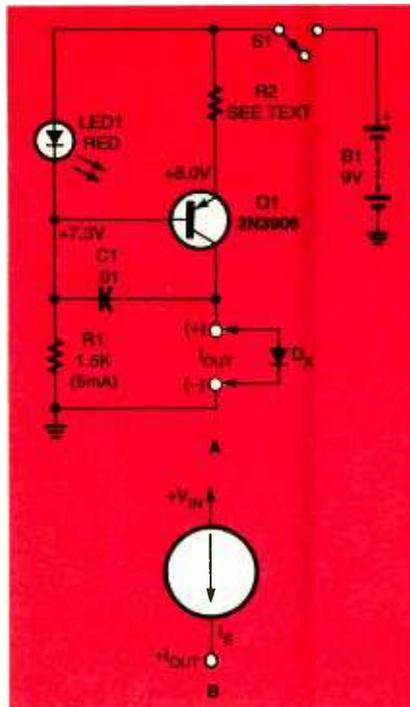


Fig. 1. When assembling the constant-current circuit shown in A on your solderless breadboard, be sure to leave terminal points so that various resistor values can be substituted for R2; do the same for load connections at D_X for various diode loads. The circuit is powered from a standard 9-volt battery, which supplies sufficient energy to power all of our experiments. Shown in B is the standard current source symbol, which can replace the entire diagram in A, and will be used for the remainder of our discussion.

You'll quickly notice the logarithmic characteristic of the diode: i.e., for every decade increase in bias current, the forward voltage increases by about 120 millivolts (mV), up to about 0.72 volts at 10 mA. Let's assume for a moment that a fixed voltage of 1 volt is applied across the diode instead of a bias current. What would happen? The forward current would try to rise to a dynamic level to match the 1-volt forward voltage and promptly damage or destroy the diode! That's why some

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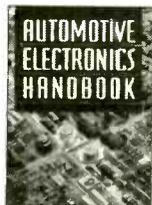
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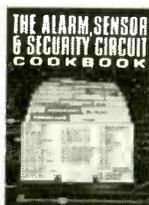
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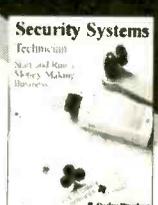
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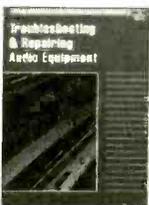
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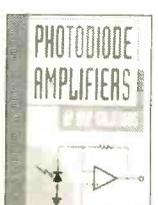
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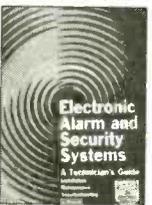
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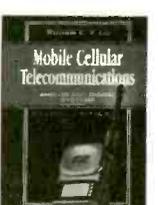
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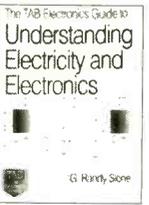
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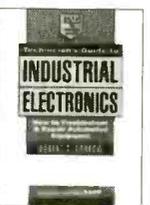
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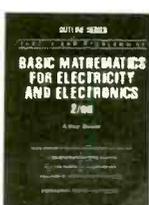
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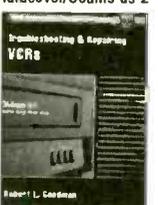
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type of resistive or active current limiting is necessary to keep the bias current within a safe operating region. That exponential relationship holds true for as much as seven decades on diodes, as well as bipolar transistors. Discrete diodes, such as the 1N4148, exhibit that 120 mV/decade increase ($n = 2$); however, diodes in integrated circuits exhibit a 60 mV/per decade increase ($n = 1$).

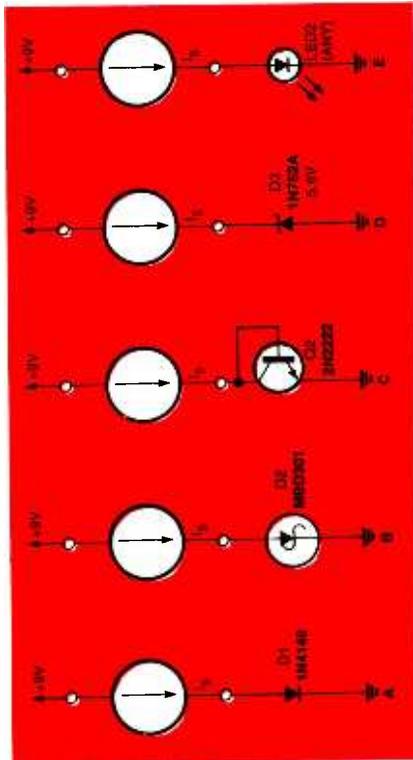


Fig. 2. Connect each experimental load to the constant-current circuit using the diagram as a guide. Be careful when connecting the transistor (diagram C) and the Zener diode (diagram D). When connecting a transistor as a load, wire the collector to the base, and then connect the collect-base node to the current source. As for the Zener diode, note that Zener diodes are designed to be connected in the circuit in reverse bias; i.e., anode to ground and cathode to the positive source. All other diodes are connected in the normal fashion, with their cathodes to ground and their anodes to the positive source.

Now change R2 to 10k (100 μ A) and set your DVM for highest resolution at the forward voltage of the diode. Grasp the body of the 1N4148 diode gently between your thumb and forefinger and watch the voltage decrease as your body

heats up the diode. Release the diode and the voltage will rise to normal. That test demonstrates the *temperature coefficient* of the silicon diode, which is about -2 mV per degree Celsius ($^{\circ}\text{C}$). That means that for every degree Celsius rise in junction temperature of a silicon diode, the forward voltage drop (at the same current) is reduced by 2 mV. That's a rather general statement for silicon, and most other diode materials—which all fall within about the same range and behave in a similar manner. That leads to some rather interesting temperature compensation schemes, which we'll address later.

In practice, that temperature coefficient of -2 mV/ $^{\circ}\text{C}$ is *not* a fixed value; rather, it varies with the bias current density through the device. As it turns out, the temperature coefficient increases in a positive direction (in a non-linear fashion) as the bias current increases. Certain higher current capacity diodes can approach and actually exceed 0.0 mV/ $^{\circ}\text{C}$ temperature coefficient into a positive valued temperature coefficient. Zener diodes in the 5- to 6-volt range exhibit positive or negative temperature coefficients in their reverse bias modes, depending on their reverse currents. We will explore this shortly.

SCHOTTKY DIODES: Set up and repeat the small-signal diode experiment, replacing the 1N4148 diode with a Schottky diode such as the MBD301 shown in Fig. 2B. At 10 μ A, you'll note that the forward drop is about 0.24 volt, and only increases at about 60 mV ($n = 1$) per decade of bias current. That results in very low forward voltage drops at moderate current levels, which can be quite useful in circuits where voltage losses have to be kept to a minimum. The 1N58xx series of Schottky rectifier diodes are used in power-supply circuits for high efficiency. MBD301 Schottky (or hot-carrier) diodes, which are used for detectors and switches, feature low capacitance, high speed, and a low voltage drop.

DIODE-CONNECTED TRANSISTORS.

Again repeat the small-signal diode experiment, this time substituting a 2N2222 transistor, configured as shown in Fig. 2C, for the diode. Shorting the base lead to the collector lead as shown causes the transistor to act like a diode; that configuration is what's called a diode-connected transistor. The transistor still operates in its active mode, and, again, the forward voltage drop only increases at 60 mV ($n = 1$) per decade of bias current.

That fact makes this "diode" an excellent low-ripple rectifier. It exhibits only 50% of the voltage variation due to current changes as a standard rectifier, and, in addition, can select just about any silicon transistor to suit your power needs!

ZENER DIODES. Standard (uncompensated) Zener diodes are available in various voltage ratings from about 3 volts to over 100 volts. Generally speaking, *Zener breakdown* occurs on devices rated at 5 volts or less. At voltages above 7 volts, *avalanche breakdown* is the operational mechanism. At 5 to 7 volts, either breakdown method may occur. Zener diodes that operate in the avalanche breakdown mode exhibit very sharp *knees* on their reverse conduction curves, thus they have an advantage where the reverse bias current varies. The lower voltage Zener breakdown units exhibit weak knees. In fact, below about 4 volts, they function poorly as voltage regulators. As breakdown voltages exceed 7 volts, Zener impedance also increases, thus, the "knees" tend to get weaker in this direction just as in the lower direction.

As mentioned before, Zener diodes can exhibit temperature coefficients in either the positive or negative regions, depending mainly on the device breakdown voltage, and the bias current used. Generally speaking, voltages below about 5 volts exhibit a negative temperature coefficient, and those above about 6 volts exhibit a positive temperature coefficient. That allows us to investigate an

unusual circuit in which you can “dial-in” the desired temperature coefficient: either positive, negative, or zero temperature coefficient! Set up the circuit shown in Fig. 2D, using a 1N752A (5.6V) Zener diode as the load, instead of the transistor used in the previous experiment. Note that the cathode is connected to the source, with the anode grounded, to establish the reverse breakdown voltage. This is one instance where the arrow points in the direction of electron current flow!

If you have access to a 4-1/2-digit DVM, you can really zero in on the zero temperature coefficient. Starting with R2 at 100k (10 μ A), grasp the diode lightly with your fingers, and observe the voltage change. It should decrease at this current level. Change R2 to 10k (100 μ A) and repeat the process; then change R2 to 1k (1 mA) and 100 ohms (10 mA). At some current level, you will see the voltage increase as you get into the positive temperature coefficient region of the diode. A 5.1-volt Zener will also work well, but requires slightly higher bias currents for similar results.

A series of 1N752A diodes tested by the author exhibited breakdown voltages of about 5.4 volts at current levels of between 100 μ A and 1 mA. The temperature coefficient went from the negative region to the positive region at those bias current levels. By substituting a 10k trimmer potentiometer in series with a 100-ohm fixed resistor for R2, it was possible to trim the bias current for almost exactly zero temperature coefficient by trial and error. That makes designing a fully temperature-compensated voltage reference a fairly simple job. Once the proper current is found, a fixed resistor in series with the diode and a constant voltage source will provide a very stable voltage source!

LIGHT-EMITTING DIODES: Sadly enough, untold numbers of LEDs have been abused or destroyed by hobbyists who merely thought of them as “light bulbs” rather than

semiconductors. LEDs do not have filaments—they are only diodes, after all. Applying a constant voltage without current limiting achieves the same results as with the small-signal diode: destruction!

Many LEDs also have a low reverse breakdown voltage, which also can damage the device when exceeded. When you’re not sure of the correct polarity, always begin your testing at low currents to avoid damage. The reverse breakdown voltage is always higher than the forward voltage, so you can quickly determine if you have correctly connected the LED with a DVM. The highest current available from our current source is 10 mA, which is well within standard forward-current ratings of most LEDs.

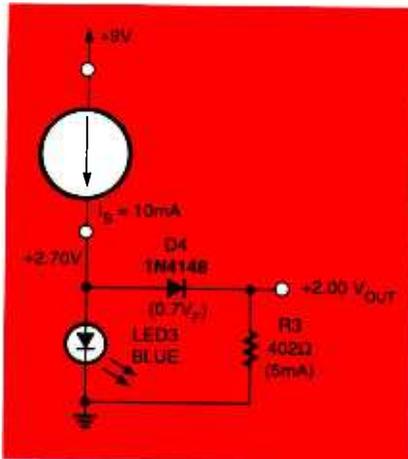


Fig. 3. Wire the voltage-reference circuit shown here into the constant-current circuit shown in Fig. 1. Using a carbide blue silicon LED and 1N4148 silicon diode the circuit exhibits less than 0.1 mV/°C of drift—only 5% of a single diode’s temperature coefficient!

Try several different color LEDs in the circuit shown in Fig. 2E, starting with R2 at 100k (10 μ A), then working up to 10 mA and noting the typical forward voltages. You may start seeing light emitted at currents as low as 100 μ A, depending on the device selected. You will also notice the much higher forward voltages (greater than 1 volt) as compared to small-signal diodes. The higher voltages are due to the construction and materials used in fabricating LEDs. They also increase in an exponential manner with each

decade of bias current, just as with the small-signal diode devices. You will also notice that each color device has a different voltage level: starting at about 1 volt are the infrared LEDs, then the red LEDs, yellow LEDs, green LEDs, and finally the blue LEDs at about 3 volts.

Some typical values of forward voltages at 5 mA are given in Table 1. Those differences are due to the actual material used in fabricating the device, and how the material was “doped” to achieve the proper color wavelength. Take note of the fact that to achieve higher energy (shorter wavelength) colors, the forward voltage has also increased for a given bias current.

Laser diodes (at these low currents) behave in a manner similar to LEDs as far as forward voltage, reverse voltage breakdown, and bias currents are concerned. Although they won’t “lase” at those currents, they are ESD sensitive. The PIN photo diode (when housed in the laser package) has a forward voltage similar to a small-signal diode. Thus, its terminals can be found easily by comparing it with the higher laser forward voltage.

REVERSE BIAS CHARACTERISTICS.

Now that we have a clear understanding of how the forward characteristics of semiconductor diodes operate, we should very briefly discuss reverse leakage characteristics. Aside from devices designed to operate in the reverse bias mode, such as Zener and PIN diodes, all diodes leak current to some extent when reverse biased. The reverse leakage current is very small in magnitude compared to the forward current, and can usually be ignored.

For very demanding applications, it should be mentioned that small-signal silicon diodes leakage currents are in the low nanoamp (nA) range; germanium diodes (such as 1N34A) have reverse leakage currents in the low microamp range; and Schottky diodes have reverse leakage currents that lie somewhere in between. Reverse

(Continued on page 74) 57

HAM Radio

Ham Radio Software...or Scamware?

JOSEPH CARR

Ham radio, like almost everything else, is seeing a proliferation of computer software that claims to make things "easier" for us. At one time, digital computers were totally incompatible with ham radio sets because of the extensive noise problem caused by the computer clock. While that is still a problem with many computers, it is not so grim as it was. We see both on-the-air and off-the-air hobby enhancing software.

In the main, I am a computer freak, and own several different types of equipment. So please don't get me

JUNK SOFTWARE

Much of the software sold to hams is pure junk. There are many really good products, but some of what is out there is poorly done, poorly thought out, and poorly programmed. Three major problems stick out like sore thumbs: DOS software in the age of Windows 95, poor user interface, and non-robust program design.

DOS software came around in the early 1980s, and included several different versions of BASIC over the years. By the 1990s, however, DOS *per se* was fading and Windows 3.x had

need to work in the lower 640K of memory. Unfortunately, many Windows programs place stuff in the lower 640K, causing it to fill up. When you attempt to run a large DOS program (as antenna modeling programs tend to be), there is insufficient residual memory in the lower 640K to run it. I know it sounds ridiculous that a 16-megabyte Windows computer gives you an "Out of Memory" error when running a 350K DOS program, but it happens. And the more programs you have on the machine, the more likely it is to fail.

There are *workarounds*. For example, later versions of MS-DOS allow for multiple configurations. Or you can create your own multiple configurations by creating alternative config.sys files, and copying them back and forth from the DOS prompt command line. Wonderful! I want to operate my computer as is, without having to mess with the config.sys files (which can be dangerous if you forget where you are in the process!). That's one reason why you haven't seen more software reviews in this column...the vast majority are too darn much trouble to use in the modern Windows environment.



MFJ Deluxe Versa Tuner II is designed for rigs rated at 300 watts and under.

wrong...I am NOT against computers in ham radio (although I do know some people who are!).

Goodness knows I've written enough software for radio and electronic enthusiasts over the past few years. For years I wrote in BASICA, GW-BASIC, Q-BASIC and QUICK BASIC 4.5 (which allowed me to create executable *.EXE files). Then Harry Helms turned me on to Visual BASIC 3.0. Now I use Visual BASIC 4.00, as well as teaching a first-semester course in VB4 programming at Northern Virginia Community College.

I also want to put my own *Mea Culpa* on record: I've committed nearly all of the sins that I lay at the door of others, but have "repented" and am now producing a much better product. That said, it's time to get a few things off my chest.

become the standard. The versions of BASIC packaged for DOS were quite powerful in the latter years, but they are eclipsed by the more modern programming languages (Visual BASIC, Visual C, etc.).

A number of software products can be found on the market using DOS-based languages. Most of them are antenna modeling programs based on the mini-NEC algorithm developed by the U.S. Navy. They work really well, and are powerful tools for antenna designers. For the most part, they are quite reasonably priced.

"So what?" you say. Why does it matter if a ham radio program is written in a DOS-based language rather than a Windows based language? Even though your Windows 3.x machine is more modern than older DOS machines, it is still constrained by the

POOR USER INTERFACE

The user interface of a computer is the means by which you and the machine communicate. While the keyboard and mouse are technically part of the user interface, the graphical user interface (GUI), i.e. the screen design, is what I have in mind. There are two main problems with many ham/SWL software GUIs. First, they do not conform to the Microsoft look and feel. Second, the human factors stink.

The reason a program should conform to the Microsoft GUI standards is that the user will already be roughly familiar with the program's operation, because it looks like other Windows' programs. My wife uses a lot of musical composition software, and once remarked how smart I was because I

(Continued on page 77)



CIRCLE 119 ON FREE INFORMATION CARD

PROVIEW TV BOX

Watch TV on any VGA monitor with the Proview TV Box.

There are no doubt plenty of computer users out there today, all busy working on something in front of a monitor. Hours can pass by unnoticed, with the time and energy some people expend at a computer. Unfortunately, if you concentrate on one thing for too long, you can begin to lose focus on the project.

It's a good idea if you can take a mental breather from time to time as you work. Sure you can always play a quick computer game. But wouldn't it be nice if you could grab a remote and instantly have cable TV on your PC monitor? Of course it would, and Proview Technology's new *TV Box* lets you do just that. (Proview Technology, Inc., 12272 Monarch Street, Garden Grove, CA 92841, 800-PRO-VIEW (776-8439), 714-379-4455, Fax 714-379-3308).

The Proview TV box is a 181-channel cable-ready tuner that connects to any VGA monitor. It lets you switch between TV and your PC on the same monitor. You cannot watch TV in a window with this device. However, all you need is cable TV or an antenna, and the VGA monitor—you don't even need a computer! So the TV Box is also the perfect complement for that old 14-inch monitor that's sitting in the closet along with your 386 PC. That old monitor instantly becomes a low-emission, high-resolution, remote-controlled color TV.

The TV Box contains its own speaker, so your monitor doesn't need one.

The volume of the built-in speaker and all other functions are controlled by a 23-key infrared remote included with the TV Box. If the unit is left turned on while you're using your computer, you can still hear the audio of the selected channel. Perhaps the best thing about the TV Box, though, is its price: only \$119. That's less than practically any remote-controlled color TV set. The unit is also available with optional closed-caption and teletext decoders.

Features. The Proview TV Box is small in size, measuring only 1- × 5.2- × 6.5-inches. It looks almost like an external modem. The front panel has no channel display, as that's done on-screen, but there are controls for channel, volume, mode, and power. There's also a power indicator LED on the front panel. A grille for the small internal speaker is located on top of the Proview TV box.

The back panel houses a DC input jack for the included power adapter, a VGA input, a VGA output, and an antenna input. The side panel houses a mono earphone jack that disables the built-in speaker, stereo audio input and output for full integration with a sound card if you so desire, and composite video input and output.

The TV Box is basically a TV tuner with a VGA output. The tuner accepts an NTSC or PAL input, and converts the signal to VGA. The VGA input is passed right through to the output in the PC mode. There's also a compos-

ite video input and output. The composite video input lets you view the signal from a VCR, camcorder, or video camera on your computer monitor. You could, for example, set up a video surveillance camera somewhere on your property and connect it to the TV Box. Then you can periodically check the camera input while you work at your computer.

The composite output lets you use the TV Box as a tuner for any video monitor, and not just VGA monitors, making the device as versatile as possible. Because of its small size, aesthetically conscious individuals might even want to use the TV Box as a tuner for a regular TV set that's not cable ready, but has a composite video input.

Unfortunately the TV Box doesn't process VGA at all. It simply converts video signals into VGA or lets VGA from your PC pass through—so it can't be used to display PC video on a regular TV. Oh well, no playing Doom on a 60-inch screen. But at least you can have your MTV on your PC.

Hooking It Up. Anybody who can hook up a VCR will have no trouble installing the TV Box, as there's really nothing to install. You simply connect a VGA monitor to the VGA output on the TV Box and turn both on. Provided you have a cable or antenna connected, you'll instantly see TV on the monitor. If you're using the TV Box as a tuner for an old, unused monitor, then you're

(Continued on page 75)

ANTIQUE Radio

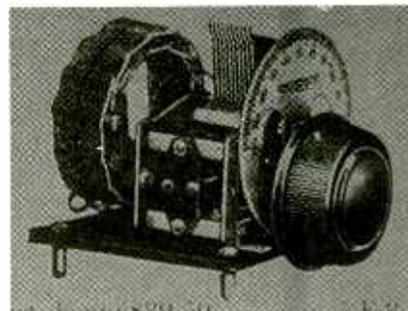
The Rise and Fall of the TRF

MARC ELLIS

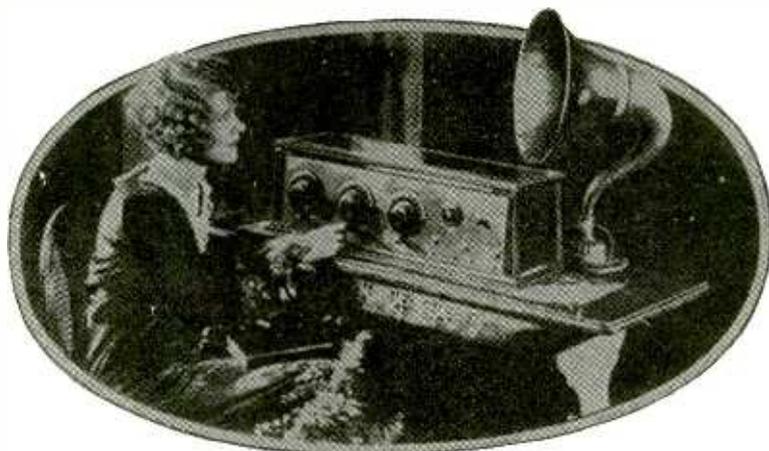
If you go to any radio meet with the idea of picking up a 1920s-era battery set, chances are most of those you'll find offered for sale will be five-tube table models in the familiar "coffin" box. The box might be severely plain or artistically embellished, but it will almost invariably have a full-length hinged lid giving access to tubes and circuitry. On the front panel will be phone jacks, perhaps some binding posts, filament adjustment rheostats, and the ever-present group of three wide-flanged control knobs, each engraved with a "0-100-inch" scale.

back into the input—being re-amplified over and over again. It has been estimated that the performance of a single tube operating as a regenerative detector is about equivalent to that of the first three tubes in a TRF set (two stages of RF amplification and a detector/audio amplifier).

Yet we know that the TRF sets were much more apt to be found in the living rooms and front parlors of 1920s' households than regenerative sets. Part of the reason for this was that Westinghouse, which purchased the regenerative patent in the mid-1920s,



One of the three tuned circuits in a Freshman Masterpiece five-tuber. The coil was deliberately mounted on a variable capacitor frame to create losses (see text).



A 1920s-era housewife enjoys listening to her Pfanstiehl Model 7 five-tube TRF. Beneath the table is a tangle of wires and batteries.

Those sets are known as "TRF," or tuned radio frequency, models. The other common receiver design of the 1920s—the regenerative circuit—is harder to find. Yet, logically, regeneratives like the little one-tube Crosley 50s, two-tube Crosley 51s, and two-tube RCA Radiola IIIs should be around in at least equal numbers. They originally cost much less than the five-tube TRFs, used a lot less expensive battery power, and could compete with them very well in performance.

REASONS FOR THE TRF DOMINANCE

In the super-efficient regenerative circuit, brain child of the legendary radio inventor Edwin Armstrong, some of the detector output was cleverly fed

limited the number of manufacturing licenses it would grant and demanded high royalties. Manufacturers who had not already been licensed under Armstrong's more easygoing policies were either out in the cold or had to pay dearly to get in.

Perhaps another reason that the regenerative sets did not become more common was that they were not exactly user-friendly. The amount of detector output fed back into the input was quite critical. With too much feedback, the set would "regenerate," or oscillate, deafening the earphone-wearing listener with howls and squeals. The listener's neighbors would be inconvenienced, too, because a set in regeneration is like a little radio transmitter, sending out interfering signals via the antenna.

Yet if there were too little regeneration, the set would lack sensitivity. In fact, the adjustment had to be kept just below the point of regeneration if the listener were to obtain the enhanced sensitivity for which the circuit was so well known.

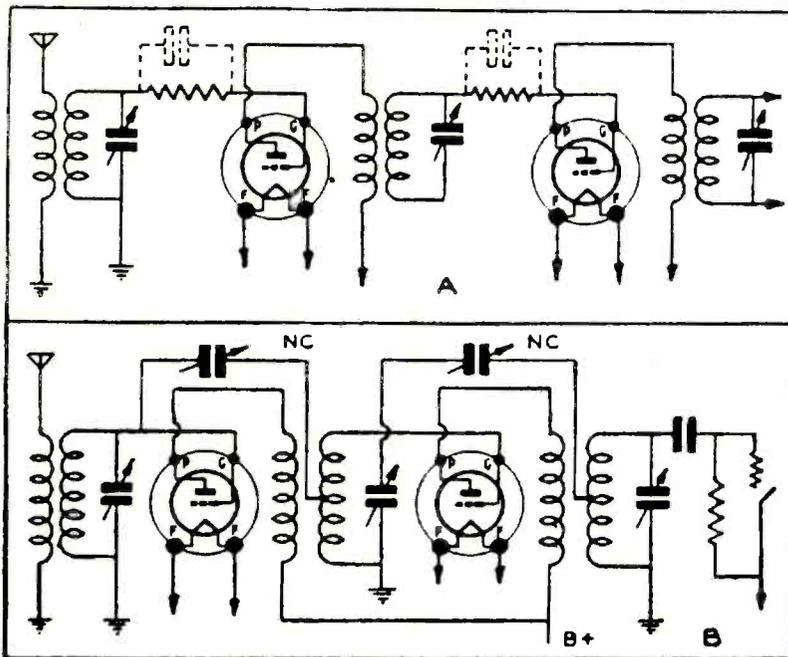
The TRFs exhibited no such crankiness and tuned much more smoothly. But the fact that they required two RF amplifiers ahead of a detector stage meant that they had to have three tuned circuits and, hence, three tuning knobs. For the most part, this seems not to have been a problem, as each of the three knobs would be tuned close to the same reading to pick up any given station. Even with the extra controls, the TRF was easier to handle than the regenerative set.

As it happened, there was a certain advantage in using three tuned circuits. As the '20s wore on and the number of broadcast stations on the air multiplied, stations were getting closer to each other on the dial and harder to separate. The extra tuned circuits made the TRF much more selective than a one-tube regen model, discriminating between stations with greater ease.

Although it took just three tubes to match the performance of a one-tube regen, most "three-dialers" had five—usually those ubiquitous 01-As. The extra two tubes were audio amplifiers, giving the set enough "punch" to operate a speaker. While many regenerative sets also incorporated those two audio



The Crosley Gembox, from about 1929, was AC-powered, but still a TRF with Neurodyne circuitry. The Dynacone speaker shown with it was an optional accessory.



One type of "losser" circuit (top) inserted a low-value resistor between the tuned circuit and the grid. Some manufacturers used bypass capacitors (dotted) to minimize losses at higher frequencies. The Neurodyne circuit (bottom) used small adjustable capacitors ("NC") connected from output to input of RF stages.

stages (sometimes offered as an optional accessory amplifier), it was more common to find them in the TRF sets. After all, once you commit to enough parts to build a three-tube set, a cabinet big enough to house it, and enough battery to run it, it's not too much more of a jump to add the extra two tubes.

THE TRF DESIGN PROBLEM

While TRF sets were easier for the lay user to operate than regen sets, they posed some unusual difficulties for the radio designers. The problem was that RF amplifiers having their inputs and outputs tuned to the same frequency (as was the case in the typical TRF receiver) tended to oscillate.

The effect, caused in part by the high internal capacitance of the early tubes, was similar to regeneration, but uncontrollable and definitely undesirable.

A radio engineer named Hazeltine came up with one of the best-known and most elegant solutions to the problem. He found that by coupling some of an RF amplifier's output back to the grid through a small, carefully adjusted capacitor, the tube's internal capacitance could be canceled out, suppressing the tendency to oscillate. He called his circuit the "Neurodyne."

The Neurodyne was perhaps the best-known of the classical TRF circuits, but manufacturers who did not want to purchase a Hazeltine license resorted to other methods of taming the unruly oscillations. For example, Clarence Tuska substituted magnetically coupled feedback for capacitive feedback in his "Superdyne" circuit. Atwater Kent and Kolster were among the manufacturers who "cooled down" RF amplifier stages by inserting small-value resistors between tuned circuit and grid. Circuits in which efficiency was deliberately cut down by this or other means were called "lossers."

Losses could also be created by deliberately employing poor design practices. One trick was to mount the tuning coils quite near, or even on, the grounded metal frames of the tuning capacitors. The frames would absorb some energy from the coils, introducing enough inefficiency to suppress the oscillations.

Unwanted coupling between TRF tuning coils, which were bulky and hard to separate, was also a problem. Some manufacturers minimized the effects by situating the coils at right angles to each other. Hazeltine came up with another elegant solution for use in Neurodyne sets. His coils were mounted in a straight line, but each was placed at an angle of 57° from horizontal—an angle calculated to minimize interactions.

DYING A SLOW DEATH

Although radio broadcasting grew explosively during the decade of the 1920s, radio circuitry did not change much. Compared to the 1930s, when manufacturers were introducing competitive innovations in tubes and circuitry about as fast as computer designs are changing today, 1920s designs were static. The five-tube, three-dialer

(Continued on page 67)

SCANNER SCENE

Action-packed Handheld

BY MARC SAXON

RadioShack calls its PRO-63 handheld model a "Portable Event Scanner." That's appropriate because it's perfect for taking along to all types of sports events. Savvy scanners know that, these days, virtually all professional (and many collegiate) sports rely heavily upon the use of two-way communications. So, you can sit in the stands and watch the event while you use your scanner to monitor pit crews talking to race-car drivers, or field coaches getting their instructions from ball-club managers. You name the sport and chances are they're using communications somehow. One reader advises that he even takes his scanner to pro-wrestling matches—and gets an earful!

The PRO-63 offers 100 memory channels set up in ten bands of ten channels each. You get basic coverage from 29.7–54, 137–174, and 420–512 MHz, plus the VHF aeronautic communications in the 108–137-MHz band. The unit has 10.7-MHz and 4555-kHz IFs. Sensitivity (20 dB S/N) is 0.7 μ V.

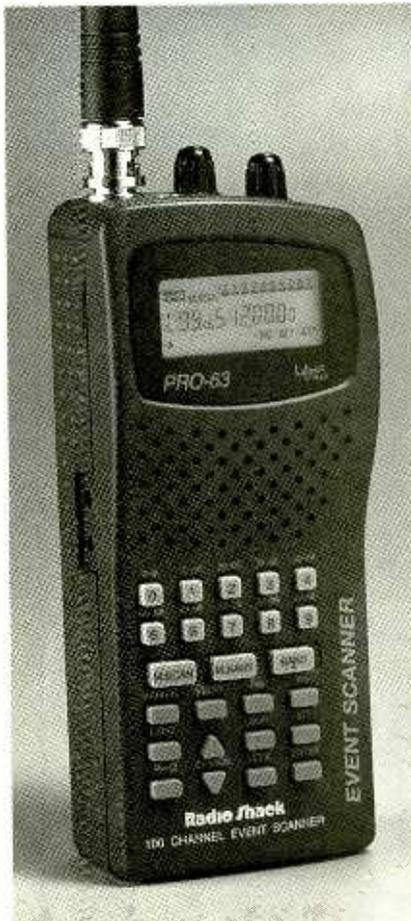
This unit scans at up to 25 channels-per-second, but searches at double speed. It features individual channel lockouts and a priority channel. The PRO-63 runs on six AA alkaline or rechargeable batteries, or you can use an optional AC adapter or DC cigarette-lighter adapter. The whole deal weighs in at a tad over a half pound, so it's a natural take-me-along. Less than six inches tall and just about 2.5 inches wide, it fits right into a shirt pocket. Air show? Soccer? Baseball? Submarine races? Here's a scanner designed so you can take it along to hear all the behind-the-scenes action. Get a look at the PRO-63 at any RadioShack store.

The PRO-63 came along just in time for reader Mike Barker of Cuyahoga Falls, Ohio. Mike wrote to ask if we could tell the frequency used by the Cleveland Indians. Check out 154.515, Mike!

WHERE'S THE FLAP?

The politicians insisted that the 62 Electronics Privacy Act and the 1994

manufacturing ban on full-frequency scanners would provide secure communications for analog cellular telephones. Many people said that cell phones could still be monitored. But there was no telling the politicians otherwise. How ironic, then, when some-



Find out just what they're saying in that pitcher's mound conference or football huddle with RadioShack's PRO-63.

one happened to overhear one of Newt Gingrich's cellular phone calls—a politically embarrassing call, at that!—last January.

The fact is cell-phone monitoring appears to be alive and well, despite efforts to discourage the practice by saying it's illegal. Many people find those calls better than any TV drama or sitcom, and thousands of people are listening in from coast to coast. The

majority of pre-1994 scanners capable of receiving the 800-MHz band can either receive cellular frequencies straight from the factory, or can be easily modified by their owners to do so. Practically no effort or technical knowledge is needed. All scanners manufactured for sale in the U.S. after April, 1994 had the 824–851- and 869–896-MHz cellular frequencies factory-blocked so that they could not readily be restored by equipment owners. Nevertheless, it was discovered that quite a few models could be reworked by qualified technicians so that cellular calls could be received anyway.

VACATION SCANNING

Going to Branson, Missouri? Did you know that Branson attracts more tourists than any other location in America? That's because Branson is a town dedicated to family entertainment, with theaters, exhibits, concerts, rides, and numerous other attractions—including big-name stars. If you're to be heading in that direction, don't forget to pack your scanner!

The Wilderness Safari can be monitored on 152.915 MHz, and Silver Dollar City can be picked up on 151.685, 151.835, 463.8125, and 468.8125 MHz. Big Surf Waterpark uses low power on 154.57 MHz, and you can tune in the Ozark Scenic Tours on 464.65 MHz. Ray Stevens Theatre uses 464.525 MHz, while the Fort of the Osage Fun Park operates on 462.05 MHz. Try Ascension Resorts on 151.805 MHz, and the Branson Inn on 464.575 MHz. Treasure Lake RV Resort and Campground uses 461.475 and 464.775 MHz, while the Mutton Hollow Craft Village is on 464.425 MHz.

MAILBAG

A Pennsylvania reader writes that sometimes in television news reports, he sees U.S. Secret Service agents protecting VIPs. They appear to be wearing hearing aids and speaking into the cuffs of their jackets. He asks if this

(Continued on page 67)

Circuit Circus

The Wave That Makes Electronics Go

CHARLES D. RAKES

Oscillators! They are found in just about every electronic piece of equipment or project seen in operation today. The oscillator circuit, in one form or another, has been around for over one hundred years. If an electronic circuit ever had a beating heart, the oscillator would certainly be it.

Make yourself comfortable and get ready to look at many different oscillator circuits. And if you have been looking for a specific oscillator for a circuit or project, maybe it will be among the following examples.

Our first oscillator goes way back in electronic history to one of the first successful RF-transmitting circuits. Before vacuum tubes and solid-state devices, transmitting at radio frequencies could only be accomplished with the crude spark-gap oscillator circuit.

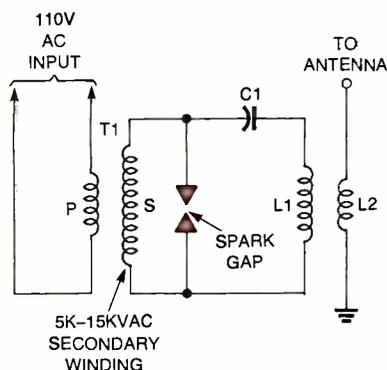


Fig. 1. Spark-gap oscillators were the first successful transmitters in the wireless communications service. They are illegal now because they blot out whole bands as Soviet broadcast shortwave jammers did years ago.

THE SPARK-GAP OSCILLATOR

Basically, the spark-gap oscillator was a simple device (Fig. 1) that used a few circuit components. A high-voltage, current-limiting transformer, T1, supplies power to the basic L/C tuned circuit. As C1 charges to near the transformer's maximum output voltage, the spark gap's air space breaks down completing the circuit between the

inductor and capacitor, L1 and C1. The tremendous inductive kick in the circuit is caused by the inductive field collapse when the spark gap shorts out the L/C series circuit. The L/C tuned circuit oscillates in a very broad-band manner knocking frequencies over a large portion of the spectrum.

The FCC does not allow this type of circuit to be used today. Today's modern short-wave receiver would hear the spark-gap transmitter from band-end to band-end. The transmitter would blanket all reception to nearby receivers. They were outlawed back in the thirties. Also, the spark-gap oscillator is the heart and soul of the famous high-voltage Tesla coil. We'll take a closer look at some Tesla circuits in a future visit.

The modern electronic oscillator normally uses an amplifying device, such as a vacuum tube, transistor or IC, to feed back a portion of the output signal to the input of the device which promotes and maintains oscillation. The trick is to control the feed-back signal so that the circuit will produce a stable oscillating frequency and output level.

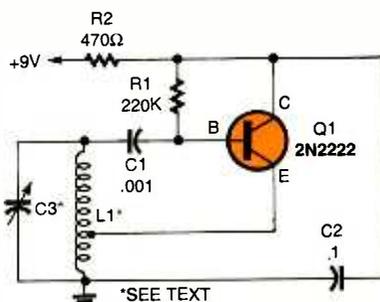


Fig. 2. The frequency of this RF Hartley transistor oscillator circuit is determined by the values of L1 and C3.

THE HARTLEY OSCILLATOR

A modern RF Hartley transistor oscillator circuit is shown in Fig. 2. The oscillator's operating frequency is determined by the values of L1 and C3. The feed-back level is determined by the location of the tap on L1, which normally will be about 1/5th to 1/4th of the total turns. As an example, the

PARTS LIST FOR FIG. 2

- C1—.001- μ F, ceramic disc
- C2—.1- μ F, ceramic disc
- L1/C3—see text
- R1—220,000-ohm, 1/4-watt, 5% resistor
- R2—470-ohm, 1/4-watt, 5% resistor
- Q1—2N2222, NPN transistor

Hartley oscillator will operate in the 5-MHz range with the following L/C values. L1 is 20 turns of number 18 enamel, copper wire close wound on a 1-inch plastic form with a tap up five turns from the bottom. Capacitor C3 may be any small variable capacitor with a maximum capacitance value of 100 pF. With the proper L/C values, the Hartley oscillator can operate from audio to UHF making it a very popular circuit with circuit designers.

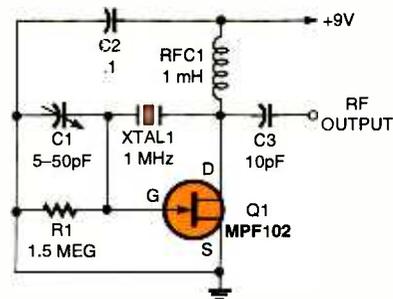


Fig. 3. A simple Pierce crystal-controlled oscillator circuit can be used as a marker generator for receiver tuning alignment.

PARTS LIST FOR FIG. 3

- C1—5-50-pF, or similar size variable capacitor
- C2—.1- μ F, ceramic disc
- C3—10-pF, ceramic disc
- Q1—MPF102 FET
- R1—1,500,000-ohm, 1/4-watt, 5% resistor
- RFC1—1-mH, RF choke
- XTAL1—1-MHz crystal

PIERCE CRYSTAL-CONTROLLED OSCILLATOR

A simple Pierce crystal-controlled oscillator circuit (Fig. 3) can be used

as a marker generator for receiver alignment use. A single MPF102 FET (field-effect transistor) is the active device supplying sufficient gain for the circuit to oscillate. Feed back is from the FET's drain (d) through the crystal to the input gate. Capacitor C1 fine tunes the oscillator.

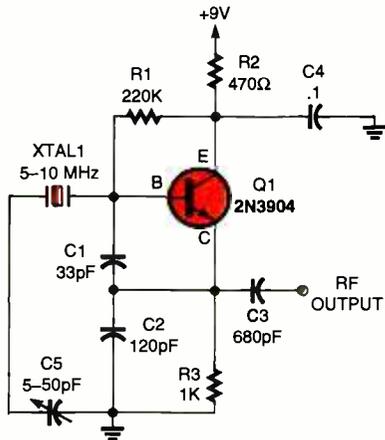


Fig. 4. The Colpits crystal-controlled oscillator uses a tapped capacitor (C1 and C2) to determine the feed back ratio that maintains oscillation. Compare this circuit to the Hartley tapped-coil, oscillator circuit.

PARTS LIST FOR FIG. 4

- C1—33-pF, ceramic disc (see text)
- C2—120-pF, ceramic disc
- C3—680-pF, ceramic disc
- C4—1-μF, ceramic disc
- C5—5-50-pF, small variable capacitor
- R1—220,000 ohm, 1/4-watt, 5% resistor
- R2—470 ohm 1/4-watt, 5% resistor
- R3—1000 ohm 1/4-watt, 5% resistor
- Q1—2N3904 NPN transistor
- XTAL1—1.5- to 10-MHz crystal (see text)

COLPITS OSCILLATOR

Our next crystal controlled oscillator (Fig. 4) is a tapped capacitor job, commonly called a Colpits, oscillator circuit. The values of C1 and C2 determine the feed-back ratio that maintains oscillation as the tapped coil did in the Hartley circuit. To obtain maximum frequency stability and output level, the values of C1 and C2 should be selected for a given frequency. Here you will need to do some experimenting. Not only is experimenting fun, it's a good way to learn.

USING TTLS

Our next entry uses two gates of a

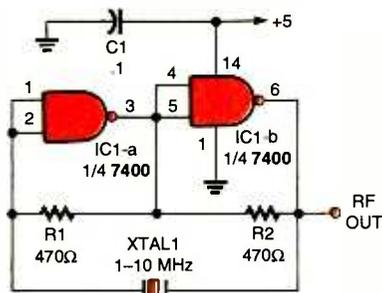


Fig. 5. Here's an oscillator circuit that uses no L/C components. It uses two sections of a 7400 TTL IC, two resistors, and a crystal to make up a simple and stable oscillator circuit.

PARTS LIST FOR FIG. 5

- C1—1-μF, ceramic disc
- R1, R2—470 ohms, 1/4-watt, 5% resistor
- IC1—7400 TTL IC
- XTAL1—10-MHz crystal

7400 TTL IC, two resistors, and a crystal to make up a simple but useful oscillator circuit (Fig. 5). Positive feed back is from the output of U1-a through the crystal to the input of U1-a. The circuit will operate from less than 1 MHz to over 10 Mhz.

THEN THERE'S THE CMOS

Up next is a single CMOS 2-input NOR gate crystal oscillator circuit as shown in Fig. 6. The oscillator's feedback path is from the gate's output at

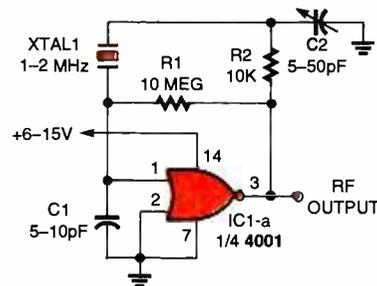


Fig. 6. This single CMOS 2-input NOR gate crystal oscillator circuit has one major limitation; it lacks high frequency performance, otherwise, it is a solid performer.

PARTS LIST FOR FIG. 6

- C1—5 to 10-pF, ceramic disc
- C2—5-50-pF, variable capacitor
- R1—10,000,000-ohm, 1/4-watt, 5% resistor
- R2—10,000-ohm, 1/4-watt, 5% resistor
- XTAL1—1- to 2-MHz crystal
- IC1—4001 quad, 2-input NOR gate IC

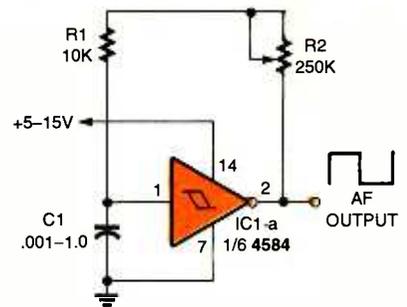


Fig. 7. The feedback path for this single CMOS, 2-input, NOR-gate, crystal-oscillator circuit is from the gate's output at pin 3 through R1 and the crystal to the input at pin 1. Note that the output is a square wave.

PARTS LIST FOR FIG. 7

- C1—.001 to 1-mF capacitor (see text)
- R1—10,000 ohm, 1/4-watt, 5% resistor
- R2—250,000-ohm potentiometer
- IC1—4584, hex, Schmitt-trigger IC

pin 3 through the 10K resistor and the crystal to the input at pin 1. Resistor R1 supplies input bias and C2 fine tunes the circuit. The one major limitation of the CMOS oscillator circuit is its lack of high frequency performance.

If you build this oscillator circuit, be sure to tie the inputs of the three unused NOR gates to ground or battery positive. If you do not, your oscillator could stop operating and the IC could go belly up.

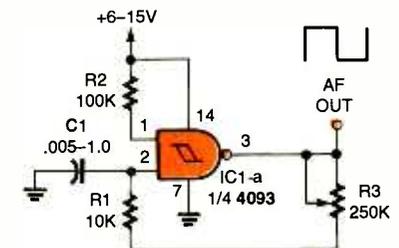


Fig. 8. Here's another square-wave oscillator that uses a CMOS IC with input hysteresis. In this R/C oscillator circuit, a single gate of a quad 2-input NAND Schmitt trigger IC is the active element.

PARTS LIST FOR FIG. 8

- C1—.005- to 1.0-μF capacitor (see text)
- R1—10,000-ohm, 1/4-watt, 5% resistor
- R2—100,000-ohm, 1/4-watt, 5% resistor
- R3—250,000-ohm potentiometer
- U1—4093, quad, 2-input NAND Schmitt trigger IC

There's several gates of the CMOS IC series that have a built-in hysteresis on the input circuitry making the devices ideal for oscillator applications. The 4584 hex Schmitt trigger-inverter IC has this feature and is the active device in our next audio frequency oscillator circuit.

A single gate of a 4584 chip is connected in a simple RC square-wave audio oscillator circuit (Fig. 7). C1, R1 and R2 set the oscillator's frequency. The frequency range can be modified easily by changing the value of C1. The larger you make the capacitor, the lower the frequency range, and contrarywise. Mylar, polystyrene, or a similar low-leakage capacitor works best in these high-impedance RC circuits.

A similar square-wave oscillator is shown in Fig. 8 that uses another popular CMOS IC with input hysteresis. In this R/C oscillator circuit, a single gate of a quad 2-input NAND Schmitt trigger IC is the active element. This oscillator operates very much like the previous one with C1, R1 and R3 setting the circuit's frequency. The frequency range of this square-wave oscillator may be changed in the same way as the previous circuit.

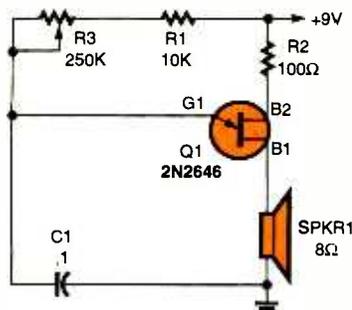


Fig. 9. This audio oscillator is another R/C-type circuit that gets the work done with a UJT (uni-junction transistor).

PARTS LIST FOR FIG. 9

- C1—1- μ F, Mylar or similar type high-quality capacitor
- R1—10,000-ohm, $\frac{1}{4}$ -watt, 5% resistor
- R2—100-ohm, $\frac{1}{4}$ -watt, 5% resistor
- R3—250,000-ohm potentiometer
- Q1—2N2646, or similar UJT
- SPKR1—8-ohm speaker, 2-3-in. diameter

ENTER THE UJT

Our next audio oscillator (See Fig. 9) is another RC type circuit with a UJT (Unijunction transistor) doing the work. You don't see this transistor type used

in today's circuitry as much as they were back in the 1960s and 1970s, but, in many applications, the UJT is still a viable device.

Here's how the UJT oscillator works. When power is connected to the circuit, C1 charges through R1 and R3. When the voltage reaches the UJT gate's (G) threshold voltage (usually around .5 to .8 of the supply voltage), the dynamic resistance between the B2 and B1 drops to a very low value. Capacitor C1 then discharges through the emitter base junction and the 8-ohm speaker.

The frequency of the UJT oscillator is determined by the values of C1, R1 and R3. As in the previous two circuits, making either the capacitor or resistor larger lowers the oscillator's frequency.

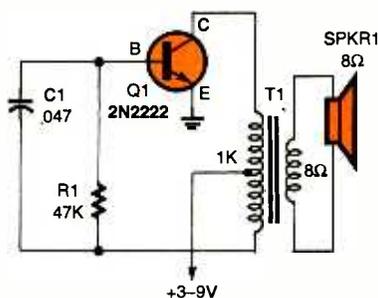


Fig. 10. This oscillator's circuit uses a center-tapped transistor output transformer to serve as a load for Q1's collector. A good budget circuit for cheap sound.

PARTS LIST FOR FIG. 10

- C1—.047- μ F, Mylar or similar type capacitor
- R1—47,000 ohm, $\frac{1}{4}$ watt, 5% resistor
- T1—1000-ohm to 8-ohm transistor output transformer
- Q1—2N2222, NPN transistor

DESIRED AUDIO FEEDBACK

Our last wave-maker for this time around is another simple, but useful, audio oscillator circuit that can be used just about anywhere there's a need for a low level alarm sounder. And, to boot, the circuit can be constructed for close to nothing even if you have a minimal junk box.

The oscillator's circuit in Fig. 10 uses a center-tapped transistor output transformer to serve as a load for Q1's collector, supply a feedback signal for the base, and the output winding for driving the speaker. R1 supplies DC bias and C1 completes the AC path from the transformer to Q1's base.

You can play around with the val-

ues of C1 and R1 to change the oscillator's output level and tone, but don't reduce R1's value too much or the transistor can draw excessive collector current and end up sending smoke signals instead of sound waves.

Even though these oscillator circuits are on the basic and simple side, many like these can be found working hard in more complex circuitry about anywhere you care to look. Just consider these oscillating, building-block circuits for future projects.

The old clock is down to the last tick and it's time to go. Happy oscillations until we meet here again next month. ■

HIGH POWER AUDIO AMPLIFIER CONSTRUCTION



BP277—Here's background and practical design information on high power audio amplifiers capable of 300±400 watts r.m.s. You'll find MOSFET and bipolar output transistors in inverting and non-inverting circuits. To order your copy send **\$6.25 plus \$3.00** for shipping in the U.S. and Canada to **Electronic Technology Today Inc., P.O. Box 240, Massapequa Park, NY 11762-0240**. U.S. and Canada only. Payment in U.S. funds by US bank check or International Money Order. Please allow 6-8 weeks for delivery. MA03

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BUY BONDS

COMPUTER BITS

Derive—Handy Software

JEFF HOLTZMANN

You can't use your computer without software. As we all have learned, sometimes the hard way, not all software is created equal. Some applications are simply wonderful while others can turn out to be impossible. I've wondered more than once how some particular software package ever found its way into my computer.

Take a look at the following complex equation:

$$\frac{x^4}{2} + \frac{3x^3}{4} - \frac{5x^2}{4} - \frac{7x}{4} - \frac{1}{2} = 0 \text{ ? what}$$

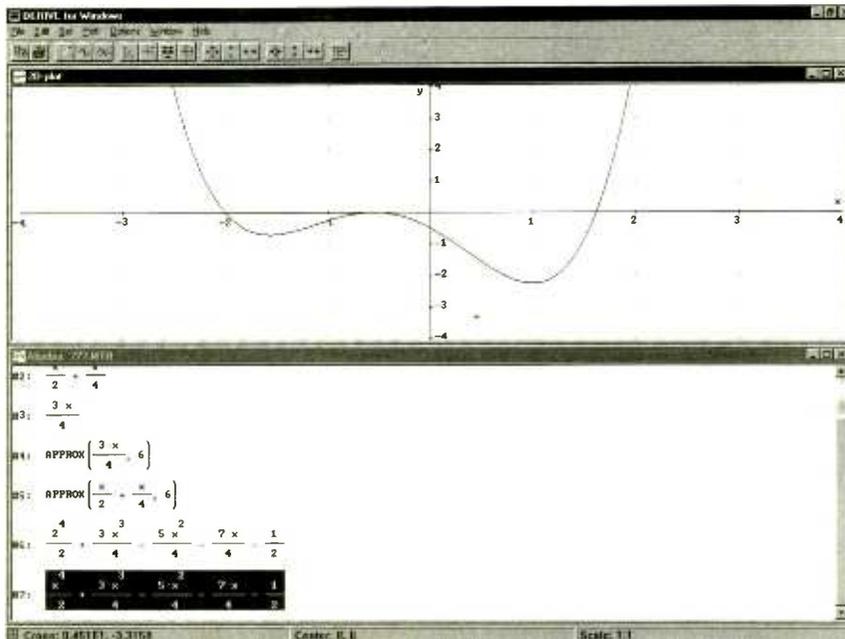
How many solutions are there? What are the values? What does the curve

look like? If questions like those interest you, then Derive is a program you're going to love. Derive has been around for years in a DOS version; the company recently released a Windows version. It runs on Windows 3.1, Win95, and NT. I tested it—no, played with it—under NT 4.0.

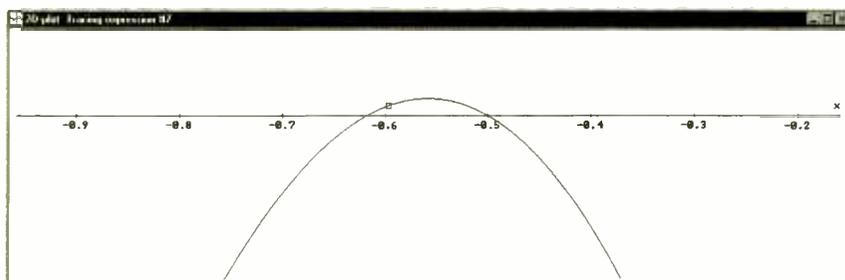
Derive is good for several things: equation solving, curve visualization, arbitrary-precision calculation, and general what-if playing with symbolic math ranging from basic arithmetic to algebra, matrices, trig, and beginning calculus. Derive has a huge international following, complete with Web sites, mailing lists, and books in more than 14

languages. The advantages of the Windows version over the DOS version include a more intuitive user interface, and a much simpler way to print and save plots. In fact, the Windows version even provides a copy to clipboard function, so you can paste an image directly into a word processing document.

You can view Derive as the intellectual equivalent of a computer game. You can easily spend hours solving and plotting variations of equations. But instead of walking away with repetitive strain injury, you will have learned something. If you're currently taking or teaching a math class, and want a more visual approach, pick up a copy of Derive. Or get your school's computer lab to do so. You won't be sorry.



How many zero points? Looks like three, no?



Zooming in on the region between zero and negative; the view reveals that the curve actually goes positive for a brief period. So there are four zeros.

COMPUTERS AND AUDIO SYSTEMS

David Jenks wrote me recently, asking about the practicalities of connecting the output of a PC sound card to a standard stereo system. Other than using a good shielded cable, and making sure all equipment shares a common ground, the only difficulty is mating connectors properly. I add the caveat about sharing a common ground because of something that happened to me more than ten years ago. The company I was working for had its offices in an old converted warehouse. One day I was setting up a new (high-speed!) 1200-bps modem. Unlike most models today, it had a built-in power supply and a 117-VAC line cord. The outlet strip by the computer was full, so I plugged the modem into a different outlet in the test lab. Next, I connected the serial cable from the computer to the modem. Then I turned the modem on. Zap! I saw a spark and smelled smoke.

It turned out that one outlet in that office was wired incorrectly. As a result, the modem circuitry provided a nice path between 117-VAC and ground. Ever since, I have never installed a piece of equipment in a new location without testing all available outlets for correct ground/hot/neutral polarity. In fact, one permanent member of my sys-

VENDOR INFORMATION

Derive for Windows (\$250), Soft Warehouse, Inc., 3660 Waiialae Avenue, Suite 304, Honolulu, HI 96816-3236. Tel. (808) 734-5801. <http://www.derive.com>.

Creating Cool Intelligent Agents for the Net (\$29.99), Leslie L. Lesnick with Ralph E. Moore, IDG Books, 1997. ISBN: 1-56884-823-4.

tem integration tool kit is one of those three-prong *doohickies* with LEDs to indicate wiring polarity status. You can pick up this 3-prong polarity tester at RadioShack. Ask for part no. 22-101. So make sure your stereo and your PC have a common ground before connecting them.

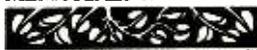
Incidentally, at one time I thought I would go for a similar setup: connecting my PC to my office stereo. But it turned out to be impractical. If I wanted to listen to music or the radio, I couldn't hear the computer. And vice versa. So I sprang for a cheap pair of self-powered speakers for the computer.

Now if a stereo had an override or mixer input, then output from the computer could override or at least mix in with the stereo's current signal.

ON THE BOOKSHELF

Creating Cool Intelligent Agents for the Net is the title of a new book published by IDG Books. What it provides is an overview of products and technologies that can be used to raise the level of intelligence of your Web searches. The book comes with a CD-ROM containing executable versions of several tools, including Web Compass, SurfBot, and more. The text is wordy; the authors take forever to get to the point. Nonetheless, there is useful information here, and the tools are useful as well. Intelligent information gathering via the Web is already one of 1997's hottest topics. This book can help clue you in to the basic issues, and give you some hands-on experience too. ■

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SCANNER SCENE

Continued from page 62

is a two-way communications system that can be monitored on a scanner.

By its very nature, this type of system would be limited to relatively short-range use unless it's being rebroadcast through a nearby high-power repeater. Our understanding is that these systems usually operate in the 407-MHz range.

Some specific frequencies mentioned in the past have included 407.025, 407.825, 407.85, 407.875, 407.925, and 407.95 MHz. During the January inauguration of President Clinton, 407.025 MHz was in use. Check the frequencies from 415–420 MHz to see if a repeater is being used.

Something to keep in mind is that if you're close enough to hear those communications on a handheld scanner, Secret Service agents might very well be able to spot you in the crowd and invite you downtown for a chat. Maybe the best and safest bet is to listen at home for repeaters if you're too far away to pick up anything when you search 407–408 MHz.

SCANNER MODIFICATION SOURCES

Here are some valuable information sources regarding cellular monitoring and modifications. CRB Research Books, Inc. (P. O. Box 56-P, Commack, NY 11725-0056) offers a catalog of easy do-it-yourself scanner modification manuals, as well as books on cellular phone monitoring, and frequency guides. You can request them by calling 516-543-9169, or send e-mail to CRBbooks@aol.com.

The technicians at Cellular Security Group (47 Causeway Street, Gloucester, MA 01930) might be able to unlock or otherwise provide for full 800-MHz frequency coverage in *your* existing handheld or desktop scanner. They can do so for more than 40 models of scanners manufactured by RadioShack, Uniden Bearcat, ICOM, and AOR. Prices start at \$40. Call them at 508-281-8892 for details.

SEE YOU NEXT TIME!

This is *your* column, and your active participation is what helps us keep it tops. Our address is *Scanner Scene*, Popular Electronics, 500-Bi-County Blvd., Farmingdale, NY 11735. ■

ANTIQUE RADIO

Continued from page 61

hung on in America's living rooms from about 1923 to 1929, its multi-lead umbilical cord sucking power from an array of batteries and/or battery eliminators under the radio table.

Near the end of the decade, radios that plugged into the wall became practical, but the TRF circuit lingered on. Lift the lid on almost any early AC set, and you'll see the familiar group of three large tuning coils and capacitors (the latter now belted or ganged to move in unison under the control of a single knob). The filament control rheostats also disappeared from the front panel, made unnecessary because the voltage being delivered to tube filaments by the set's power transformer was now constant and required no adjustment.

Even the development and marketing of radios with the powerful new superheterodyne circuit did not seriously affect the TRFs dominance at first. What kept the venerable circuit alive was the introduction of the type-24 screen-grid tube (later replaced by the quicker heating 24-A). This *tetrode* (four-element) tube could amplify RF signals to very high levels without any oscillation problems.

For a time, screen-grid sets captured the public's fancy, and radios with the new circuitry were heavily advertised in consumer and hobby publications. Licensing and royalty fees for the screen-grid circuitry being more affordable than those for the superheterodyne, many manufacturers were happy to concentrate on TRFs. During the late 1920s and early 1930s, screen-grid TRFs were made in large numbers as both compact table models and imposing living-room consoles. Even during the 1940s and 1950s, when the superheterodyne had all but taken over, the TRF circuit occasionally cropped up in low-end table-model radios.

TRF radios, particularly the "three-dialer" battery sets, make a great nucleus for a new collection. They are still quite plentiful at the radio meets, and therefore can be purchased at moderate prices. These sets date from an era when radio fans listened for the sport and excitement of it—and they look it.

Next time, we'll take an in-depth look at one of the first Neutrodyne three-dialers to be widely sold and advertised: the Freed-Eisemann NR-5. ■

Think Tank

More From Carlos

JOHN J. YACONO
LAB TESTING COORDINATOR
WINDOWS MAGAZINE, IEEE

This month we've got more circuits from Carlos, and he's asked a rather popular question among Think Tank winners: Beyond being one of the prizes for contributing to Think Tank, just what is a MCL1010 chip? The simple answer is it's a quad NOR gate, but it's also a piece of history. The Motorola 1010s we give out are in individual plastic packs stamped with the year 1967. By that year, ICs had become accepted design components, but not until after a prolonged wait-and-see period among engineers. Motorola had been cranking out ICs well before that, but they didn't have a niche until the moon race, which as you know reached a climatic close two years after 1967.

Even if you ignore the significant increase in integration, ICs have changed quite a bit since then. The MC1010s use negative power-supply voltage. They represent a logic high by a voltage a little less than zero volts, and a logic low around -2 volts. However, if need be, such chips can be interfaced with modern circuits by connecting their ground terminal to 5-volts, their supply-voltage pin to the circuit ground, and pull-down resistors at the outputs. You can OR two gate outputs by just tying them together. So you could replace the circuit shown in Fig. 1A with the circuit in Fig. 1B. You can also implement an XOR gate with one of these old quad, NOR-gate chips.

Turning our attention back to our tutorial topic, let's continue our discussion of using diodes as voltage references. As I mentioned a couple of columns ago, there are diodes called Zeners that are specifically designed to work when reverse biased. In fact, they work in their break-down region as shown in Fig. 2, which would destroy typical diodes. That is accomplished by creating a very thin PN junction when forming the diode. The Zener therefore breaks down much easier with no appreciable damage unless the current shoots beyond a maximum value we'll denote I_{MAX} .

As you can see from the curve, once the reverse current pushes the

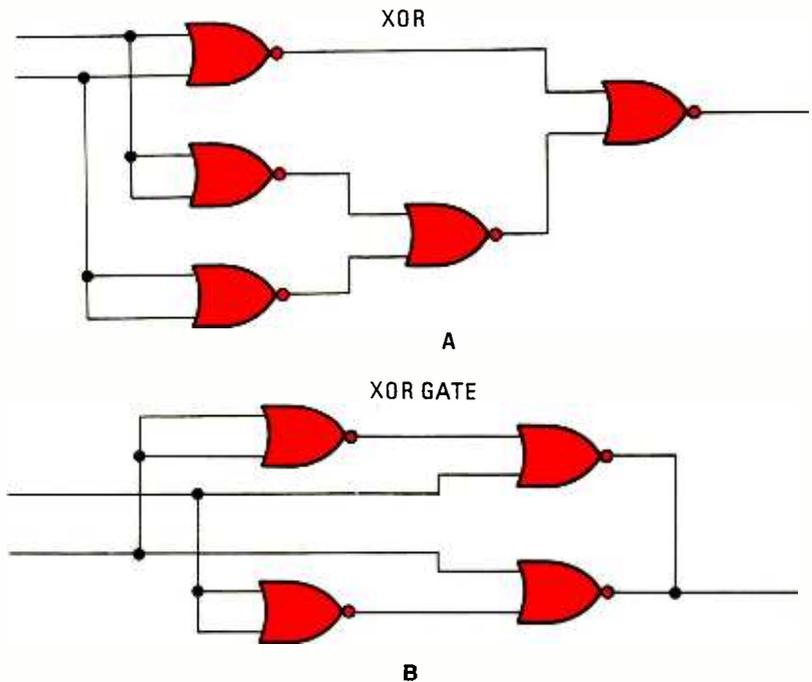


Fig. 1. The logic required to make an XOR is a bit complex and requires five NOR gates as shown in A. Using four old TTL NOR gates does the same job in B.

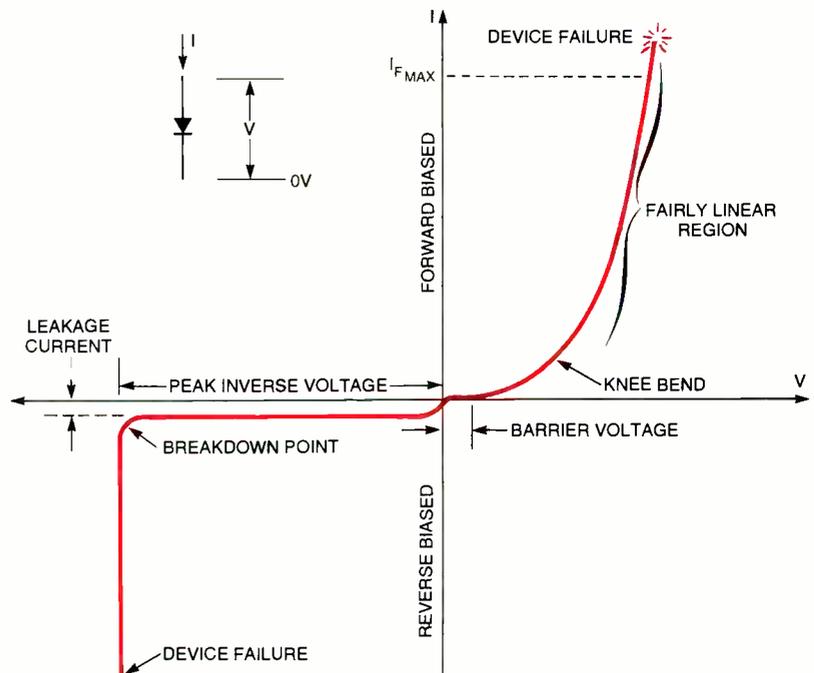


Fig. 2. Here's the characteristic curve of current through a standard diode vs. the voltage applied across it.

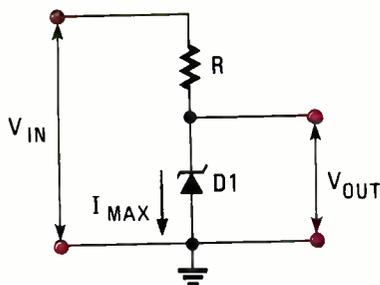


Fig. 3. Zener diodes make excellent voltage regulators.

and maximum current is determined at manufacturing time. A Zener is selected so its operating voltage is approximately equal to the desired V_{OUT} . Another important characteristic is power dissipation (P), which is selected to suit the needed I_{MAX} value as follows:

$$P = V_{OUT} I_{MAX}$$

Like V_{OUT} , the value of I_{MAX} needed depends on the load, and so does the resistor's resistance and wattage.

load. Assuming the input and output voltage remain fairly constant (typical for a regulator circuit) we know from Ohm's law that the current through the resistor is proportional to the voltage across it, or:

$$I_R = (V_{IN} - V_{OUT}) / R$$

Combining the equations we get:

$$(V_{IN} - V_{OUT}) / R = I_Z + I_L$$

Since the variables used on the left are more or less constant, it implies when the load current is at a minimum (call it I_{LMIN}), the diode current is at a maximum (I_{MAX}). Substituting those variables in we get:

$$(V_{IN} - V_{OUT}) / R = I_{MAX} + I_{LMIN} \quad \text{(Equation 1)}$$

When the load demands maximum current, then the diode current should be negligibly small for the sake of efficiency. In other words

$$(V_{IN} - V_{OUT}) / R = I_{LMAX} \quad \text{(Equation 2)}$$

What the math is telling us is that while the resistor should protect the diode, it should be selected to provide sufficient current to the load. With a little rearranging we get:

$$R = (V_{IN} - V_{OUT}) / I_{LMAX}$$

Once we know R , we can figure the resistor's power dissipation using:

$$P = I_{LMAX}^2 R$$

We can also determine the diode's maximum reverse current by rearranging Equation 1 and after substituting it in Equation 2 we get:

$$I_{MAX} = I_{LMAX} - I_{LMIN}$$

What the equation implies is that the Zener picks up the slack in the minimum and maximum load conditions by dissipating current. It draws current through R to create a voltage drop across the resistor, reducing the voltage available to the load.

Well, it's time for the letters. Since Carlos sent in enough for a column he'll receive an historical MCL1010 chip and a kit in addition to the book awarded for

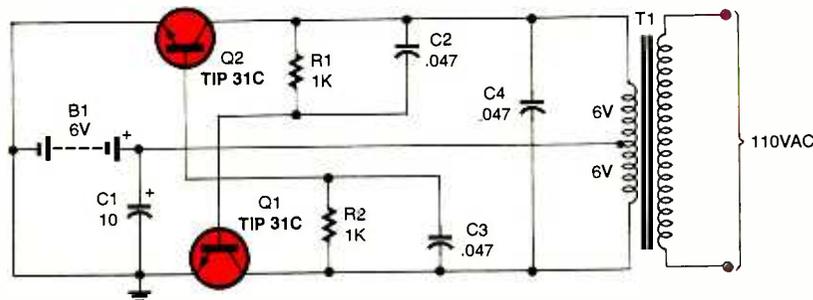


Fig. 4. The inverter circuit pushes and pulls its output through the secondary winding of a 12-volt center-tapped power transformer.

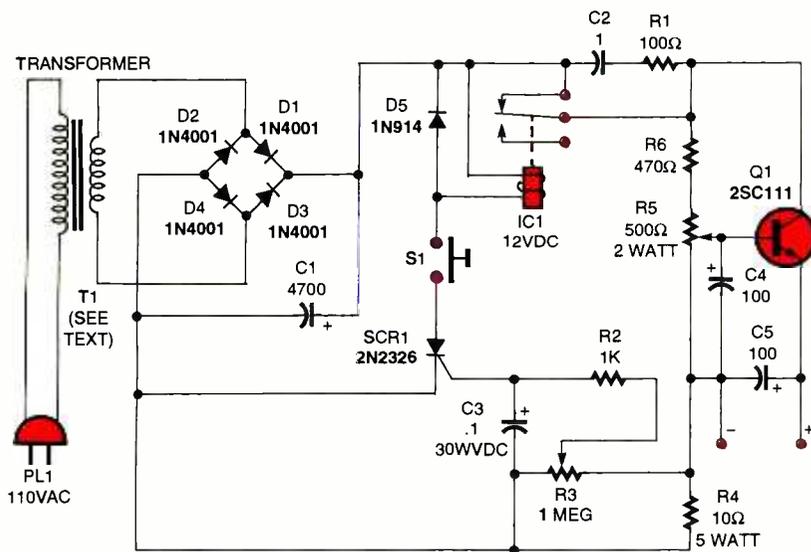


Fig. 5. A simple and effective power supply for DC voltages up to 22 volts.

diode into the break-down region (after a knee bend), the voltage across the diode remains fairly constant. In a sense, the diode can be used as a voltage regulator by simply placing a load in parallel with it. All that is needed is a current-limiting resistor to prevent damage to the Zener.

Figure 3 shows precisely that. In the figure, with the help of the resistor, $R1$, reduces an input voltage (V_{IN}) is reduced to a desired output voltage (V_{OUT}). The Zener's operating voltage

Specifically those values depend on the minimum and maximum values of current needed by the load. Since the current flowing through the load plus the current flowing through the Zener must first flow through the resistor we can say:

$$I_R = I_Z + I_L$$

Where I_R is current through the resistor, I_Z is the current through the diode, and I_L is the current through the

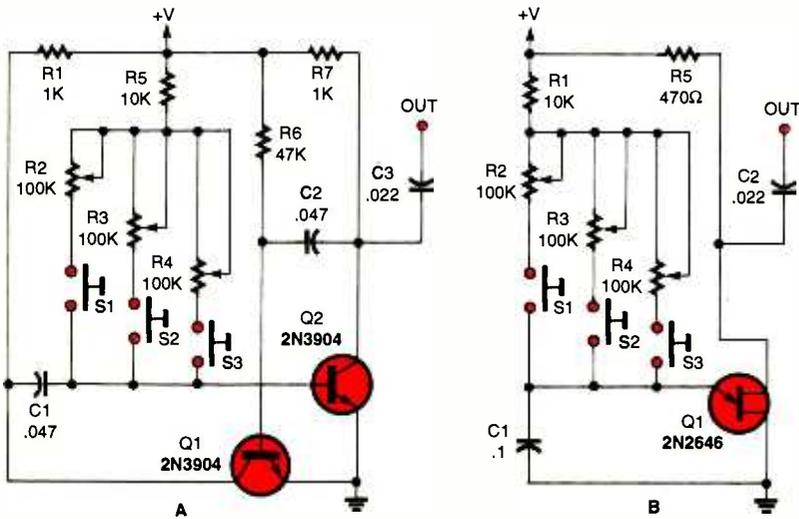


Fig. 6. Two circuits that can be lots of fun, useful, or both! Here's the beginning of a toy musical organ.

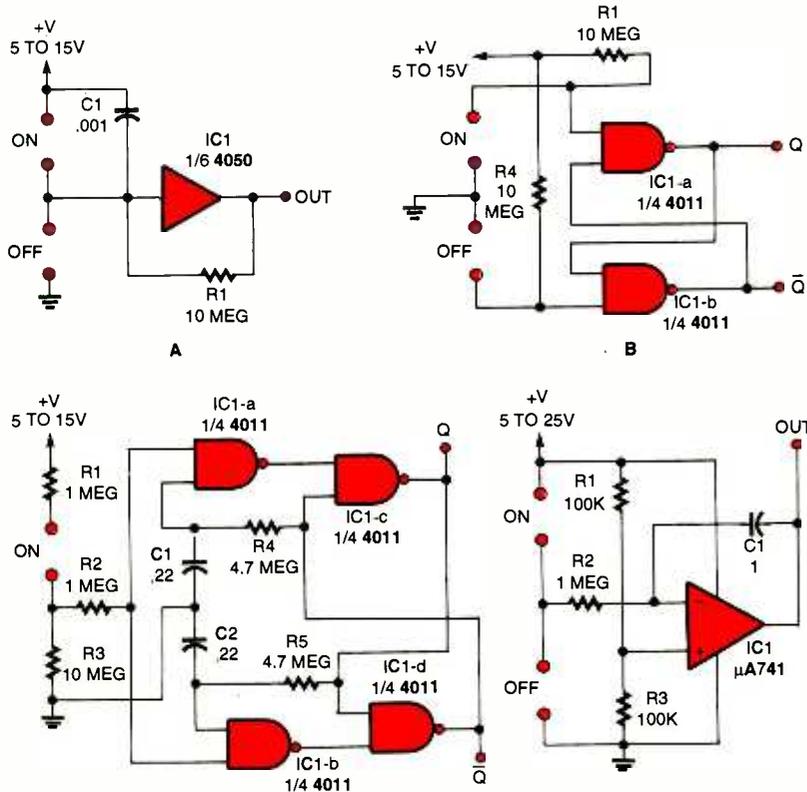


Fig. 7. Author's first touch circuit is shown in A. Next one (B) is a configured flip-flop using a 4011 chip. In C, the author uses one touch-off/touch-on pushbutton. In D, the circuit uses an opamp for switching action.

stand-alone submissions. Remember, if you'd like to participate, send a schematic and thorough explanation to *Think Tank*, **Popular Electronics**, 500 Bi-County Blvd., Farmingdale, NY 11735. Now, onto the circuits!

6-VDC TO 110-VAC INVERTER

The inverter circuit in Fig. 4 is

based on a simple astable multivibrator, that pushes and pulls its output through the secondary of a 12-volt center-tapped power transformer. The circuit works off 6 volts DC provided by 4 AA batteries. It's powerful enough to light fluorescent lamps up to 50 watts if you replace T1 with a 220-VAC transformer with its secondary connected to

the lamp's terminals.

—Carlos Eduardo Corpeno Dubon, Comayaguela, Honduras

As with all high voltage circuits, folks should use caution and good sense when building and using the unit. Heatsinks on the transistors are a good idea, too.

OVERLOAD-PROTECTED POWER SUPPLY

I built the power supply circuit in Fig. 5 back in 1994. It's very simple, but very effective for controlling up to 22-VDC, depending on the transformer's secondary voltage. The output voltage is adjusted with the 500-ohm potentiometer.

When the protective circuit notices a rise in current, the SCR will energize the relay coil, cutting power to the load and leaving the circuit in standby mode. When the problem is resolved, S1 must be pressed in order to disarm the SCR. The sensitivity of this protective circuit is adjusted by the 1-Megohm variable resistor. You can experiment with other values for that device. **WARNING:** The relay coil's voltage must be around the rectified voltage which will energize it, not above or below.

The 2SC111 transistor is the voltage regulator; however you may use an IC voltage regulator (like the LM317) instead.

—Carlos Eduardo Corpeno Dubon, Comayaguela, Honduras

Wow, that's really nice! Makes me want to retrofit some of my power supplies with your protection circuit. Indicators before and after the protection circuit or a high-current buzzer in series with the SCR might keep me from scratching my head when power's cut. Again folks, heat-sink the transistor.

MULTI-TONE GENERATORS

The schematic diagrams in Fig. 6 are two tone generators which I built on breadboards. Both circuits work from 6 to 15-VDC. The frequencies are adjusted by the variable resistors in series with each pushbutton. You can add more potentiometers and pushbuttons in order to add more tones. In the first circuit only half the waveform's timing is altered by the pushbutton/switch pairs.

—Carlos Eduardo Corpeno Dubon, Comayaguela, Honduras

These would make nice toy-organs

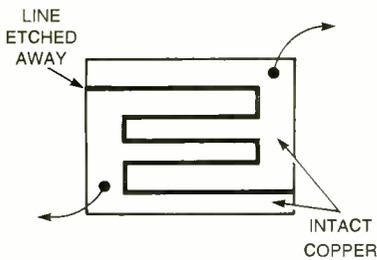


Fig. 8. Simple layout for a touch switch using a PC board. Keep the spacing small enough so that a child's finger will touch over copper spacing.

I designed the simple touch-sensitive switch shown in Fig. 7A. Then I decided to make another similar circuit, but this time with a 4011 configured as a flip-flop, shown in Fig. 7B.

At this point I figured that there should be a way to eliminate one of the pairs of contacts, leaving one touch-on/touch-off pair of contacts. That's why I designed the circuit in Figure 7C. The circuit in 7D departs from the rest because it uses a 741 op amp, which generates an output signal when the

your soldering iron. With S1 open, the circuit only feeds half cycles to the iron.

The circuit in Fig. 9B is an astable circuit that will automatically connect and disconnect your soldering iron every 2-5 minutes or so (depending on the leakage in C2.)

You can experiment with the values, in order to control the duty cycle, frequency and pulse width. You can also try using the TLC555 instead.

You can assemble this circuit (with its DC power supply) in a box permanently connected to the iron if you want to dispense with the plug and socket. For this you can also connect a switch in parallel with the relay contacts if you want the iron to stay on.

—Carlos Eduardo Corpeno Dubon, Comayaguela, Honduras

I had a circuit similar to the one in Fig. 9A, but I used an AC light dimmer for variable control. The circuit in Fig. 9B is something I never thought of. It's pretty neat!

That's all we have room for this time. Until next month keep sending that good stuff in. ■

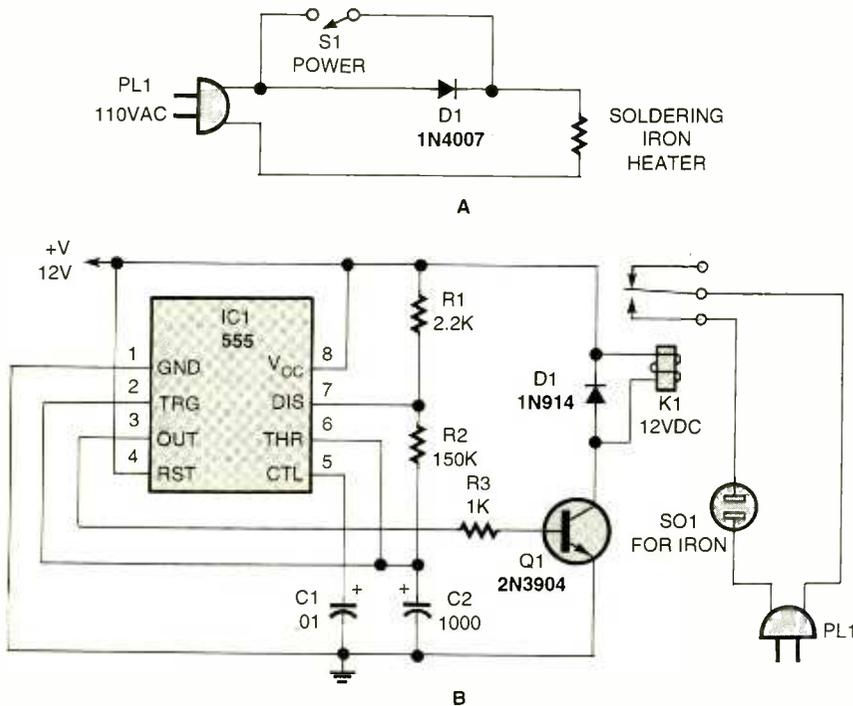


Fig. 9. A budget diode dimmer circuit (A) can be used to protect the tip of a soldering iron when not in constant use. The circuit in B builds in a timing sequence that may be more useful to the person who solders.

for young kids interested in electronics. The circuit in Fig. 6A could be altered to provide more symmetric output and increase the audible frequency range. You just replace R6 with a switch/resistor network like that connected to Q2, but make the switches double throw and use them to replace S1-S3.

TOUCH SENSITIVE SWITCHES

The circuits in Fig. 7 began with an accident: I didn't know that some CMOS ICs could respond to the touch of my fingers. One day I was making a logic circuit with a 4050 on my breadboard, when I accidentally touched an input of a buffer and ground, and I noticed a low state in the output—my finger was acting like a pushbutton. So

on contacts are touched. The output-signal level falls to zero when the off contacts are touched.

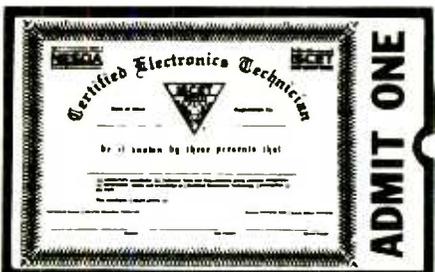
The pairs of contacts can be made from a regular PC board by etching away a zig-zagged line, as shown in Fig. 8.

—Carlos Eduardo Corpeno Dubon, Comayaguela, Honduras

Touch switches are cool. I usually like to pass their signals through a monostable timer just to avoid problems with contact bouncing.

SOLDERING IRON PROTECTORS

Here are two circuits that can improve the life of your soldering iron (see Fig. 9) The one in Fig. 9A is a typical protection/half-power controller for



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Send material about ISCET and becoming certified.
 Send one "Study Guide for the Associate Level CET Test." Enclosed is \$10 (inc. postage).

ELECTRONICS LIBRARY

Continued from page 15

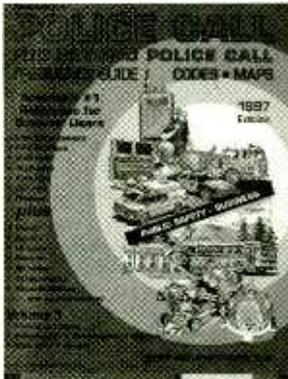
The 1997 MI-Series Audio Transformer Catalog is free upon request from Sescom, Inc., 2100 Ward Drive, Henderson, NV 89015-4249; Tel: 800-634-3457; Fax: 800-551-2749; E-mail: sescom@anv.net.

CIRCLE 92 ON FREE INFORMATION CARD

POLICE CALL PLUS BEYOND POLICE CALL: Volume 1, 1997 Edition

edited by Gene Hughes
& Richard Barnett

This book combines two popular scanning references, *Police Call* and *Beyond Police Call*. The former covers law enforcement, firefighters, aircraft, rescue, railroads, highways, and forestry; the latter lists frequencies for malls, sports, schools, security, amusement parks, hotels, utilities, and more. Nine regional volumes are available.



Police Call lists channels by state and by frequency; there are also alphabetical listings of U.S. Government operations and maps depicting police locations by state. Volume 1 covers the Northeast—Connecticut, Maine, Massachusetts, New Hampshire, New York, Rhode Island, and Vermont.

Beyond Police Call provides listings by state, with alphabetical subheadings for category (from alarm monitoring to utilities); most of those categories also are represented in a list of frequencies nationwide. There are separate sections for racing, railroads, aircraft, and frequencies listed by FCC radio service, including maritime VHF, weather, CB, family radio, automotive emergency, and more.

While the book serves primarily as a frequency guide, it also provides a wealth of other useful information. It lists scanner clubs, related magazines, and other radio clubs. It outlines the basics of scanning, including laws relating to monitoring, an introduction to REACT (Radio Emergency Associated Communications Teams), a look at FCC rules and licensing, and descriptions of various radio services and systems. Technical information about radio in general—frequency vs. wavelength, radio bands, frequency characteristics, frequency spacing—is presented in a style that's easy for beginners to understand. The book covers the technical side of using scanners and selecting antennas. It also explains commonly used radio codes and signals, and includes a glossary of slang and abbreviations.

Police Call Plus Beyond Police Call costs \$12.99 plus \$3.95 shipping and is published by Hollins Radio Data, P. O. Box 35002, Los Angeles, CA 90035; E-mail: scangene@aol.com or ccrg84d@prodigy.com; Web site: <http://www.policecall.com>.

CIRCLE 93 ON FREE INFORMATION CARD

COMPUTER SOURCEBOOK

by Alfred and Emily Glossbrenner

Written for anyone who works with, plays with, or is thinking of buying a computer, this unique book gathers just about everything you could ever need



to know about computing and information technology into a single volume. You probably won't sit down and read all 800-plus pages front to back, but you'll want to have this comprehensive reference on hand when any computer-related question arises. Thought-provoking quotes from the famous and

not-so-famous, short excerpts from related works or articles, plenty of intriguing computer trivia and statistics make browsing fun. They also come in handy for publicists, marketers, speech writers, journalists, and venture-capital solicitors starting new high-tech firms.

The book is organized into nine categories: Hardware; Software; Support; Training and Seminars; Online Communications; Publications, Publishers, Databases, and CD-ROMs; Trade Shows, Associations, and Standards Organizations; Sourcebook Yellow Pages; and Computer Company Names and Numbers. There are also "Top" lists relevant to each chapter along with expert recommendations and insights, frequently asked questions for all leading hardware and software packages.

Computer Sourcebook costs \$35 and is published by Random House Reference & Information Publishing, 201 East 50th Street, New York, NY 10022; Tel: 800-793-2665; Web site: <http://www.randomhouse.com/>.

CIRCLE 94 ON FREE INFORMATION CARD

VISUAL INTERFACE DESIGN FOR WINDOWS

by Virginia Howlett

Written by the director of Visual Interface Design at Microsoft (the team that designed the visual interfaces for Windows 3.1, Windows NT, and Windows 95), this book reveals the secrets of designing visually functional, usable, and attractive Windows applications. It teaches developers and designers the design principles needed when programming for the Windows family of operating systems. It describes the aesthetic parameters built into the Windows interface, as well as the psychology and human factors that make an application user-friendly. The book discusses design decision-making and strategies. It covers basic graphic-design and visual-perception principles, along with such fundamentals as color, fonts, and icons.

Visual Interface Design for Windows costs \$39.95 and is published by John Wiley & Sons, Inc., 605 Third Avenue, New York, NY 10158-0012; Tel: 800-225-5945; Web: <http://www.wiley.com/comppbooks>.

CIRCLE 95 ON FREE INFORMATION CARD

NEW PRODUCTS

Continued from page 16

models to give a wider view and to fit over prescription glasses. Switching speed is faster to reduce or eliminate flicker. And installation is simple: The glasses connect to the PC via the parallel port and installation software is included on the games CD-ROM.

Working with developers including Interplay, NuVision bundled three high-end games with the glasses—an eight-level version of *Descent™ II*, and full retail versions of *Whiplash™* and *Slipstream 5000™*—and several more games should be on the market by the time you read this.

3-D SPEX has an estimated street price of \$99.95 including games and accessories. For further information, contact NuVision Technologies, 1815 N.W. 169th Place, Building 3060, Beaverton, OR 97006; Tel: 1-800-920-9327; Fax: 503-614-9100; Web site: <http://www.nuvision3d.com>.

CIRCLE 82 ON FREE INFORMATION CARD

ORGANIZER PLUS RADIO

When *Olivetti Office USA* discovered that people who carry around personal organizers also tend to carry personal radios, they decided to combine the two products. The result is four Royal-brand organizers with built-in FM radios. The *Models DM98nx* and *DM88nx*, as well as the *BG98* and *BG88* ("Brain Gear" versions), each come with a headset and removable belt clip for easy listening at home or on the go.



In addition to radio, the organizers contain business and personal telephone directories, a schedule function complete with alarms, memo memory functions, home/world time, 10-digit

calculator, and secret memory. The *DM98nx* and *BG98* each can store as many as 1000 items, while the *DM88nx* and *BG88* each can store up to 350 items.

The *DM98nx* (pictured) and *BG98* cost \$39.99 each, and the *DM88nx* and *BG88* cost \$29.99 each. For further information, contact Olivetti Office USA, Consumer Product Division, 765 U.S. Highway 202, Bridgewater, NJ 08807-0945; Tel: 908-526-8200; Fax: 908-526-8405.

CIRCLE 83 ON FREE INFORMATION CARD

CLAMP-ON DIGITAL MULTIMETERS

Two low-cost clamp-on digital multimeters from *Wavetek* measure AC current to 600 amps, AC voltage to 600 volts, resistance to 40K ohms, and have a quick continuity check function. The *Models AC60* and *AC65* are identical except that the *AC65* is a true-RMS meter.



Both digital multimeters are small in size, yet packed with technician-preferred features including a 4000-count, easy-to-read LCD; autoranging; long battery life; auto-off; and data-hold button. Their new "hand-guard" design meets international user-safety standards.

The *Models AC60* and *AC65* digital multimeters are list priced at \$99.95 and \$139.95, respectively. For additional information, contact Wavetek Corporation, 9045 Balboa Avenue, San Diego, CA 92123; Tel: 619-279-2200; Fax: 619-565-9558.

CIRCLE 84 ON FREE INFORMATION CARD

WIRELESS A/V SYSTEM

RF-Link Technology's Wavecom™ Sr. (Wireless Audio Video Everywhere *COMMunicator*) allows you to enjoy crisp, interference-free stereo audio and video reception anywhere in your

home or office without having to run wires all over the place. A built-in remote-control extender even allows you to change the channel, adjust the volume, or control your VCR, satellite receiver, CD player, or laserdisc player from any room with the existing remote controls.



Wavecom Sr. transmits the audio and video signal at the reliable 24-GHz frequency, which penetrates walls, doors, ceilings, and floors up to 300 feet away. The system can be used to watch cable or DBS programs on your kitchen TV without a separate hookup, or watch a movie that's playing on the living-room VCR in your bedroom.

The system consists of a small portable transmitter and receiver pair that uses FM rather than AM signals. A proprietary antenna design minimizes interference from unwanted signals and minimizes the inherent problem of multipath. The remote control extender works by converting the remote control infrared signal to a radio frequency wave and then back to infrared at the equipment to be controlled. Quality is said to be comparable to audio and video images achieved through cable transmission.

The *Wavecom Sr.* has a suggested retail price of \$249.95. For more information, contact RF-Link Technology, Inc., 411 Amapola Avenue, Torrance, CA 90501; Tel: 1-888-2RF-LINK; Web site: <http://www.rflinktech.com>.

CIRCLE 85 ON FREE INFORMATION CARD



DIODE GUIDEBOOK

Continued from page 57

leakage increases with temperature and reverse voltage magnitude. If the reverse voltage exceeds the device's rating, avalanche breakdown occurs (as with Zener diodes), damaging the device unless the current is limited to a safe value.

HOME-BREW VOLTAGE REFERENCES.

Now we all should have a good idea of the complete semiconductor diode package. Again, you should realize that you can replace the entire current source we have been using with a single, current limiting resistor. The proper resistor value can easily be selected using Ohm's Law, since we now know an approximate voltage drop for each diode type. Simply subtract the forward voltage (or Zener voltage) from the supply voltage and divide the result by the desired bias current, which should be selected to be in a safe operating range.

As long as you adhere to the specifications in the device's data sheet, the single resistor biasing method works just fine. In reverse biasing a Zener diode, simply allow

enough current to flow through the bias resistor to supply bias for the Zener itself, along with the load current demands. Of course, you can always use a constant-current source similar to the one shown in Fig. 1A for more demanding circuit applications.

Now that we have all of this data, let's put it to some practical use. Refer to the simple circuit shown in Fig. 3, and the data in Table 1 for the following experiments: Table 1 lists the average forward voltage drops at a bias current of 5 mA for some standard T-1 case LEDs, along with silicon and germanium diodes. As stated previously, those diodes all share similar temperature coefficients in the range of -1.5 to $-2\text{mV}/^\circ\text{C}$ at normal (low) currents.

Consider the arrangement of LED3 and D4 shown on Fig. 3, and assume that the current source is supplying equal bias currents of 5 mA to each diode. The input voltage is developed across LED3, which, as a blue unit, is about 2.7 volts. The output voltage is in series with D4 (a 1N4148 silicon diode), which has a forward voltage of about 0.7 volts. Thus, the output voltage is equal to 2.70 volts minus 0.70

PARTS LIST FOR THE DIODE GUIDEBOOK

SEMICONDUCTORS

- Q1—2N3096 general-purpose PNP transistor
- Q2—2N2222 or 2N3094 general-purpose NPN transistor
- LED1—Standard red light-emitting diode
- LED2—Assorted color standard light-emitting diode
- LED3—Assorted color T-1 case light-emitting diode
- D1—1N4148 silicon switching diode
- D2—MBD301 Schottky diode
- D3—1N752A 5.6-volt, 400 mW Zener diode
- D4—1N34A germanium diode

RESISTORS

- R1—1500-ohm, $\frac{1}{4}$ -watt, 5% resistor
- R2—See text
- R3—See text

ADDITIONAL PARTS AND MATERIALS

- C1—0.01- μF ceramic disc capacitor
- B1—9-volt transistor-radio battery
- S1—Single-pole, single-throw switch
- Solderless breadboard, digital multimeter, wire, etc.

volts, or 2.00 volts. Resistor R3 is selected to draw 5 mA at 2 volts. The current source can be set to supply 10 mA by changing R2 to 100 ohms, so that both LED3 and D4 each are supplied with 5 mA of bias current. To get an output voltage exactly equal to 2.000 volts, you can trim R2 to change the input current, or R3 to change the output current. It is not necessary to keep both diode currents equal, or even at the 5 mA level. However, allow at least 1 or 2 mA bias for each diode to keep them above their knee voltages, but stay below their maximum ratings.

The bonus feature in this circuit is that the temperature coefficients also subtract out of the output! That means that if both diodes are operating at similar temperature coefficients (dictated somewhat by their bias-current levels), the resulting output voltage has a very low temperature coefficient. The circuit shown in Fig. 3, using a silicon carbide blue LED and 1N4148 silicon diode exhibited less than $0.1\text{mV}/^\circ\text{C}$ of drift—only 5% of a single diode's temperature

(Continued on page 78)

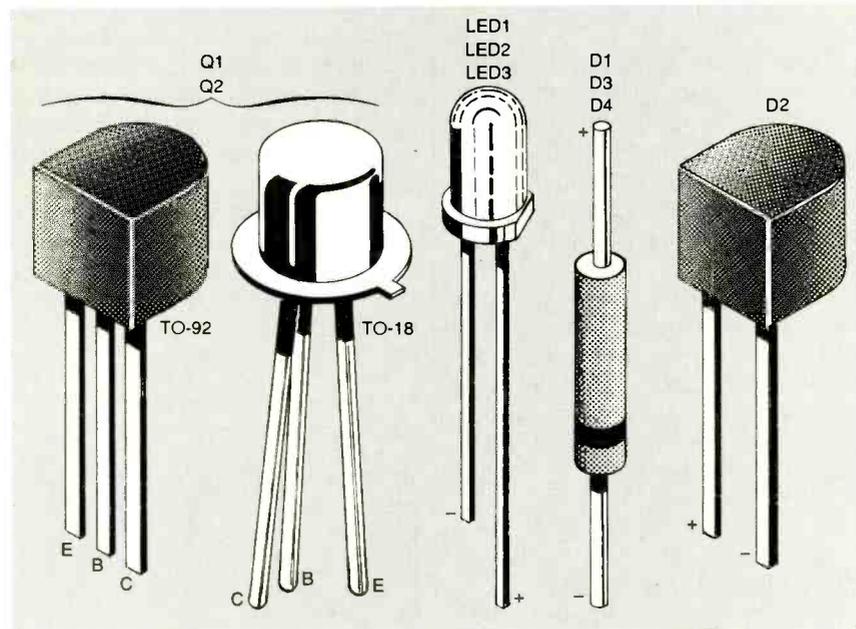


Fig. 4. Diodes and transistors are available in various package outlines. Just a few of the more common ones are shown here. Note that the diode and transistor can be housed in the same package, and are usually easily distinguished from each other by the number of leads.

MULTIMEDIA WATCH

Continued from page 10

levels in the game are completed, more stories are added to the storymobile's shelf. Children can visit Busytown's school, market, farm, campground, or beach, finding new activities as they go along. Pizza rules in Simon & Schuster's interactive game, *Pie Jackers*. This is where pizza deliverers of the future outwit one another in a

race to hungry customers in a pizza-obsessed world.

Mediola's comic-book-inspired adventure game, *Who's Fat Lou?* is intended for older kids, ages 14 to 18. The game takes place in fictional Outta-daway Park, where characters are out to defeat an evil dictator. You're challenged to understand cool urban music and create your own compositions to advance the game. And all along, of course, you're trying to find out Who's Fat Lou? This one sells for \$24.99. ■

WHERE TO GET IT

Activision

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

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<http://www.ssinteractive.com>

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<http://www.toray.com>

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800-446-2001
<http://www.voyagerco.com>

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PROVIEW TV BOX

Continued from page 59

done with the installation at this point. Otherwise you then have to connect the VGA output from your PC to the input on the TV Box using a supplied cable.

If you have a composite video signal you want to display, you can connect that as well. If there's an audio signal that accompanies that video signal, then it connects to the TV Box's line-level input. If you want to feed the audio signal from the TV tuner to your sound card, you simply use the line-level output on the TV Box. You can also use the earphone output, which has remote-controlled volume.

The first time you use the TV Box you'll want to use the remote to have the tuner auto-program all of the received channels. It's a simple matter of adding or deleting channels from memory after that. Then you use the familiar up/down and direct-access channel controls on the remote control or the channel up/down buttons on the front panel to change channels. A mode button on the remote or on the front panel switches the display between PC, TV, and composite inputs.

A function button on the remote scrolls through various on-screen controls including those for color, tint, contrast, and so on. It's also used to activate the optional closed-caption and teletext decoders. Our test unit included the closed-caption decoder, and it worked like a charm. Two modes include one that displays closed-caption text over a black background and an enhanced mode that displays the text directly over the video image. About the only complaint we have about the TV Box is that the built-in speaker doesn't have all that much power, although it's certainly adequate. And you can always connect it to your sound card and amplified speakers. The TV picture produced on a VGA monitor is nice and clear, and sharper than most regular sets.

The Proview Technology's TV Box is a pleasure to own, and easy to afford at \$119. It lets you break away from boring word processing to watch your favorite TV show without getting up. It also puts old, but serviceable monitors to good use. ■

ROBOTICS

Continued from page 43

when you need help finding answers to those problems you can't solve by yourself. Many clubs reserve part of their meeting agenda for instructional presentations by the more experienced members. Thus, club meetings can also be a good place for the beginner to get some semi-formal training.

I have included a list of robotics clubs that I believe are currently active. Some of these have Web pages that you can visit directly; the others have either mail or e-mail addresses to which you can send inquiries.

So there you have it. Armed with the information in this article you should feel better prepared to take on the hobby of amateur robotics.

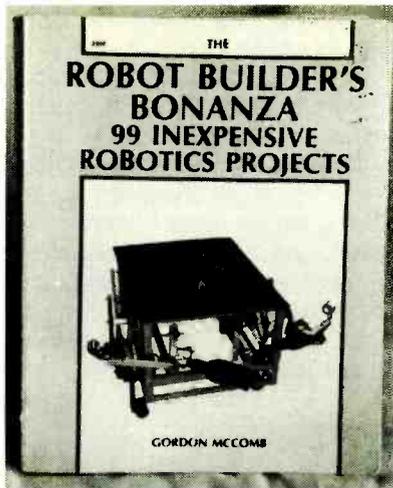


Fig. 4. The Robot Builders Bonanza, taking a modular cookbook approach, offers a mountain of practical, easy-to-follow, and inexpensive robot experiments.

I hope I'll be reading about one of your robot creations in a future issue of **Popular Electronics**. ■

SUGGESTED READING

BOOKS:

Mobile Robots: Inspiration to Implementation

by Joseph L. Jones & Anita M. Flynn
Publisher: A K Peters, Ltd., Wellesley, MA 02181
The robot hobbyist's bible.

The Robot Builder's Bonanza: 99 Inexpensive Robotics Projects

by Gordon McComb
Publisher: Tab Books, Blue Ridge Summit, PA 17294
Geared to the novice and intermediate hobbyist, it contains 99 projects that can be used separately or together as modules for building a robot.

Sensors for Mobile Robots—Theory and Application

by H. R. Everett
Publisher: A K Peters, Ltd., Wellesley, MA 02181
An in depth-review of sensor design and application.

The Art of Electronics

by Paul Horowitz and Winfield Hill
Publisher: Cambridge University Press, New York, NY 10011
The authoritative text and reference of electronic circuit design suitable for those with no electronics background.

Easy Pic'n

by David Benson
Publisher: Square 1 Electronics,

Kelseyville, CA

A beginners guide to using PIC 16/17 microcontrollers.

The Microcontroller Idea Book

by Jan Axelson
Publisher: Lakeview Research, Madison, WI 53704
Circuits, programs & applications using the 8052-BASIC single-chip computer.

Microcomputer Engineering

by Gene H. Miller
Publisher: Prentice Hall, Englewood Cliffs, NJ 07632
Explains the basics of the Motorola 68HC11 microcontroller and has many clear and concise assembly language example programs.

PERIODICALS

Robotics Digest

Whirlwind Publications
966 Elm St.
Rocky Ford, CO 81067
e-mail: 102505.3055@compuserve.com

Nuts and Volts Magazine

430 Princland Court
Corona, CA 91719
e-mail: 74262.3664@compuserve.com

Circuit Cellar Ink—The Computer Applications Journal

PO Box 698
Holmes, PA 19043-9613

SOFT SWITCH

Continued from page 48

Now open S1. The lamp will begin to fade. After some 20 seconds (adjustable by R33), it will extinguish.

Mode 2: Instant On/Slow Off. In this mode, leave S1 open and press S2. That brings the lamp to full brightness immediately. Release S2 and the lamp slowly fades to off. Dimming time can be varied by adjusting R33.

Mode 3: Timer/Dimmer. In mode 3, leave S1 open. Press S2 and the lamp lights to full brightness. Release S2, the lamp remains at full brightness for approximately 10 seconds (adjustable by R34). It then dims and will extinguish in around 10 seconds (adjustable by R33).

Mode 4: Slow On/Slumber Switch. In this mode, closing S1 causes the lamp to go to full brightness in approximately 10 seconds (adjustable by R33). At this point, open S1. The lamp will remain at full brilliance for about 10 seconds (adjustable by R34). The lamp then fades to off in the same time it took to go from off to full brightness.

Whatever operational mode you've chosen, take time to adjust the appropriate potentiometer (R33 and R34) through its full range to determine the minimum and maximum time delays provided by the components installed in your circuit. Then, if desired, you can extend the timing range of the off-time and on-time clocks by increasing the values of capacitors C7 or C8, respectively, guided by the table shown in Fig. 5.

Since the Soft Switch operates from a 117-volt AC power source, it's strongly suggested that you house the circuit in an enclosure. (No enclosure is included with the kit of parts.) The author's unit was housed in a plastic enclosure, which helps to reduce shock hazards. In addition to providing a safe enclosure, "boxing" your project will give you a surface on which to mount the two switches (S1 and S2) and appliance receptacle (SO1). Unfortunately, neither the switches or the receptacle come with the kit. They must be purchased separately. ■

HAM RADIO

Continued from page 58

could figure out her software. Now that she has used Windows software for several years, and is able to intuit the operation of new products from knowledge of the old just like I do, she has returned to her previous opinion of my relative brilliance.

The human factors of a computer screen aid the user (or not) in the use of the product. Garish colors, while on the official Microsoft palette, are rarely the best design. Some type fonts, especially in the smaller sizes, do not show up well on some background colors. Also, not all fonts work well at all sizes. In addition, the "flow" of the data entry should be natural and logical. For example, I've seen Windows ham-radio software in which numerical data are entered into text boxes, and then the <TAB> control pressed to go to the next data entry. The natural thing for people to do is press the <ENTER> key, not the <TAB> key (hint for VB programmers: learn the use of the *KeyPress* and *KeyPreview* events).

ROBUSTNESS

A robust program is one that prevents accidental or incorrect input from the user, and which exits gracefully when an error occurs (does NOT bomb or hang-up the computer). While it is probably impossible to catch all possible user errors, some of them are so common that there is no excuse not to catch them.

For example, when entering numerical data into an input box or text box control on the Windows screen, what happens if the user enters a alphabetic letter or punctuation mark? The proper approach is to either give a warning on-screen, or not let the program progress until a proper numeric, in the right range (if that's appropriate) is entered.

Every now and then some combination of data and/or control events conspire to create an error (the dread General Protection Fault). The program should be designed with enough error handlers to prevent these from causing a serious problem. At worst, the program should terminate and put you back to the Program Manager screen. That would certainly be a welcome change from what seems to be the norm. I've seen one ham-radio database program (which shall remain

nameless) that frequently produces either GPFs or simply locks up the screen so that neither the mouse nor the keyboard are effective.

One idea for checking DOS-based programs is to look at the files' dates. If the dates are several years old, you could be wasting your time. Stick with the new stuff—be modern.

NEW HAM PRODUCT

The photograph on page 58 (first page of this column) shows a new antenna tuner from MFJ Enterprises (P.O. Box 494, Mississippi State, MS 39762; 601-323-5869 (voice), 601-323-6551 (Fax), orders on 1-800-647-1800, or at the Web site at <http://mfjenterprises.com>). The MFJ-969 operates from 160-meters up to 6-meters, and is rated at 300-watts. It is perfectly suited to those who need a tuner for a lower power rig, and don't want to mess with the big *honkin'* models that are suited for megablastrer 2-kW stations.

One interesting feature of the MFJ-969 is that it uses a roller inductor, which is rare on low-power, low-cost instruments. Most similar instruments use a switched inductor, so are inherently limited as to the impedances that can be matched.

Two other interesting features are the *Self-Resonance Killer™* and the *QRM-Free PreTune™*. The resonance killer prevents destructive self-resonances from appearing near the operating frequency, and thus renders them less potentially destructive.

The pre-tune feature not only makes good sense, it allows you to operate more legally. It permits off-the-air testing and tune-up, preventing you from QRMing your band neighbors. The pre-tune feature dumps the RF into an internal shielded dummy load until you have roughed in the adjustments. It's rude to do otherwise.

If you don't presently use an antenna tuner, then you ought to consider it, especially on the high-frequency bands. These neat little instruments make the transmitter/antenna system more effective, and allow you to use forms of antennas that otherwise are not possible (especially with SWR-sensitive modern solid-state final amplifiers!).

CONNECTIONS....

I can be reached by snail mail at P.O. Box 1099, Falls Church, VA, 22041, or by e-mail at carrij@aol.com ■

LETTERS

Continued from page 6

HAVES & NEEDS

I would appreciate it if you could publish the following request. I am looking for alignment procedures for the following hand-held transceivers: IC-215, IC-2GAT, and IC-O2AT.

Of course I would reimburse for expenses and can be contacted at my email address.

Mike Smialowski Smithers
BC, Canada
mikesmi@mail.netshop.net

After seeing the excellent results other readers have gotten from their letters to **Popular Electronics'** "Haves & Needs," I decided to submit my own request.

I need a velocity-type vibration pick-up, Model MU6-7 Pn B 11032-1 or MB-11, with an output of 96 mV/in/sec, or similar. Crystal pick-ups will not work. Thank you for any help.

A.F. SCHWEDLER
R.D. 7, Box 7350
Stroudsburg, PA 18360

I would like to ask my fellow **Popular Electronics** readers for their help. I need a copy of the owner's manual for an Olympus HVS camcorder, Model VX-402-U. I will gladly pay all costs. Thank you.

JOHN MROZKO
72 Fonda Road
Cohoes, NY 12047-4805 ■



"American Embassy? How do I ask for new batteries for my electronic language translator?"

LED OSCILLOSCOPE

Continued from page 40

in the finished product. Thus, their use in oscilloscopes is not surprising. What is surprising, however, is that only in recent years has there been

pragmatic employment. The scope lends itself easily to modification, such as bar/dot mode selection on both channels, separate horizontal sweep control for each channel, or full wave depiction, with both the positive and negative sides visible. The LED Oscilloscope is very capa-

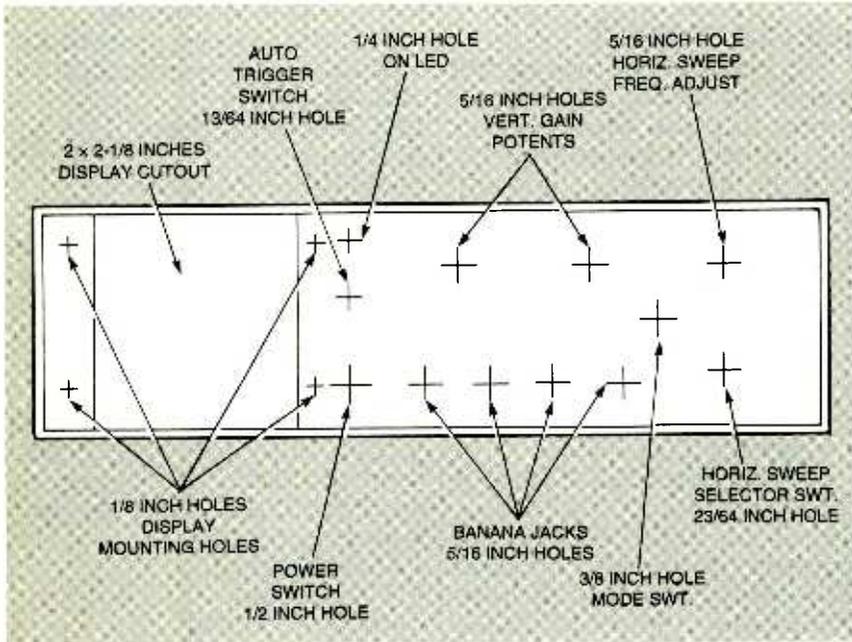
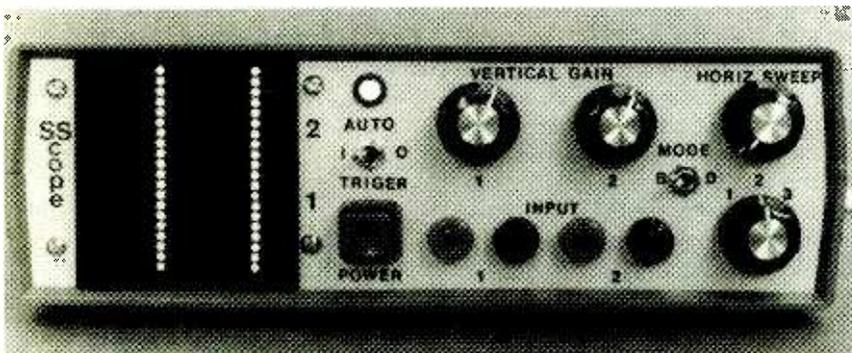


Fig. 6. The author's unit was housed in a standard bench-style instrument case, measuring 2-1/2 inches high, 8-1/2 inches wide, and 6 inches deep. If you choose a similar enclosure for your unit, the template shown here can be used to help layout your front panel. After making the appropriate alterations to the front panel, it can be painted and labeled with dry transfer lettering, and then given a final spray coat of clear plastic to protect the labels.



Shown here is the author's prototype unit. The front panel holds all the off-board components—the vertical gain and horizontal sweep potentiometers, as well as the input jacks, home-brewed 20x20 LED matrix display, and sweep frequency selector and power switches—except the fuse.

a trend towards their application in this type of equipment. I trust this will change as their potential is further realized.

In the meantime, enjoy building, and working with this unit, as it can provide hours of fascinating, and

able of performing many of the tasks of a conventional CRT scope. The project also explores technology that is rapidly becoming a standard, and a comprehension of this field will be valuable in future endeavors.

DIODE GUIDEBOOK

Continued from page 74

coefficient! Many similar low temperature coefficient reference circuits can be assembled using Table 1 as a guide. Select any two combinations—LED/diode; LED/LED; or diode/diode—to approximate the desired output voltage. Assemble the circuit in Fig. 3 on your breadboard for fine tuning. Once again, a resistor can be used in place of the current source as slight changes in bias current due to temperature variations have little effect on LED3's forward voltage. Metal film resistors are the best choice for this type of circuit.

Very low millivolt references can be assembled in the same manner by just selecting two 1N4148 diodes that have slightly different forward voltages.

Another temperature compensation scheme was shown way back in Fig. 1A: LED1 compensates for Q1's base-emitter forward voltage. Thus, the temperature coefficient of the voltage across R2 is quite low, aiding in maintaining a constant current output from our current source. Diodes and transistors are available in various package outlines. Just a few of the more common package styles are shown in Fig. 4.

Note that the diode and transistor can be housed in the same package, and are usually easily distinguished from each other by the number of leads.

SUMMARY. As you have seen in our diode mini-course, the semiconductor diode can be a quite versatile tool in design work. When properly biased, diode circuits provide practical and simple solutions to many electronic design problems.

We have only scratched the surface here; there are many other applications for diodes, and many other types of diodes that were not even mentioned here. So, what are you waiting for? Get out that breadboard and start designing your next project!

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Telephone Call Restrictor

Connects to telephone wall jack. Disables all phones on the line if attempting to either: dial a number that has been stored in memory "Block" mode or, dial a number that has not been stored in memory "Allow" mode. Use touch-tone phone to enter telephone numbers into memory, and choose mode. Program from any phone on the line using your password. **\$35.00**

50 MHz Frequency Counter

Reads frequency from 1Hz to 50MHz and displays up to 7 digits on a 16x1 character LCD display. Auto-range feature provides floating decimal point and automatic placement of suffix (Hz, KHz, or MHz). Microcontroller based provides for very small parts count, only 2" x 3" big. **\$48.50**

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IR Remote Control Receiver

Learns and records the data patterns emitted by standard infrared remote controls used by TVs, VCRs, Stereos, etc. Lets you control all your electronic projects with your TV remote. Seven individual I/O pins can be assigned to any button on your remote, and can be configured for either "toggle" or "momentary" action. **\$32.00**

RS-232 Digital I/O

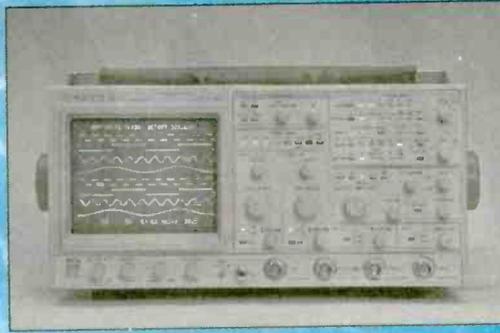
Give your home-brewed PC/Mac programs a link to the outside world! 12 I/O pins can be configured individually for input or output. Turn on/off relays, tracs, etc. Respond to button presses, switch changes, 4x4 matrix decoding with auto-debounce. Stack up to 16 units on the same serial port for a total of 192 I/O points. **\$32.00**

DTMF Decoder/Logger

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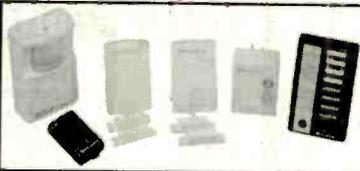


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Specifications: 10" dual voice coil treated paper cone woofer with poly foam surround ♦ Frequency response: 30-100 Hz ♦ Nominal Impedance: 8 ohms per coil ♦ Power handling: 100 watts RMS channel/140 watts max ♦ SPL: 89 dB 1W/1m ♦ Dimensions: 27" D x 14-5/8" W x 9" H ♦ Net weight: 29 lbs.

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\$139⁹⁵

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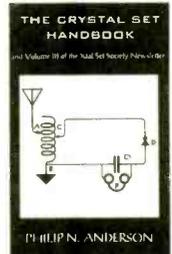
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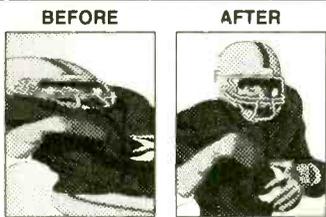


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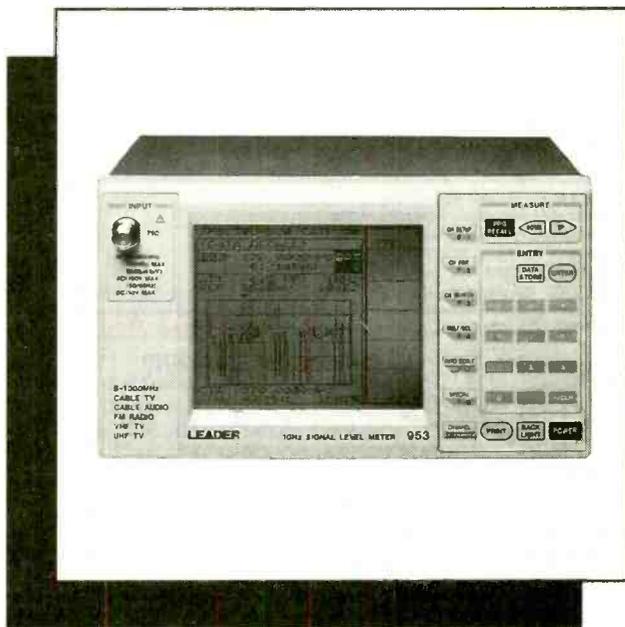
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 Range: Resolution: Accuracy:
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 2000µA 1µA ±(1.2%rdg+2dgts)
 20mA 10µA
 200mA 100µA
 10A 10mA ±(1.2%rdg+2dgts)
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 Range: Resolution: Accuracy:
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GS114	114mm x 165mm/4.6" x 6.6"	4.80	3.49	3.20
GS152	150mm x 250mm/5.91" x 9.84"	8.69	5.98	5.78
GS153	150mm x 300mm/5.91" x 11.81"	10.20	7.20	6.80
GS1212	305mm x 305mm/12" x 12" NEW!	18.88	15.73	12.59

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



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

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



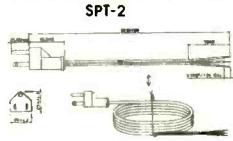
Etching Tank This handy etching system will handle PC boards up to 8" x 9", two at a time. Ideal for etching your PCB's! System includes an air pump for etchant agitation, a thermostatically controlled heater for keeping etchant at optimum temperature and a tank that holds 1.35 gallons of etchant. A tight fitting lid is also supplied to prevent evaporation when system is not being used. Typical etching time is reduced to 4 minutes on 1oz. copper board!

REDUCES ETCHING TIME!

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

AC Power Cords

Our power supply cords are economical and practical for OEM and replacement applications. We stock 6' lengths, with the open end conveniently stripped and tinned (5mm).



CAT NO	SIZE	TYPE	RATING @ 125V (A)	LENGTH (ft)	COLOR	TEMP
SPT-1BLACK	18/2	SPT-1	10	6	Black	60°
SPT-1GRAY	18/2	SPT-1	10	6	Gray	60°
SPT-2BLACK	18/3	SPT-2	10	6	Black	60°

CAT NO	PRICE EACH			
	1	10	100	500
SPT-1BLACK	\$.88	\$.57	\$.51	\$.46
SPT-1GRAY	.92	.61	.55	.49
SPT-2BLACK	1.97	1.21	1.07	.97

June 1997, Popular Electronics

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Digital Panel Meters (LCD & LED)

Don't let the prices fool you. These digital panel meters are not surplus, so even if you design them into an ongoing manufactured product, you can be assured of continued availability. These high quality digital panel meters are decimal point selectable with guaranteed zero reading at zero volts input.



3-1/2 Digit LCD 3-1/2 Digit LED 4-1/2 Digit LCD

PM-328: 4-1/2 Digit LCD Digital Panel Meter

Features

- 200.00mV Full Scale Input Sensitivity
- Single 9V DC Operation
- Decimal Point Selectable
- 11mm LCD Figure Height
- Automatic Polarity Indication
- Low Battery Detection and Indication
- High Input Impedance (>100 Mohm)

Applications Include:

- Voltmeter
- Thermometer
- pH Meter
- dB Meter
- Watt Meter
- Current Meter
- Capacitance Meter
- LUX Meter
- LCR Meter
- Other Industrial & Domestic Uses

PM-128: 3-1/2 Digit LCD Digital Panel Meter

PM-129: 3-1/2 Digit LED Digital Panel Meter

Features

- 200mV Full Scale Input Sensitivity
- PM-128 - Single 9VDC Operation
- PM-129 - Single 9VDC Operation
- Decimal Point Selectable
- PM-128 - 13mm Figure Height
- Automatic Polarity Indication
- Guaranteed Zero Reading for 0 Volt Input
- High Input Impedance (>100Mohm)

Specifications - PM-128/PM-129

Maximum Input : 199.9mV DC
 Maximum Display : 1999 counts (3-1/2 Digits)
 w/Automatic Polarity Indication
 Indication Method : PM-128 - LCD Display
 PM-129 - LED Display
 Measuring Method : Dual-Slope Integration
 A/D Converter System
 Overrange Indication : '1' Shown in the Display
 Reading Rate Time : 2-3 Readings per sec.
 Input Impedance : >100 Mohm
 Accuracy : +0.5% (23+-5°C, <80% RH)
 Power Dissipation : PM-128 - 1mA DC
 PM-129 - 60mA DC
 Decimal Point : Selectable w/Wire Jumper
 Supply Voltage : PM-128 - 9V DC
 PM-129 - 9V DC
 Size : 67mm x 44mm

Specifications - PM-328

Maximum Input : 199.9mV DC
 Maximum Display : 19999 counts (4-1/2 Digits)
 w/Automatic Polarity Indication
 Indication Method : LCD Display
 Overrange Indication : '1' Shown in the Display
 Input Impedance : >100 Mohm
 Accuracy : +0.05% (23+-5°C, <80% RH)
 Power Dissipation : 1mA DC
 Decimal Point : Selectable w/Wire Jumper
 Supply Voltage : 9V DC
 Size : 67mm x 44mm

AS LOW AS \$5.25 ea.

CAT NO	DESCRIPTION	PRICE EACH				
		1	10	25	100	250
PM-128	3-1/2 Digit LCD Panel Meter	\$ 9.90	\$ 7.09	\$ 6.40	\$ 5.86	\$ 5.25
PM-129	3-1/2 Digit LED Panel Meter	11.49	9.54	8.67	7.95	6.95
PM-328	4-1/2 Digit LCD Panel Meter	19.88	16.40	14.90	13.66	11.93



Ball Bearing 12V DC Fans

These High Quality Fans feature Ball Bearings and Brushless DC Motors. All of them are designed to meet UL, CSA & VDE Standards. Design these fans into power supplies, computers or other equipment requiring additional air flows for heat removal. These fans are regular Circuit Specialists stock items — they are not surplus.

INDUSTRY BEST PRICING!

CAT NO	PRICE EACH			
	1	10	25	100
CSD 4010-12	\$ 9.88	\$ 6.38	\$5.48	\$4.87
CSD 6025-12	9.38	5.91	5.41	4.71
CSD 8025-12	8.88	5.85	5.19	4.49
CSD 9225-12	8.95	6.14	5.29	4.59
CSD 1225-12	11.45	8.96	7.82	6.85

Specifications

CAT NO	DIMENSIONS (MM)	RATED VOLTAGE (V)	START VOLTAGE (V)	INPUT CURRENT (A)	AIR FLOW (CFM)	STATIC PRESSURE (INCH-H ₂ O)	SPEED (RPM)	NOISE LEVEL (dB)	WEIGHT (g)
CSD 4010-12	40x40x10mm	12	7	0.06	5.1	0.19	5,500	26	20
CSD 6025-12	60x60x25mm	12	5	0.13	13.7	0.165	4,500	28	65
CSD 8025-12	80x80x25mm	12	5	0.16	37.8	0.177	3,000	31	80
CSD 9225-12	92x92x25mm	12	5	0.32	42	0.18	2,800	37	95
CSD 1225-12	120x120x25mm	12	5	0.35	62	0.180	2,500	42	135

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We stock high quality 60/40(Sn%/Pb%), .031" and 63/37, .031" diameter. This is prime JIS certified solder that we maintain as a regular stock item (It is not "Left-overs, Rejects or Surplus") and you can buy it from us at a fraction of the price that you are used to.



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CAT NO	DESCRIPTION	PRICE EACH		
		1	10	25
RH60-1	1-lb. Spool, .031", 60/40	\$ 6.90	\$ 5.96	\$ 5.30
RH63-1	1-lb. Spool, .031", 63/37	6.95	6.10	5.41
RH60-4	4.4-lb. Spool, .031", 60/40	24.00	21.90	17.92
RH60-TUBE	6-oz. Tube, .031", 60/40	.99	.89	.79

CAT NO	DESCRIPTION	PRICE EACH	
		1	5
CA-H34A	PCB Mounted IRCCD Camera	\$99.00	\$85.00
A34	Power Supply Regulating Kit	\$6.95	-----

CCD Camera - IR Responsive

As Low As \$85!!

This black and white monochrome CCD Camera is totally contained on a PCB (70mm x 46mm). The lens is the tallest component on the board (27mm high from the back of the PCB) and it works with light as low as 0.1 lux. It is IR Responsive for use in total darkness. It comes with six IR LED's on board. It connects to any standard monitor, AUX or video input on a VCR or through a video modulator to a TV. Works with a REGULATED 12V power supply (11V-13V). Hooks up by connecting three wires: red to 12V, black to ground (power & video) and brown to video signal output.



Power Supply Regulating Kit for CA-H34

This simple kit is designed to fit onto the back of the CA-H34 CCD camera. It resolves the problem of hooking up the camera to an UNREGULATED supply (which damages the camera) by providing safe regulated power from any 12V-14V DC supply. It also provides regulated 12V DC from a 12V AC source.

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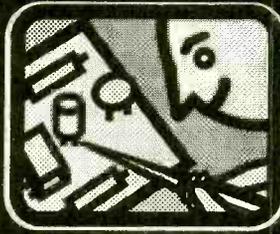
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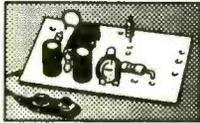
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AP-1

KIT \$9.95

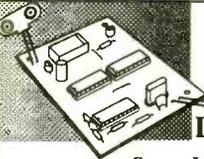
Read the code from any INFRARED Device



- Complete with Software for any 80386 or 80486 base machine, operating on DOS 3.3 or higher.
- Sampled data can be saved to disk for instant comparison & analysis.
- Zoom in on and view any 8 millisecond portion.

TIR-1

KIT \$89.95



Sweet 16

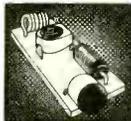
TONE DECODER

Sweet 16 tone decoder operates great over phone lines, radios or scanners.

- 16 TTL Level Outputs
- DTMF Decoder Decodes 16 different touch tones using the phone, radios, or scanners.
- One relay & driver circuit on board.
- 9v battery powered. Size: 2 3/4" x 2 1/8"

TT-16

KIT \$34.95



MICRO-MINIATURE WIRELESS MIKE

So small you could hide this one on some real bugs! It's the smallest we've ever seen. With it's super sensi-

tive mike it transmits a whisper or a room of conversation to an FM radio, tunable from 88 to 108MHz FM. With a proper antenna it transmits about 1/2 mile. The kit is made with surface mounted parts, we have already mounted these parts. You install the leaded parts. Power requirement 6 to 12v DC. Size .35"x.9"

MMWMS

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TV NOTCH FILTERS FOR CHANNELS 2 thru 22 ONLY



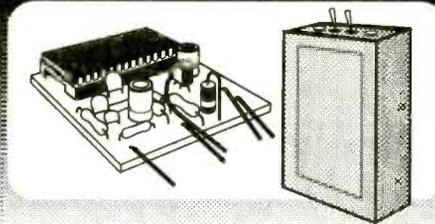
Our TV filters eliminate unwanted TV channels or interference that alters both sound and video with a beep beep beep. Works on cable channels (2 thru 22) only.

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

AUTO CALL ID'ER



Send your call sign or call CQ automatically with the push of a button. Change your message as often as you like.

The AUTO CALL enables you to electronically store a 20 second message of your choice.

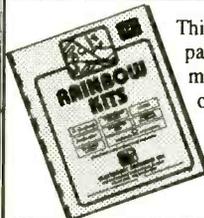
- (Your call sign or call CQ, for instance) and send it with the push of a button. Change your message as often as you like.
- Your message is stored in on board non-volatile memory calls, providing zero-power data storage. This is a high-quality voice recording and playback unit.

RX-1

KIT \$49.95

RX-1C SIZE: 1"H x 2.4"W x 3.8"D

CABINET \$12.95



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- Temperature inside car / outside car
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LCD-T1
LCD-T1C

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ST-1

KIT \$11.95



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. Power requirement 6 to 12v DC. SIZE: 1.75" x 1"

AA-1

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PHONE TRANSMITTER

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: 1.25" x .6"

TEL-B1

KIT \$12.95



WIRELESS FM MICROPHONE

Small but mighty this little jewel will out perform most units many times its price. It really stomps out a signal. The WM-2 kit is a buffered wireless mike

that operates from 80MHz to 120MHz FM, the frequency of any broadcast FM radio. Includes a mini-electret mike. 6 to 12v DC. SIZE: 1.25" x 1"

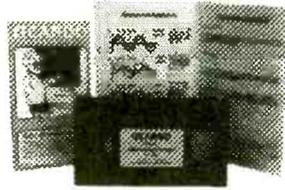
WM-2

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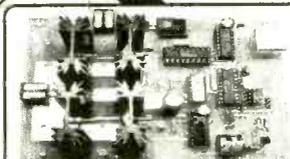


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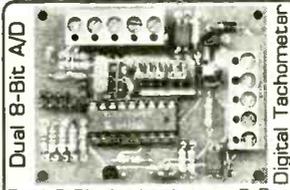
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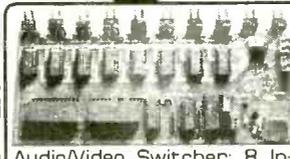
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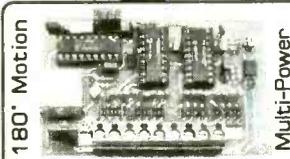
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Infrared Transceiver for Remote RS-232 Communication with 16 IR Controllable Devices. IRT8 Kit \$24 Asm \$39 RSB Serial Booster Gives your RS-232 Port the Power It Needs to Drive 16 NCD Devices. RSB Kit \$12 Asm \$24

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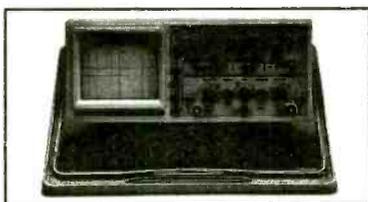
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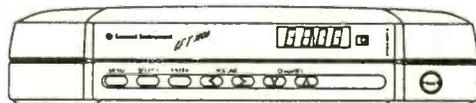
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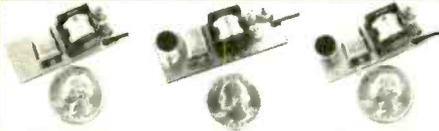
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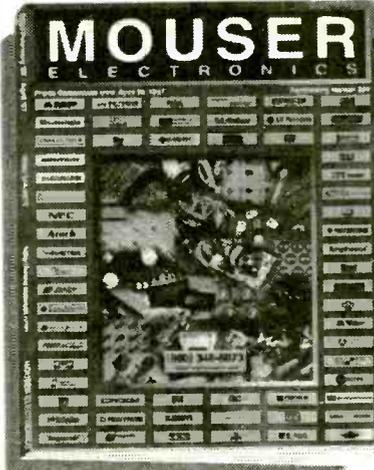
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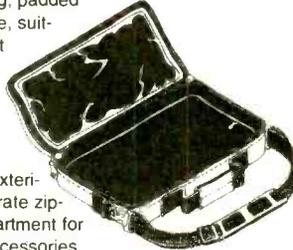
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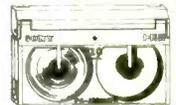
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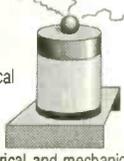
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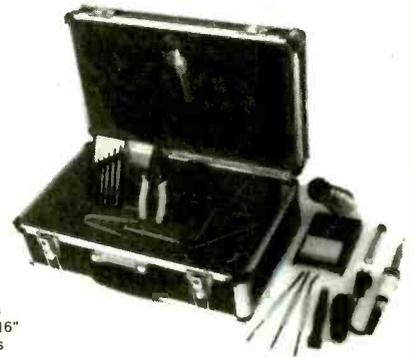
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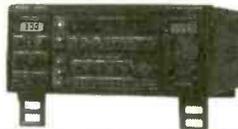
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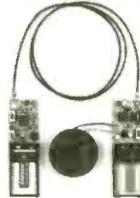
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ANALOG		Sensitivity (max)	No. of Channels	Sweep Rate Max ns/div	Delayed Sweep	Video Sync	Component Tester	Beam Find	Time Base
Model	Bandwidth MHz								
S-1360	60	1mV/div	2	10ns/div	Yes	Yes	Yes	Yes	2
S-1345	40	1mV/div	2	10ns/div	Yes	Yes	Yes	Yes	2
S-1340	40	1mV/div	2	10ns/div	No	Yes	No	No	1
S-1330	25	1mV/div	2	10ns/div	Yes	Yes	Yes	Yes	2
S-1325	25	1mV/div	2	10ns/div	No	Yes	No	No	1
DIGITAL STORAGE		Analog Sen (max)	No. of Channels	Sampling Rate	Memory Channel	Internally Backed Up	Pretrigger %	Output	
Model	Bandwidth MHz								
DS-303	30	1mV/div	2	20MS/S	2K	Yes	0, 25, 50, 75	RS232	
DS-603	60	1mV/div	2	20MS/S	2K	Yes	0, 25, 50, 75	RS232	

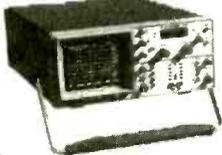
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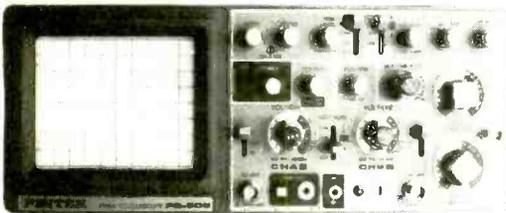
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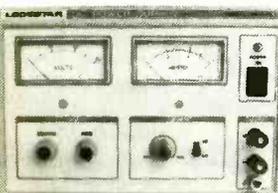
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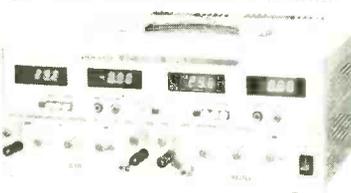


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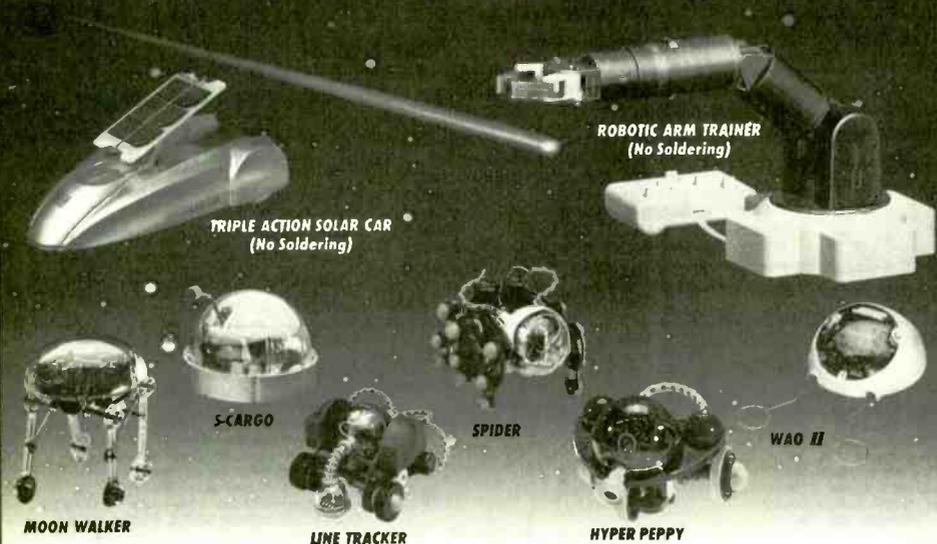


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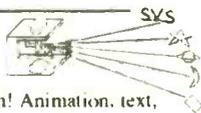


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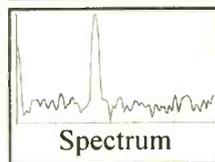
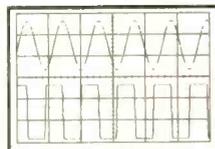
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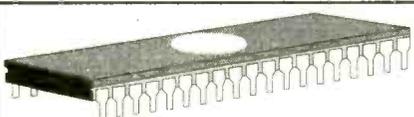
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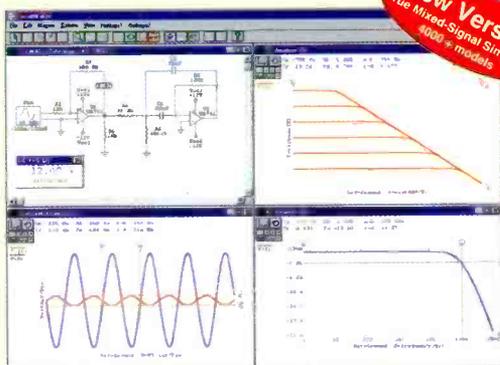
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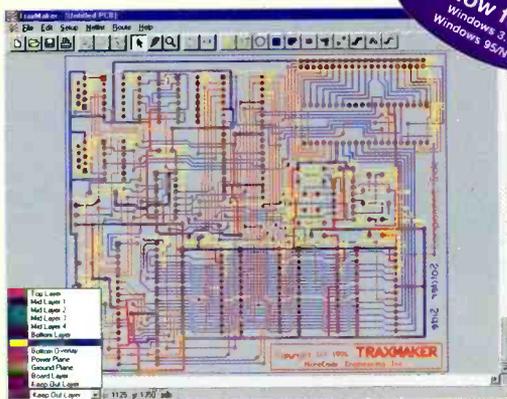
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