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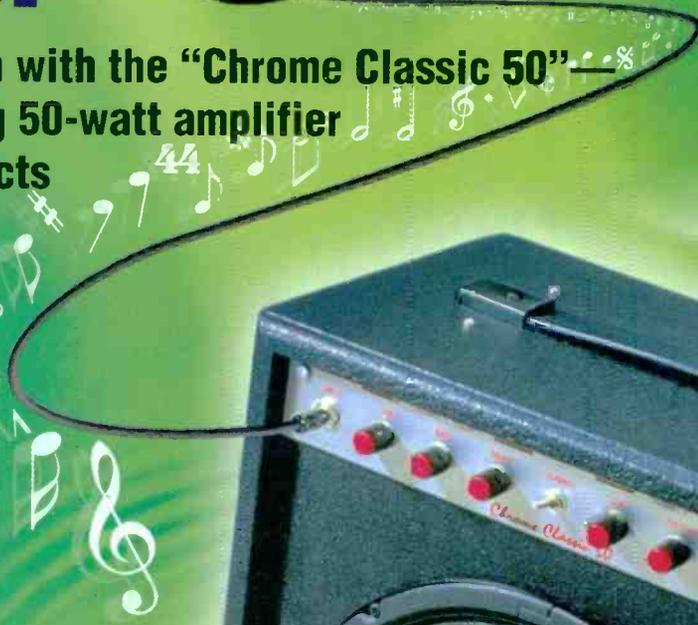
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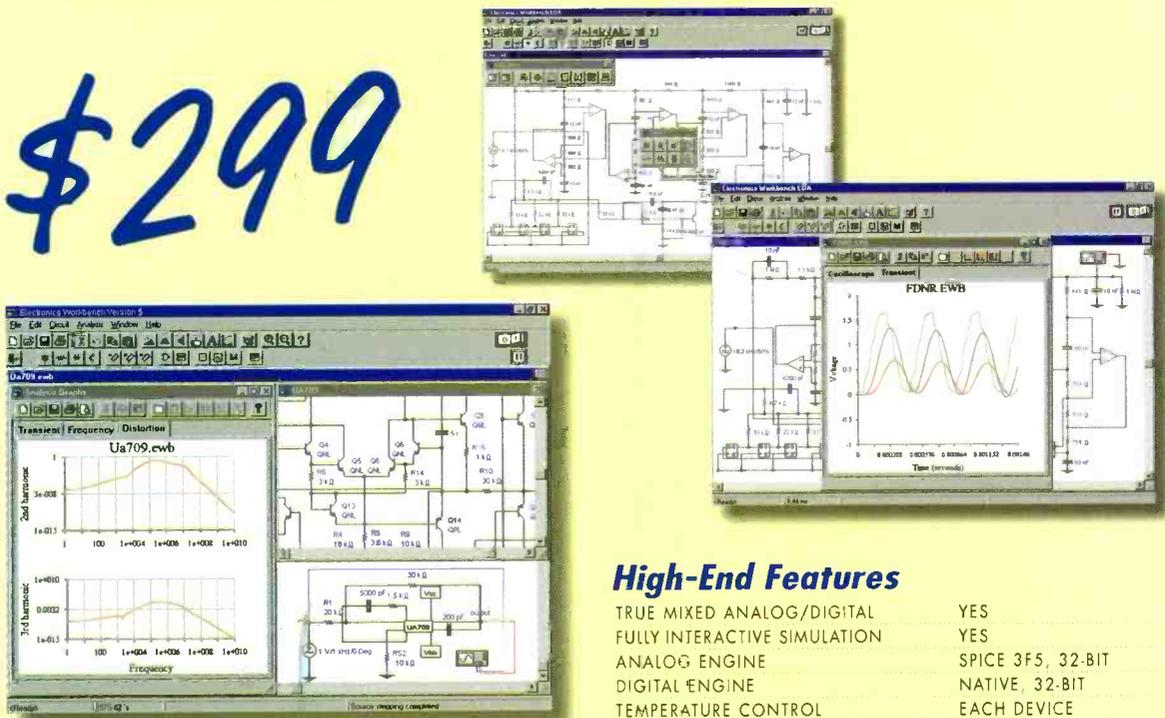
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COVER STORY

33 Guitar Amplifier

Build the "Chrome Classic 50," which features a 50-watt amplifier, "clean" and "crunch" channels, adjustable tone and distortion controls, and a 10-inch, aluminum-cone speaker, for under 200 bucks!—*Rodrick Seely*

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49 Build The Mobile Phone Annunciator

Prevent those unpleasant conversations with your neighbors by giving your car phone a more pleasant way to announce that you have an incoming call—*Curt Jenó*

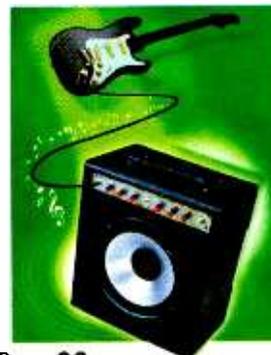
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Learn how analog optical coupling is accomplished by building your own optocoupler devices, and by conducting experiments with them. Perhaps, incorporate one or two of these useful little gadgets into your next project—*Dennis Eichenberg*

51 Monitor Clean-Up

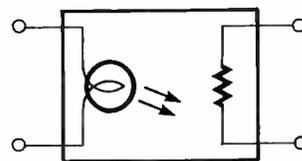
Extend the usability and life of your computer monitor, while maintaining its like-new appearance with these easy-to-follow instructions and a little elbow grease—*Marty Knight*



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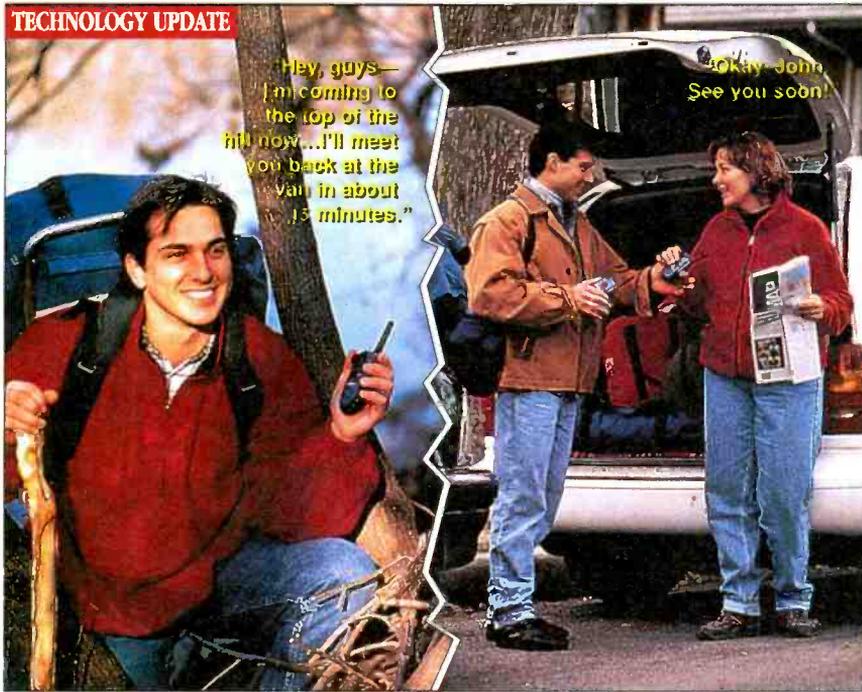
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TECHNOLOGY UPDATE



Hey, guys—
I'm coming to
the top of the
hill now...I'll meet
you back at the
van in about
15 minutes."

Okay, John.
See you soon!

Reach out and touch some- one...without wires or fees!

Motorola integrates microchip technology into a palm-sized two-way radio to create the ultimate communication device.

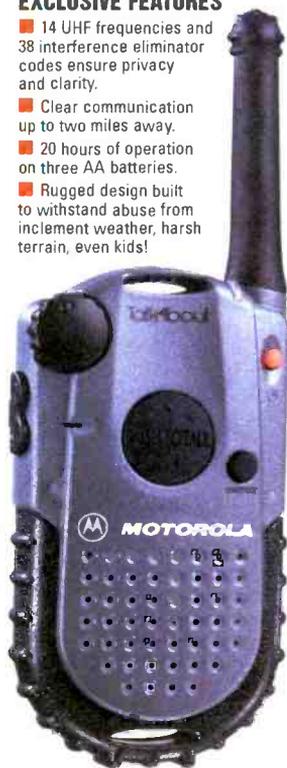
by Erin Kahn

Picture this...you're on a camping trip with your family. It's getting dark, and the kids haven't returned from "exploring." It's your first time at this particular campground, and your imagination is running wild as you wonder why they have been gone an hour longer than promised. What do you do? Alert the Park Rangers? Split up and try to find your children? No...you simply turn on your Motorola Sport Radio, push a button and tell the kids to return to camp and get to bed. These radios are the ultimate in personal communication, with literally hundreds of uses, both practical and fun.

Two-way the right way. Hand-held personal communication devices have been around for a long time. Unfortunately, the technology had not advanced to the point that they could be made small, powerful and affordable. Some models looked like they belonged in an old war movie and were roughly the size of a shoe box. Others were smaller,

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but even with long, clumsy antennas, they had poor sound quality, inadequate static reduction and an extremely limited operating range. Most affordable models were constructed of brittle plastic and fake chrome. They were sold in pairs, so once you dropped one or broke its antenna, the other one was useless. The only way to get clarity, power and durability in personal communication was to use expensive cellular phones, with sky-high usage fees and limited coverage in rural areas. This has all changed due to a recent ruling by the Federal Communications Commission and technological advances in radio design.

Crystal-clear and convenient. The FCC has designated a new band of radio frequencies specifically for family use, with no licensing fees or usage charges. Motorola, the world's leader in wireless two-way communication, has integrated the latest electronic technology into a product that operates on these Family Radio Service (FRS) bands. The radio can be tuned to any one of 14 UHF frequencies

and 38 interference eliminator codes, so you can pick any channel you want, without experiencing the annoying interference that you get from CB radios. Unlike cellular phones, these radios are not subject to air-time charges or limited satellite coverage areas, and you can reach the other party with the push of a button. The powerful circuitry and unique antenna design enable crystal-clear reception for a two-mile range. Because you get to pick the transmission channel, as many friends and family members as you like can stay connected. The only limit is the number of radios you have!

Compact and durable. The Sport Radios are designed to operate anytime, anywhere—from comfortable family outings to the most extreme sporting activities. Whether you are camping, skiing, biking or simply shopping or attending a concert, clip a Sport Radio to your belt and you'll never be out of touch. The lightweight yet rugged casing has undergone extensive testing and stands up to anything you, the environment or even your kids can dish out. The controls have been engineered for the ultimate in functionality and ease-of-use, and the unit will operate for up to 20 hours on three AA batteries. Never before has a communication device featured this degree of clarity, power, portability and range...and it fits in the palm of your hand.



Wireless freedom and safety.

Once you have tried this remarkable product, you'll wonder how you ever lived without one. You'll be amazed as you discover all the ways the Sport Radio can enhance your lifestyle. With the power to communicate without wires or monthly usage fees, you can make many of your activities easier, safer and more enjoyable than ever.

Use the Sport Radio to communicate between:

- cars on a road trip
- boats on a lake
- different seats at a ball game
- the kitchen and the playground

The only limit is your imagination!

Risk-free. The technological advances that led to these radios occurred only recently, so this product might not yet be available in stores. The Motorola Sport Radios come with our exclusive risk-free home trial. If you're not fully satisfied, return your purchase within 90 days for a "No Questions Asked" refund. They are also backed by a one-year manufacturer's limited warranty.

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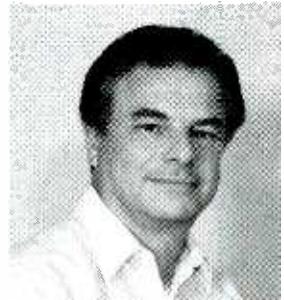
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EDITORIAL

It's That Time of Year

This issue of **Popular Electronics** should get to you well in advance of the holiday season. We hope that its contents will help you through this busy time of year. To keep your soldering irons cooking, this edition features building the Guitar Amplifier. This construction is a first-class project to work on over the holidays and have ready to play at your favorite party. Then our Gizmo Department presents its annual Holiday Gift Guide, which should help you find just the right electronic gifts for your loved ones. And don't forget our Net Watch and New Products departments for your shopping suggestions.



With the approach of a New Year, I always get a little nostalgic. I recently went into the **Popular Electronics** archives and picked up a copy of the very first issue of our magazine. The date was October 1954, and the editor was Oliver Read, W1ETI. After looking over the magazine's contents and getting a chuckle on reviewing the old advertisements, I read Oliver's editorial and felt I would like to share just a part of it with today's readers:

*"Circuitry has become more complicated through the years. Television and industrial electronics, telemetering and computing, and now color TV have necessitated a higher level of approach for technical magazines. This, unfortunately, has deprived thousands of people interested in electronics of a regular source of information written in simple understandable terms. **Popular Electronics** is the answer to the demand for a monthly publication devoted entirely to electronics at a practical and hobby level."*

***Popular Electronics** is, as its title implies, devoted to the science of electronics at How-It-Works, Why-It-Works, How-To-Do-It and How-To-Use-It level."*

That was our goal over 43 years ago, and that is still our intent now and in the future. Perhaps we will set up a little nostalgia column and review these back **Popular Electronics** issues on a "then and now" basis—would you like that?

On behalf of the staff here at Gernsback Publications, I would like to wish you and your family a joyous holiday season and a very happy and healthy New Year.

Ed Whitman
Managing Editor

LETTERS

SORRY, WRONG NUMBER

In the article "The PC Parallel Port Relay" (*Popular Electronics*, September 1997), the incorrect telephone number for the kit supplier Marlin P. Jones was given in the Parts List. You can reach them at 800-652-6733 for ordering, 561-848-8236 for tech information, or visit their Web site: www.mpja.com.—Editor

DTMF WIRE TRACER CORRECTION

I noticed a small misprint in the article "DTMF Wire Tracer" in the July issue. The parts placement diagram on page 41 has Q2 where Q3 should be and Q3 where Q2 should be. I think this is an interesting project, and I hope that you will continue to publish more projects like this one. Plans for a wireless DTMF transmitter encoder/receiver decoder system with relay switching for all 16 possible DTMF tones would be nice for control purposes.

M.K.

LaPorte, IN

Thanks for spotting this error. Those units were mislabeled in the parts placement diagram, and if switched this way would cause the unit to fail. The schematic on page 38 is correct. We appreciate your suggestions for future articles.—Editor

COMMODORE 64 REVISITED

I just read the request in *Haves & Needs* in the Letters column (*Popular Electronics*, September 1997) for information on the Commodore 64. Old computers, like the CBM line, are still alive and functioning. I can't speak for all such 1980s' machines, but the Commodore line has a loyal following, and I try to support them as much as possible with information and WWW resources. I still see a lot of C64 and 128 machines in use by folks who design creative things around them, or use them simply because they are cheap and easily replaceable. I know many hobbyists use old machines like the 64 and VIC-20 for projects ranging from low-cost controllers to ham radio machines.

I have in front of me a 16 MB 20 MHz Commodore 64 with a huge SCSI hard drive, a 56 kbps modem, 1.44 MB floppy (IBM compatible), 230 kbps serial port, 6-voice sound card, and 3-button mouse. I am eagerly awaiting the delivery of an additional 16 MB of RAM with daughtercard to bring my machine up to 16 MB of "fast" (20 MHz) RAM and 16 MB of "slow" (1 MHz) RAM. It never ceases to amaze me that people cannot believe that a 1982 machine could be so equipped.

In any case, I thought your readers might want to know that 1980s' machines are still supported and can be purchased rather cheaply. In addition, the Internet is turning into a huge "User group" for owners who thought they were alone.

Some Commodore sources on the Web are: www.jbrain.com/cswap/ (a classified ad system), www.jbrain.com/caboom (a Commodore meta-index system), and www.jbrain.com/vicug (Commodore user's group).

J.B.

via e-mail

You're right on! Speaking of 1980s' computers, at home I have my venerable Apple IIe used for packet radio in my ham station, while my trusty Apple IIgs runs many of my file management and database programs with the AppleWorks utility. Of course most of the world revolves around PCs and Windows-based programs—however, there is a vast audience of people out there who use the 1980s' machines for personal uses.—Editor

QUAD-PACKAGE JFET DEVICES

In the September Think Tank column, in the discussion of operation of the "Four Channel Audio Mixer" circuit, a question arose concerning possible substitutes for the LF353 dual JFET, but in a quad package.

There are actually several good quad op-amps for audio available. The oldest is the Texas Instrument TL074. The problem with the FET input TL074, and the LF353, is the propensity for latch-up and/or input inversion when the input signal exceeds the power

supply rails. For this reason it is a good idea to clamp the inputs to the power supply rails with 1N4148 diodes.

The newer quad devices can withstand input peaks greater than their supply voltages, and are suitable for high-quality audio use. The ones I have used with much success are the Analog Devices AD713KN and the Linear Technology LT1058CN (available from Jameco and Digi-Key, respectively). These devices have an added advantage in that the offset voltage is less than 1 mV, so you can direct couple the signals after the input stage and save quite a few film capacitors.

C.H.

Tinton Falls, NJ

Thanks for the feedback. How about putting together some audio circuits for the column using these new devices?

—Editor

HAVES & NEEDS

I need updated set-up information for a Triplett tube tester, model 2413. You've helped me before. I appreciate any assistance from the readers of your fine publication.

Larry R. Cook

362 E. South Street

Richland Center, WI 53581-2721

I would like to acquire the following three schematics for a PAIA Universal Electronics Test Set: the digital readout module, the volt ohmmeter module, and a power supply circuit board. Thanks.

Arthur R. Vickery

P.O. Box 742

Torrington, CT 06790-0742

I am a radio TV technician and in many instances I am unable to find a substitute for an IC or transistor because they are not listed in the ECG-, SK-, or NTE-substitute guides. Sometimes it is not easy to contact the various manufacturers to get the original parts. Could anyone recommend a handbook containing all or most of the semiconductors used in radios, TVs and VCRs? Thanks.

Ervin Velez

Calle 2, B-36 Tintillo Gardens

Guaynabo, PR 00966



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

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



Replace your unsightly "rabbit ears" today!

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

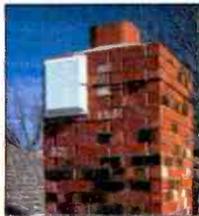
Picture imperfect. Cable subscription solves the problem of getting the signal to your television, but storms and other factors can result in cable outages. If you prefer not to pay the rising monthly fees for cable or live in an area where it's not available, your picture is likely to be weak, undefined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

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

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

power of a large antenna in an inconspicuous, low-profile size.

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

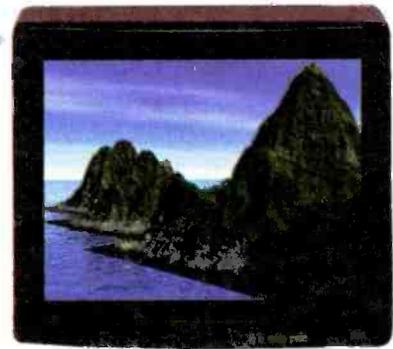
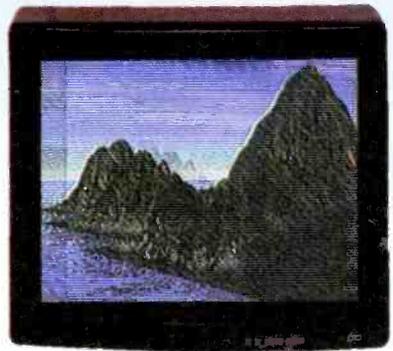


Your neighbors won't know it's there unless you tell them.

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

At a lab in Colorado, they developed two patented design improvements that made the Optima antenna possible. First, they created a flexible circuit board with a serpentine antenna, resulting in a large surface area confined to a small space. Second, they developed a technique that converts the copper shielding on the attached cable to an additional signal receiver that results in an antenna almost 10 feet long. This greatly enhances the antenna's reception power and

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



allows you to tune the antenna by simply moving the cable! The handmade assembly is encased in aircraft-grade plastic and high-density foam. The weather-resistant cover is a neutral white and can be painted to match the color of the house or room. Plus, the omnidirectional design allows you to mount the unit anywhere you please. The Optima's universal design makes it adaptable to any component, and installation is a snap. Simply mount the antenna on a wall inside or outside the house, connect the cable and fasten it in place. Then sit back, relax and enjoy the clearest picture you can get from your television.

Get the picture...risk-free. Call now to order the Optima Indoor/Outdoor TV Antenna or the Dishmate™, the small antennas that get big reception. They both come with a 90-day manufacturer's limited warranty and Comtrad's exclusive risk-free home trial. Try them, and if you're not completely satisfied, return them within 90 days for a full "No Questions Asked" refund.

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MULTIMEDIA WATCH

A Great New Wireless Keyboard

MARC SPIWAK
ASSOCIATE TECHNICAL EDITOR
COMPUTER RESELLER NEWS

Keyboards can sometimes be a nuisance when they're tied to a PC by a short wire. But that problem has been eliminated by a new wireless keyboard made by Interlink Electronics. The *VersaPoint Wireless Keyboard* works really well, and has an unusual built-in pointing device as well. Its size and shape are just right for laptop use, and it works no matter where it's pointed.

inches high, and it weighs 1.5 pounds including the batteries. The receiver is powered from the computer keyboard and mouse ports, and measures only about two inches high—so it doesn't take up much desk space. You simply place the receiver next to your monitor. The *VersaPoint Wireless Keyboard* is a neat peripheral that can really come in handy. With a suggested retail price of \$159.95, it won't break the bank either.

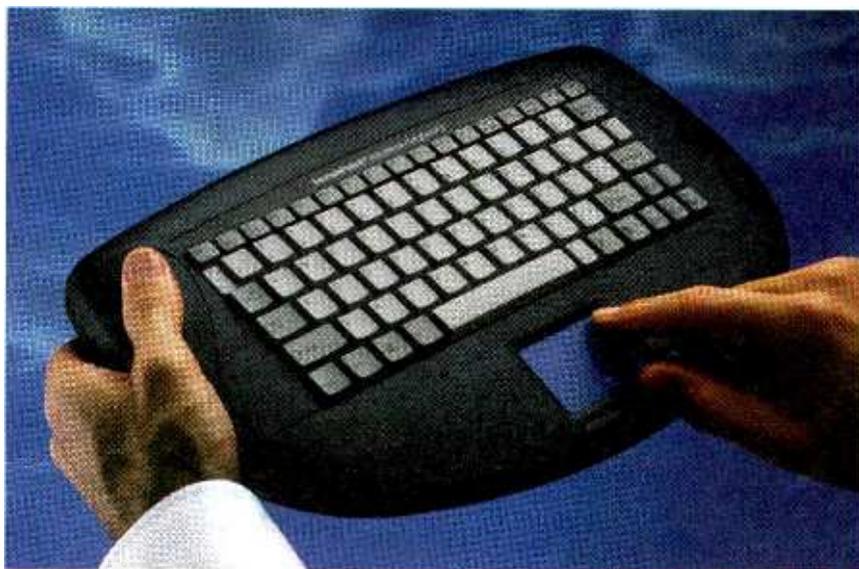
and then paste them into other applications. The touch pad also features built-in click and drag, one-touch pan and scroll speed control, and customizable toolbars. It has an active area measuring 2.18 x 1.55 inches. The *VersaPad Touchpad* is also available as a separate peripheral. The suggested retail price is \$69.95.

NEW SOFTWARE

New from Expert Software comes *Personal Roots*, the easy way to record and preserve your family heritage. Until now, families have had to rely on word of mouth and photo albums to keep track of their roots. However, details are easily forgotten over time and photographs can get lost. *Personal Roots* lets you use the power of a PC to preserve those stories in a database. You can then print reports to pass down to future generations. While you can enter up to 2 million relatives for each family tree, I certainly hope nobody has to go that far! Also from Expert Software is *Harpoon II Deluxe*, a high seas naval warfare game that's a lot of fun and very affordable. These titles sell for \$14.95 each.

Sweet! Digizine, published by e.works, is a quarterly CD-ROM magazine that is both entertaining and informative to teenagers. It combines popular entertainment content with practical information. In addition to the latest movie and music video previews, *Sweet! Digizine* offers original content in areas such as technology, career planning and financial aid for college. The multimedia magazine has a suggested retail price of \$6.95 per issue.

Inside JavaBeans, a tutorial CD-ROM from MindQ Publishing, helps you learn the principles and nuances of the JavaBeans application programming interface (API). Animated sequences explain Java's new event model, how events and actions are connected, and more. Many programming examples are explained in detail, including introspection and reflection, persistence, multicasting and unicasting, simple and



The *VersaPoint Wireless Keyboard* combines a touch-pad pointer and a comfortable keyboard in a convenient wireless package. Use it for Internet browsing on a big-screen monitor, or game playing, video conferencing, and more. It has a range of up to 50 feet.

VersaPoint combines a touch-pad pointer with a comfortable keyboard in a convenient wireless package. It's useful for Internet browsing on a big-screen monitor, game playing, video conferencing, and more. Its broad beam infrared signal is so powerful that it just bounces off the walls to the receiver. It has a range of up to 50 feet. No special drivers needed, either, although one is included that provides special functions if you choose to install it. You simply have to plug the receiver into the keyboard jack on your computer and start typing. The keyboard is powered from four AA batteries that will last for up to a year. Keyboard size measures 13.8 inches wide by 8.5 inches deep by 1.8

The built-in *VersaPad Touchpad* is also unique. It does not use capacitive coupling like most other touch pads. Other pads require a moist fingertip to work, but excessive moisture screws them up. They also do not work if something non-conductive is used to apply pressure—only a fingertip works. The *VersaPad Touchpad*, on the other hand, features Interlink's patented Force Sensitive Resistor (FSR) technology. This uses a resistor matrix that can sense where and how much pressure is applied to it. The cursor doesn't skip around when your finger grazes the *VersaPad*.

A stylus is included along with a utility to capture sketches and signatures

WHERE TO GET IT

Access Software, Inc.

4750 Wiley Post Way
Building 1, Suite 200
Salt Lake City, UT 84116
800-800-4880

<http://www.accesssoftware.com>

**CIRCLE 60 ON FREE
INFORMATION CARD**

Activision

11601 Wilshire Blvd., Suite 1000
Los Angeles, CA 90025
310-255-2000

<http://www.activision.com>

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<http://www.expertsoftware.com>

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LucasArts Entertainment Company

PO Box 10307
San Rafael, CA 94912
415-472-3400

<http://www.lucasarts.com>

**CIRCLE 65 ON FREE
INFORMATION CARD**

MGM Interactive

2500 Broadway Street
Santa Monica, CA 90404
310-449-3000

<http://www.mgm.com>

**CIRCLE 66 ON FREE
INFORMATION CARD**

MindQ Publishing, Inc.

450 Springpark Place
Suite 1200
Herndon, VA 20170
703-708-9380
800-MIND-008

<http://www.mindq.com>

**CIRCLE 67 ON FREE
INFORMATION CARD**

indexed properties, and so on. This one costs \$59.95.

Access Software is at it again with more virtual golf courses for your PC. There's *The Cloister*, *Sea Island*, *Georgia*, with its warm, southern hospitality, just as it has been for over 100 years. Greens fee for this game is \$39.95. The *Pelican Hill Course* is carved into the canyons and bluffs north of Crystal Cove in Newport Coast, California, and it features the Pacific Ocean as a backdrop on every hole. Enjoy golfing here for \$29.95. The *Kapalua Resort* in Maui rests on the wind-swept coast of Maui and features two stunning courses: *Kapalua Village Course* with its distinctly European flavor and a commanding view of the West Maui mountains, and the *Kapalua Plantation Course* with its expansive slopes, deep valleys and native vegetation. Look for these games in the Links LS golf simulator for \$79.95. Also included in the package is Arnold Palmer's home course at the *Latrobe Country Club*.

Twinsen's Odyssey from Activision take you on a mind-altering 3-D action-

adventure with over 60 hours of gameplay. Twinsen has been the hero of the planet Twinsun since he vanquished the evil dictator Dr. FunFrock. Trouble begins with the arrival of unidentified space ships piloted by beings called Esmers. Twinsen is kidnapped and taken to the planet Zeelich. Twinsen must battle the aliens and their mysterious god, the Dark Monk, and save his planet and family. Also from Activision comes *MechWarrior 2: Mercenaries 3Dfx Interactive Edition*. This is designed for use with all 3-D

video cards containing 3Dfx technology. Gameplay speed is accelerated to a new level in all-out armored combat. These 3-D voyages will run about \$46.95 each.

LucasArts' *the Curse of Monkey Island* is the third installment of the popular Monkey Island game series, which includes the Secret of Monkey Island and Monkey Island 2: LeChuck's Revenge. This time Guybrush must save Elaine Marley, his true love, from being made into the evil pirate's demon bride. Players become integrally involved in the story by finding various objects and solving various puzzles in order to finish the game. Players can pick up and use objects, examine collected items, and talk to other characters throughout the game. This journey will cost you \$39.95.

MGM Interactive's new *Machine Hunter* puts you on Mars—and it's being overrun by a horde of alien-dominated death robots who plan to invade Earth. You must destroy this army of killers, invade their bodies, and use their powers to annihilate the rest of them before they destroy Earth. Hop aboard this Mars Sojourner for \$39.95. ■

ELECTRONIC GAMES

BP69—A number of interesting electronic game projects using IC's are presented. Includes 19 different projects ranging from a simple coin flipper, to a competitive reaction game, to electronic roulette, a combination lock game, a game timer and more. To order BP69 send **\$8.00 (includes s&h)** in the US and Canada to **Electronic Technology Today Inc., P.O. Box 240, Massapequa Park, NY 11762-0240**. US funds only. Use US bank check or International Money Order. Allow 6-8 weeks for delivery. MA07



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NET WATCH

Holiday Shopping Time

DAN KARAGIANNIS

Hard as it may seem to believe, it's that time once again. Time for long lines, busy parking lots, and, for some, the management of screaming children while trying to carry bags and bags of gifts. Yes, the Holidays are upon us once again.

If you're a long-time reader of this column, however, you might have learned of a different shopping philosophy that could make your Holiday experience a little less painful. And if you're a newbie to the Net, have no fear, there's a first time for every experience. Welcome to the pleasant world of online shopping!

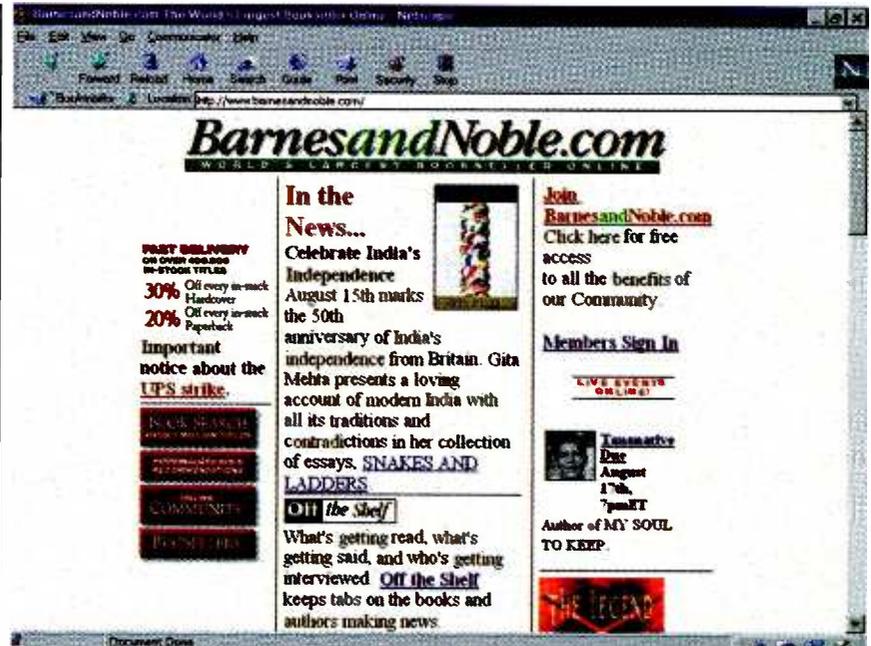
Shopping on the Net will eliminate just about all your Holiday-time gift-buying woes, including the common complaint of spending too much. "But what about safety?" I hear some of you asking. Don't worry, sending your credit-card number over a secure Net connection is safer than giving it over the phone (though if you opt for the latter, you can still do so). For some hacker to get your credit-card number off a secure Net connection would be analogous to that individual finding a red marble rolling down a hill amidst a stream of 20,000 orange ones!

So if it's safe and easy on your hands (don't you just hate shopping-bag-handle rope burns?), what are you waiting for? There are gifts out in cyberspace for everyone on your list.

BARNES AND NOBLE

Just about everyone has an interest that can be enhanced by some type of book, which is one of the reasons why the online bookstore, Amazon.com, has become one of the most successful Internet businesses. We covered this site in the past, so it seems fitting to now take a look at the Web presence of one of the biggest booksellers in the world.

BarnesandNoble.com brings you access to all the titles you'd find in one of Barnes & Noble's superstores, as well as hundreds of thousands of extra books that it's just not feasible



Housing even more titles than one of the company's superstores, BarnesandNoble.com is a perfect place to look for gifts.

for any building to stock. Best of all, to compete with Amazon.com's low prices certain books you buy from BarnesandNoble.com probably won't cost you as much as going to a bookstore in person—even after shipping! Here's why: Online, all in-stock hardcovers are 30% off list price, and all in-stock paperbacks are 20% off list. Because most hardcovers are only 10% off at a superstore, and there's no discount at all on paperbacks in these stores, you will save money in most cases even with standard shipping added.

BarnesandNoble.com carries over 400,000 in-stock titles, so there are plenty of bargains to choose from. But if you want a hard-to-find book, and are willing to pay full price, you can also choose from an additional 600,000 or so titles—making your total search possibilities number over one million. If you can't find a gift among this many books, you might as well send out checks to those on your list this year.

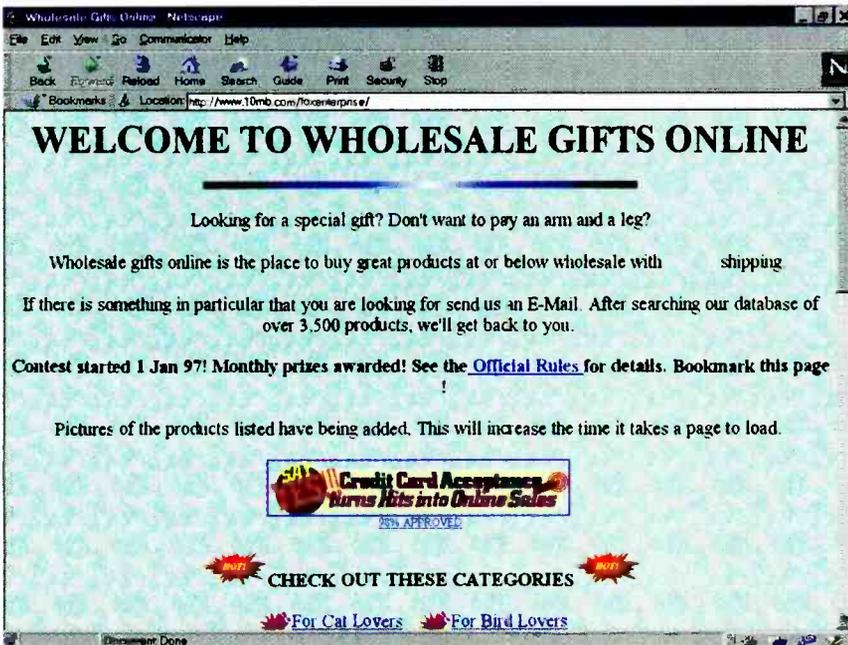
If you're an impulse shopper, you'll like the opening page of the site, which

contains blurbs about special featured selections. Or, if you prefer to look under categories that fit each person on your list, click on one of the following: Biography; Business; Children's & Young Adult; Computers; Cooking; Family & Relationships; Fiction & Literature; History; Horror & Suspense; Humor; Mind, Body & Spirit; Mystery; Politics & Society; Pop Culture; Reference; Romance; Science Fiction & Fantasy; Sports & Adventure; or Travel. Have a specific title in mind? Just go to the Search link and type in Author, Title, Subject, or Keyword.

Another aid for shoppers is something called the BarnesandNoble.com Community. You don't need to become a member to shop at the site, but if you do enroll for free, you get to post messages to the Book Forum bulletin boards, and receive Personalized Book Recommendations. The latter is great if you'd like to know every time a book dealing with a favorite subject of yours is released. Before we move on, I just want to point out that Barnesand Noble.com also has a great live events pro-



Keep the little ones happy with quality gifts from White Rabbit Toys—the Internet's first online toy store.



If you'd like to buy presents at wholesale prices, and don't feel like paying for shipping, check out Wholesale Gifts Online.

gram. Just about every day, an author is online and available for a Live in the Auditorium question-and-answer forum. You can submit a question and participate right from your browser.

WHITE RABBIT TOYS

A lot of Holiday shopping time is spent trying to figure out what to get for the little ones on your list. An innovative company located in Ann Arbor, Michigan—White Rabbit Toys—has decided to make shopping for children

easy for customers all around the world. Calling itself "the Internet's first full service, specialty toy store," White Rabbit Toys is in a good position to help parents get their little ones "high quality toys that help children to create, learn, imagine and explore."

While there aren't thousands of toys here to choose from, this is actually a good thing. Who has time to search and search? Instead of putting all its many thousands of toys online, White Rabbit has chosen a fair selection of

HOT SITES

BarnesandNoble.com

<http://www.barnesandnoble.com>

White Rabbit Toys

<http://www.toystore.com>

Wholesale Gifts Online

<http://www.10mb.com/foxenterprise/>

popular toys from all over the world. Let's take a brief look at some of the types of international toys you'll find.

Brio, from Sweden, manufactures a train set called Wooden Railway. Made of natural beechwood, these tracks and brightly colored trains and accessories are designed with just enough detail to engage children in imaginative play. You choose how many components you want. It's a great gift for children ages 3 and older. Another European country, Germany, houses the company Ravensburger, which has a "matching game" for preschoolers, as well as other family games for all ages.

Primetime Playthings, from the United States, employs child psychologists as well as toy designers to make educational playthings for infants. For older children, check out the arts and crafts kits from Creativity for Kids, another US company. Or, for children of all ages, as well as the older sweet-heart in your life, world-famous US plush-manufacturer Gund, a company in the business for almost a hundred years, has some lovable stuffed animals available here.

A Music on Tape section lets you also choose from kids' favorites of all kind. You'll find soundtracks from films like *The Lion King* and *Beauty and the Beast*, as well as Muppet tapes and other sing-along-type programs.

Each item has a photo you can download, so you can see what you're getting. When you've made your selections and are ready to order you can even opt for having your purchases gift wrapped for \$2 each. Think of the hours you'll save on Christmas Eve! If you want to ship directly to those on your list, White Rabbit will even include a card!

Since they ship orders within 48 hours of receipt, you can rest assured your gift will get there sooner, rather than later. The company will send you

(Continued on page 80)

Product Test Report

Zenith IQ3597BT 35-Inch TV Monitor/Receiver

STEPHEN A. BOOTH

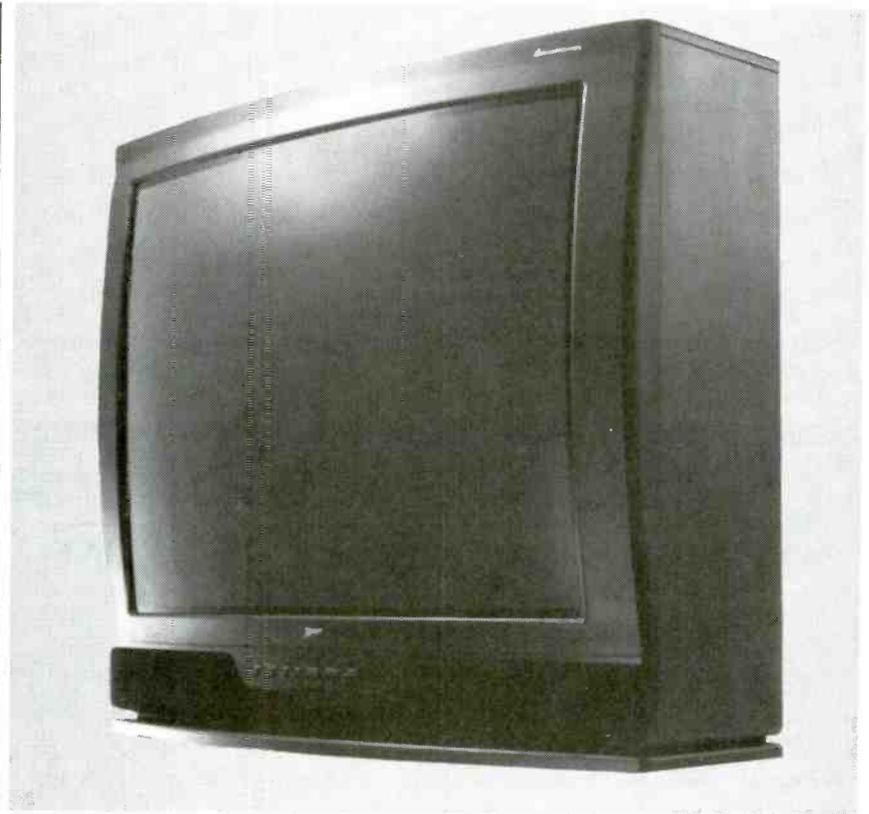
Inteq is Zenith's designation for its very top-of-the-line video products. Originally, it was to be a separate brand in the manner of Thomson's (RCA) ProScan or the now-defunct Prism marquee of Matsushita (Panasonic). Instead, Zenith opted for an arrangement similar to Pioneer's "Elite" series: Link the names to exploit the existing brand recognition, and boost the brand's equity further with a series of no-compromise products with exclusive features and state-of-the-art technology.

That's Inteq, and it's meant to compete against the other high-end labels either with features they don't have or only offer at higher prices—such as the digital 3-line comb filter in this set. The Zenith IQ3597BT 35-inch monitor tested here is pretty much ideal except for some unwarranted horizontal overscan—a shortcoming that should be addressed in the future as Zenith and other TV makers migrate from 35- to 36-inch tubes.

The fact is, Zenith already has begun to move to the 36-inch class, replacing this 35-incher with the new IQZ36Z46D model, whose tube is sourced from another manufacturer. Consequently, you're likely to find this and other 35-inch sets priced appealingly as manufacturers and retailers move to close out their inventories. Accordingly, if you can overlook the overscan, our laboratory bench-tests and hands-on appraisal indicate that the IQ3597BT is a very satisfactory TV.

FEATURES

Zenith's APF-50 tube (Advanced Performance Flatter picture tube) is typical of the dark-glass, high-contrast, reduced-curvature CRTs that most TV makers now incorporate in their premium receivers. In the case of this 35-inch model, Zenith says the tube has 50 percent less curvature than conventional 35-inch CRTs. Besides better off-axis viewing, the benefits of the new geometry include less optical-distortion. Additionally, the flatter screen has



less color distortion, especially in the corners, caused by mis-registration of the electron beam. The more planar screen also collects less from reflected ambient light, which otherwise would rob contrast.

As most people expect today, high-end TVs offer Picture in Picture (PIP)-viewing from a second video source, such as a VCR. With the IQ3597BT

you can scale the PIP in three different sizes, place it in any corner of the screen, swap its location or swap it with the main picture. In this case, the audio accompanies the video on the main screen.

Most people don't expect to get two remote controls with a TV, but that's what Zenith supplies. One is the multi-brand, universal control that lets you operate up to seven audio or video components of any brand. The second is Zenith's unique and ergonomic Intraq remote, a less convoluted affair that lets you run just the TV and a VCR. In place of the usual buttons, it uses a trackball to navigate the TV's on-screen menus.

Menus are menus—you can go a la carte and use them to customize the wide assortment of picture and sound controls, or you can just go with the house specials of factory presets. But TVs of the price and features of the IQ3597BT invite tweaking, and one

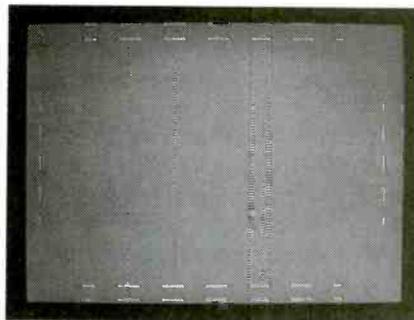


Fig. 1. Large horizontal overscan is this set's biggest oversight.

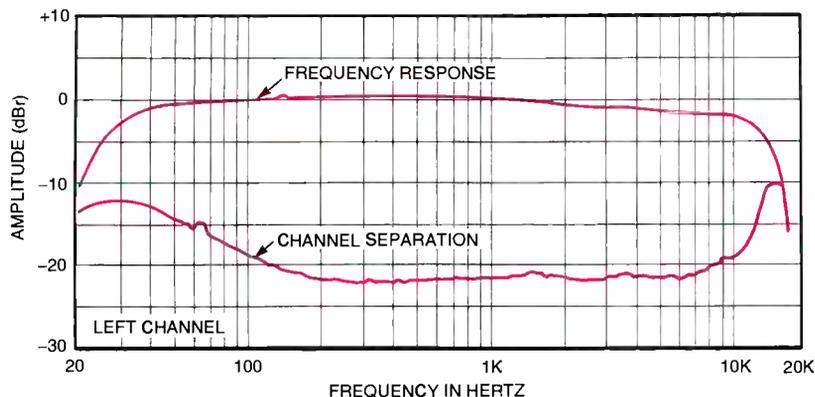


Fig. 2. Left channel frequency response and stereo separation.

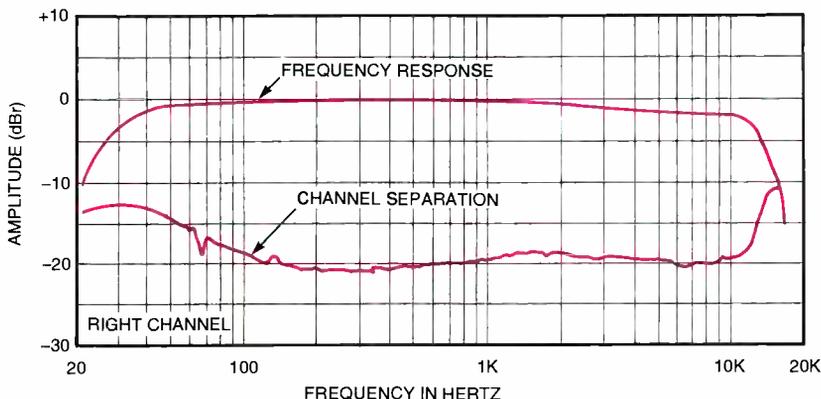


Fig. 3. Right channel frequency response and stereo separation.

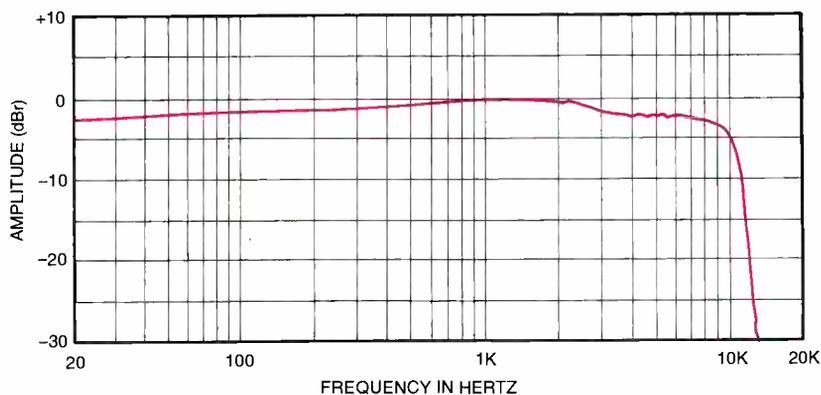


Fig. 4. S.A.P. Mode frequency response characteristics.

item videophiles will go for is the color temperature adjustments. These include a "Warm" setting that corresponds to the NTSC standard of 6500-degrees Kelvin (and came reasonably close in the lab tests). Additionally, Zenith's picture-preference menu includes brightness, contrast and color settings optimized for movies, sports, videogames, and daylight (or bright ambient light) viewing. Yet another bit of processing, called Weak Signal, employs dynamic noise reduction and other

tricks to clarify snowy images from videotapes or sub-par reception.

Audio menu offerings include a feature everybody can appreciate, called SoundRite. This feature keeps whatever volume level you've set constant, either when you change channels or sources, or when commercials interrupt the program. The BBE Sonic Maximizer meanwhile is a recording-studio feature, from Barcus Berry Electronics, that restores the dynamics of the original sound that might have been dis-

torted through numerous stages of recording and transmission. You can select two levels of restoration—or none at all. Although the IQ3597BT has its own stereo amplifiers and speakers, you might want to connect the TV to an external sound- or surround sound system. A selection in the audio menu makes it possible to turn off the TV's built-in speakers—almost. We'll explain what the lab learned in Performance (below).

Two features you can't adjust on this TV are the set's digital 3-line comb filter and its scan-velocity modulation. You wouldn't want to. The first separates the color signal from the luminance, thereby eliminating annoying artifacts such as dot-crawl at the edges of images, and color bleeding. The latter dynamically varies the velocity of the scanning electron beam to maintain sharp transitions between blacks and whites.

PERFORMANCE

The IQ3597BT underwent the usual battery of electrical measurements at the Advanced Product Evaluation Laboratory, an independent testing facility in Bethel, Connecticut. By and large, the set measured up quite well.

With Digital high-definition TV (DTV) sets arriving this time next year, **Popular Electronics** now begins specifying the width-to-height aspect ratio of displays tested. A 4:3 aspect ratio is the standard for today's NTSC television. Next year, new DTV sets will have a one-third wider 16:9 display as standard issue. Several manufacturers already have begun selling wide-screen sets with inputs for future DTV add-on tuners. Consequently, **Popular Electronics** will highlight this feature in future test reports. When appropriate, test reports will use industry standard nomenclature to express the diagonal measurement of these sets as "00W-inch," —for example, "41W" or "57W-inch."

APEL measured Maximum Usable Luminance at 54 foot-lamberts, a brightness level typical for a large 35-inch display. Horizontal Resolution maxed out at 560 lines, more than enough sharpness to handle the high-

FOR MORE INFORMATION

Zenith Electronics
1000 Milwaukee Ave.
Glenview, IL 60025
847-391-7000

ZENITH IQ3597BT—TEST RESULTS

Brand:	Zenith
Model:	IQ3597BT
Price	\$2799 list price—but deeply discounted (see text)

VIDEO MEASUREMENTS:

Maximum usable luminance	54 foot-lamberts
Horizontal resolution	560 lines
Convergence (center)	0.0%
Convergence (corners)	0.4%
Overscan (horizontal)	2.0% (See Fig. 1)
Overscan (vertical)	1.0% (See Fig. 1)
Interlace	60/40
Transient response	Very good (slight ringing)
Color temperature (standard)	8200° K
Color temperature (warm)	6720° K
Color temperature (cool)	10,250° K
Color quality	Excellent
Reception (100 μ V/m)	Very good

AUDIO MEASUREMENTS:

Audio Out

0-dB reference level (@ 1 kHz, 3.00% THD)	2.5 volts
Signal-to-noise ratio ("A" weighted)	66.9 dB
Total harmonic distortion (1 kHz, -10 dB)	0.11%
Frequency response (@ -10 dB)	20 Hz to 20 kHz

MTS STEREO TV DECODER MEASUREMENTS:

Stereo Mode/Left Channel

Signal-to-noise ratio: (@100% modulation, "A" weighted)	55.5 dB
THD (@ 1 kHz, -20 dB)	0.16 %
Frequency response ¹	29 Hz to 12.2 kHz
Separation ¹	21.5 dB

¹See Fig. 2 (Left channel).

Stereo Mode/Right Channel

Frequency response ²	29 Hz to 12.3 kHz
Separation ²	19.9 dB

²See Fig. 3 (Right channel).

S.A.P. Mode

Signal-to-noise ratio: (@100% modulation, "A" weighted)	63.8 dB
THD (@ 1 kHz, -20 dB)	0.35 %
Frequency response: (@100% modulation; see Fig. 4)	20 Hz-6.0 kHz

Mono Mode

Signal-to-noise ratio (@100% modulation, "A" weighted)	57.0 dB
THD (@ 1 kHz, -20 dB)	0.28 %
Frequency response (@100% modulation)	22 Hz to 4.5 kHz

ADDITIONAL DATA:

Picture size	35-inch (diagonal—4:3 aspect ratio ³)
Loudspeakers (2)	9 × 3-inch oval (1 per channel)
Power requirements	170 watts
Dimensions (HxWxD, inches)	31 × 34 × 23.6
Weight	198 pounds

³See text for details on this measurement.

FEATURES CHART:

- Multi-brand universal remote control
- Intraq trackball TV/VCR universal remote control
- APF-50 flat picture tube
- Digital 3-line comb filter
- Picture-in-picture
- Adjustable color temperature
- Composite and S-video inputs
- Soundrite volume regulator (for volume level-matching)
- Trilingual menus

est resolution input sources available today, including DVD, laserdisc, direct-broadcast satellite, and even the new Digital Video Cassette (DVC) camcorders (which yield some 500 lines of resolution). Meanwhile, Color Quality (saturation and hue) referenced to the standard Macbeth chart was excellent.

The IQ3597BT scored well in geometry class but not a perfect mark. Its shortfalls in Interlace and Transient Response are negligible, in that test equipment is faster than the eye. Even Convergence at the corners (measured after eight hours of operation) might be overlooked given the display's size. But the oversight we've got to cite is something you won't see—about half an inch of picture cropped off the sides by the set's 2% horizontal overscan (illustrated in Fig 1). APEL says that in this day and age, it's more overscan than a TV should have—certainly a high-end TV like this one.

Meanwhile, the tuner in this TV is very good. Under worst-case conditions, reception showed minimal snow. Audio quality matches the generally good video. The receiver's MTS broadcast stereo decoder is particularly noteworthy, striking a good balance of Signal-to-Noise with very good stereo separation over a broad range of frequencies. Frequency response and stereo separation for Multichannel TV Sound broadcasts are measured using real-world reception conditions of -20 dB relative to 100% signal modulation. These results are shown graphically in Figs. 2 and 3. The MTS decoder is better than most in the S.A.P mode, with wide frequency response beginning at the lowest audible point of the low end.

One anomaly APEL found with the set's audio has to do with turning off the internal speakers. Even after doing so through the menu, the speakers emitted sound from the lab's signal generator (though not from any program source). In fairness to the IQ3597BT, it was being tested to learn what volume level would drive the audio system into 3% distortion—and that signal level was so high it somehow radiated to the supposedly-disabled speakers. Not to worry—you'd never crank the volume so high intentionally. And given the close-out discounts now available on the 35-inch set, you might consider the IQ3597BT a sharp bargain—even if it shaves a quarter-inch of picture off the sides. ■

DX LISTENING

The Demise of Commercial Shortwave Broadcasting

DON JENSEN

Commercial shortwave radio broadcasting in the U.S. is, for all practical purposes, dead—no more successful in revival than it was a half century earlier when it first was tried. Two events during 1997 symbolize the failure of commercial shortwave.

The first was the death of Joseph Costello III, who in the early 1980s founded WRNO, a commercial shortwave station in New Orleans. Costello, a successful radio entrepreneur, believed that there was money to be made by programming a shortwave outlet in the same manner as traditional AM and FM stations. Costello's idea was a throwback to the 1930s, when shortwave broadcasting was in its infancy, and radio manufacturers like RCA and Crosley, and the NBC and CBS networks tried, unsuccessfully, to make commercial shortwave pay. In the 1980s, Costello and several others revived the old notion, but mostly they too failed. Such commercial support as they did receive came largely from selling blocks of airtime to religious and political fringe groups. And though WRNO remains on the air after his death, it too, in my opinion, did not live up to its founder's expectations.

This failure of commercial shortwave was underscored this year by the Christian Science Church announcement that it would sell or lease its two shortwave stations: WSHB in South Carolina and KHBI on Saipan in the Mariana Island group in the Pacific Ocean.

When the Christian Science Monitor began SW broadcasting ten years ago, it had an optimistic view of commercial shortwave. The church spent \$37 million on building its stations, and another \$13 million annually on oper-

ating and editorial costs. Commercial sponsorship of its respected broadcast news operation was expected to help underwrite the cost of religious programming. It seemed, at the time, to be the best of both worlds. But it didn't happen, and a decade later the church conceded that attempts to make the SW service self-sufficient have failed. It is time, a spokesman said, to focus on producing programs, rather than operating the channels of distribution, the two shortwave stations. Instead, the Christian Science church decided to concentrate on buying air time from domestic stations in Africa, Asia and South America to broadcast its programs.

The sale or lease of WSHB and KHBI was to be handled by George Jacobs Associates, the technical and engineering firm that helped put them, and other private U.S. shortwave stations, on the air during the past decade and a half. Jacobs, incidentally, was honored recently with a lifetime achievement award from the National Association of Broadcasters. His radio career began in 1941 as an electronics navigator. He joined the Voice of America in 1949, and remained there for 27 years before moving to the federal government's Board of International Broadcasting (BIB) in 1976. In the 1950s, he worked with Congress in the drafting of legislation designed to encourage private U.S. shortwave broadcasting. He left the BIB in 1980 and opened his own SW consulting firm. In that capacity, he represented Costello before the Federal Communications Commission finally gave WRNO shortwave the green light.

While commercial U.S. SWers failed to make the grade, the same cannot be said about private shortwave outlets operated by religious organizations. Motivated more by the notion of doing good rather than moving goods, these American SW voices are increasing in number.

The newest of these stations—still without call letters at this writing—is expected to go on the air in January or February 1998 on 11,910 kHz from Macon, Georgia. Headed up by Charles C. Josey, a longtime amateur radio operator who directs an organization called Oil & Wine Ministries, the station received a construction permit from the FCC last spring. The 50,000 watt transmitter station, with a rotatable yagi antenna mounted on a 130-foot tall tower, is rumored to be constructed mainly from electronic salvage. It is to broadcast from a site near downtown Macon, with religious programming from 7 PM to 7 AM Eastern time. Initially, however, there will be programming for only a couple of evening hours. Reportedly the station will be a retirement project for Josey and his wife, Joanne. They hope to air religious programs produced in other countries and broadcast it back to listeners there. If you hear this new station, send your reception reports to Oil & Wine Missions, P.O. Box 18174, Macon, GA 31209.

NUMBER TWO AND TRYING HARDER

It's no real revelation that English language programming, aired 24 hours a day, is key to the British Broadcasting Corporation's highly popular World Service. But what may come as a surprise to most SWLs, though, is that Arabic programming is not far behind. Started in 1938, Arabic is the oldest of the BBC World Service's 44 foreign language services.

The Arabic Service currently transmits on shortwave for more than 12 hours a day. The BBC has added five more hours in Arabic on its regional AM medium wave and local FM transmissions, bringing those schedules to nearly 18 hours a day. If resources permit, SW also will broadcast the extended Arabic schedule in 1998. Arabic is one of the BBC's top language priori-

(CREDITS: George Maroti, NY; Stephen Pitts, MN; John Sgrulletta, NY; Dan Ziolkowski, NY; North American SW Association, 45 Wildflower Road, Levittown, PA 19057)

ties, aiming for nearly 14 million people in the Arab world. The Arabic Service targets listeners across northern Africa and the Middle East. Largest audiences are in Egypt, Sudan, Morocco and Saudi Arabia, though there also is significant listenership among Syrians, Lebanese, Jordanians and Palestinians. Head of the BBC Arab Service, Gamon McLellan said, "These extra programs will mean the station is continually present on the air during the day, whenever listeners choose to tune in, and continuing crises in the region make it imperative that the BBC is there, on air, when news breaks."

IN THE MAIL

"How can I hear Alaska on short-wave?" asks Peter Schmitz of Sheridan, WY.

Peter, you can tune for KNLS. This Alaskan SW station broadcasts in English at 0800 UTC on 9,615 kHz, and at 1300 UTC on 7,365 kHz. Reception reports may be sent to Mike Osborne, KNLS, Box 473, Anchor Point, AK 99556.

W. Harold Owens writes from Bowling Green, KY. "A while ago, you asked DX Listening readers which are their favorite stations. Well, my favorite is Spanish External Radio in Madrid on 6,055 kHz at 0100 UTC. I especially enjoy the Spanish music."

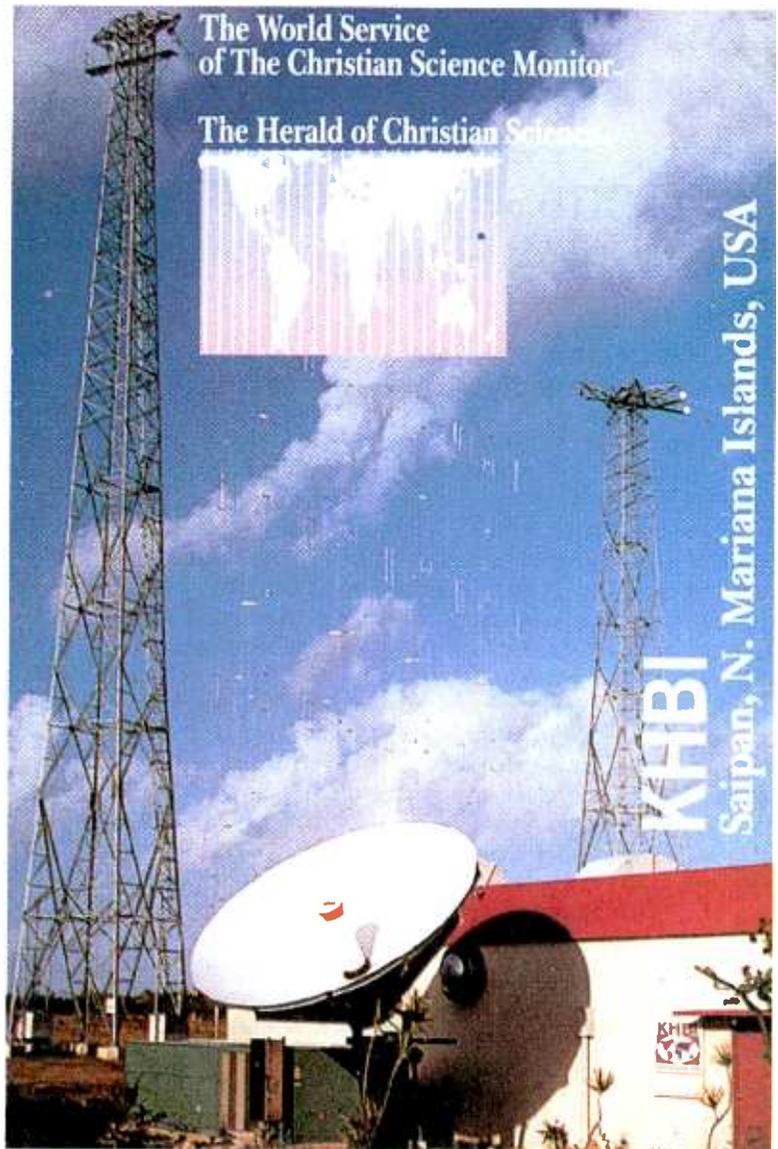
Over the years, this broadcaster has used different names for its overseas English language service. Personally I always favored the rather exotic sounding Spanish title, Radio Nacional de Espana. Like you, Mr. Owens, I've enjoyed its programs quite regularly since I visited Spain some years ago. Apparently others do too, since the station says it estimates a weekly SW audience of about 80,000.

DOWN THE DIAL

Looking for something to tune for? Try these:

ALGERIA—15,160 kHz, Radio Algiers International has English programming from 1400 to 1500 UTC, including music, identifications, program schedule and news and press reports.

CONGO—4,765 kHz, Radio Congo was heard signing on at 0520 UTC, with interval signal, national anthem and identification as "Ici Brazzaville." On another day, the sign on was at 0400 UTC.



QSL card from KHBI, the Christian Science Monitor shortwave outlet on Saipan in the Northern Mariana Islands. The Christian Science Church's broadcasting arm is selling this station and WSHB in South Carolina.

CYPRUS—9,410 kHz, British Broadcasting Corporation programs in English are relayed from this Mediterranean island site. It was noted at 2359 UTC, announcing the Cyprus transmitter location, followed by time signals and a newscast.

INDONESIA—3,905 kHz, Radio Republik Indonesia's station at Merauke, in Irian Java, the western half of New Guinea, may be tuned here when reception conditions are right around 1245 UTC.

IRAN—7,260 kHz, Teheran's short-wave outlet, VOIRI has English scheduled from 2000 UTC, including news and commentary.

NIGERIA—6,050 kHz, Radio Nigeria from Ibadan broadcasts in

English with news, ID, frequency and sign-off at 2305 UTC, with the announcer saying, "Good evening, everyone."

SAO TOME—4,960 kHz, Voice of America morning program is relayed from this island off Africa's west coast. It has been heard until 0330 UTC sign-off with the VOA's morning "Daybreak" show.

SWAZILAND—4,760 kHz, Trans World Radio broadcasts from this southern African country. It was logged with a Bible program and hymns in the Swahili language.

TURKEY—7,300 kHz, Voice of Turkey signs on about 0355 UTC, with a tuning signal, then opening announcements in English, including the schedule, identification and news. ■

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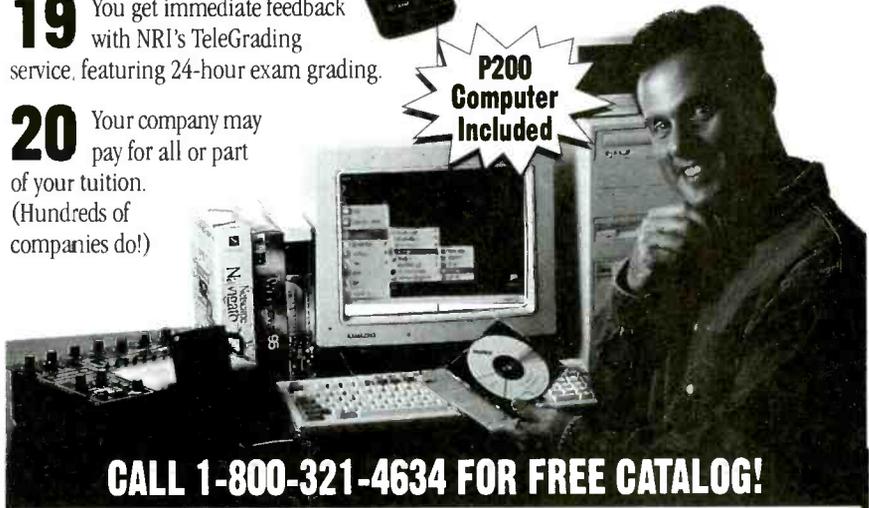
23 You can turn to NRI for letters of recommendation, transcripts, tips on resume writing, and more.

24 You get the skills and confidence to move up on the job, start a new career, or open your own business.

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December 1997, Popular Electronics

NEW PRODUCTS

ELECTRO-MAGNETIC METER

The *Tri-Field Natural EM Meter* from *Alphalab, Inc.* detects changes in extremely weak static (or natural) electric and magnetic fields. It's compact, inexpensive, and easy-to-use. Both a tone and a needle-type gauge signal changes in either electric or magnetic fields, while ignoring AC fields.



On the **MAGNETIC** setting, the Tri-Field Meter signals the movement of any strong magnetic source in the sky. Neither a cloudy sky nor the source dipping behind a hill interferes with the meter reading. The meter which can be used indoors, as well as in the dark, is sensitive to changes in the magnetic field as small as 0.5%. The tone sounds whether the field increases or decreases. If the field stabilizes for more than five seconds, the tone stops and the meter returns to normal. Turning the side knob adjusts the threshold level or squelch of the tone. On the **ELECTRIC** setting, the meter responds to changes in electric fields as small as 3 volts per meter. Because of this sensitivity, it can be used as a motion-activated intruder alarm that can even detect the presence of a person through a wall.

If you turn the dial to **SUM**, the meter will add any changes in the electric field to any changes in the magnetic field. A radio wave and microwave detector is also built into this device. The **RADIO/MICROWAVE** mode reads radio waves from 50 MHz to 3 GHz, and it can also check a microwave for leakage.

The Tri-Field Natural EM Meter sells for \$229, including UPS Ground

Delivery or \$232 with UPS Second Day Air service. For more information, contact Alphalab Inc., 1280 South Third West, Salt Lake City, UT 84101-3049; Tel/Fax: 503-543-6545.

CIRCLE 80 ON FREE INFORMATION CARD

AUTOMOTIVE DIGITAL TESTER

HC Protek's Model D-488 digital multimeter is a handheld digital tester with the features service technicians need for diagnosing and troubleshooting modern automobile and truck problems. Under the hood or under the dash, the Model D-488 tests and measures AC/DC volts, amps, ohms, and, with the inductive pick-up probe, RPM/Tach readings for both distributor and distributor-less vehicles. A Celsius and Fahrenheit temperature-reading function makes conversion charts unnecessary when servicing foreign vehicles. In addition, the frequency function tests engine sensors, ABS, and other automotive systems.



The handheld meter has a 3-3/4-digit, 3200-count LCD readout. An "auto-power-off" feature extends battery life. Data Hold freezes display readings for easy reference. Continuity, diode test, duty cycle, and dwell measurements are standard features. The D-488 will also test and measure ignition and engine systems; sensors, solenoids and components; coils, diodes, and alternators; charging systems; and cooling, heating, and lighting systems.

The Model D-488 digital multimeter, complete with test leads, alligator clips, temperature probe, RPM pick-up, battery, manual, rubber holster, and padded carrying case, costs \$179. For further information, contact HC Protek, 154 Veterans Drive, Northvale, NJ 07647; Tel: 201-767-7242; Fax: 201-767-7343.

CIRCLE 81 ON FREE INFORMATION CARD

WIRELESS COLOR SURVEILLANCE SYSTEM

For people at home or at work who need to have their eyes in two places at once, *American Innovations' WSS-300 Wireless Color Surveillance System* is the answer. It can be used as a child monitor, as a security system, or to monitor on-the-job performance.



The WSS-300 has a 300 foot range, not obstructed by walls, floors or ceilings. The compact AM/FM cassette-radio (11-inches wide by 6-inches high, 3-1/2 inches in diameter) incorporates both the camera and transmitter. (Due to camera placement, the cassette player can't operate.)

With a super low sensitivity rating of 2 lux, as well as built-in backlight compensation, the high-resolution (380 lines) color camera and the FCC-approved transmitter deliver consistently sharp video images to the designated receiver. In addition, the state-of-the-art circular polarized directional transmitting and receiving antennas maximize the signal range and minimize interference.

The WSS-300 comes complete with a working AM/FM radio, the color camera, the transmitter, and a four channel FCC-approved receiver. Also included is the video cable to connect to your VCR or monitor, an A/B switch to select between receiver and cable/

antenna reception, coax cable, power adapter to provide 12 VDC power to the receiver, as well as an easy-to-follow instruction book.

The WSS-300 Wireless Color Surveillance System has an introductory price of \$895. For more information, contact American Innovations, Inc., 119 Rockland Center, Ste. 315, Nanuet, NY 10954; Tel: 914-735-6127; Fax: 914-735-3560; Web: <http://www.spysite.com>.

CIRCLE 82 ON FREE INFORMATION CARD

COLOR MULTIFUNCTION DEVICE

The 5-in-1 Panafax UF-344 from Panasonic Office Products Company is a stand-alone multifunction unit that offers color printing, color scanning, color copying, plain-paper fax, and PC-Fax capabilities. Designed for small, mid-sized, and corporate offices, it provides clear faxes on letter, legal, and A4 formats. Panasonic's Super Smoothing technology automatically sharpens and clarifies character edges, providing sharp, legible printouts and incoming faxes.



The UF-344 can be turned into a color inkjet printer with 360 x 360 dots per inch (dpi) resolution by snapping in a color cartridge. As a copier, the device outputs at the same resolution, and also reduces and enlarges images. In plain-paper fax mode, the UF-344 uses a 14.4K modem and Modified Modified Read (MMR) compression to deliver up to six-second-per-page transmission speed (depending on content). An incoming fax can be stored in memory while a print job is in progress and printed when the device is free. The UF-344 can broadcast up to 112 stations per job, and allows for deferred transmissions. Panasonic's Windows-based fax software is used to transmit and receive documents directly from the PC. A bi-directional parallel port connects the UF-344 to the PC with a single cable, offering easy setup and

faster speeds than a traditional serial port.

The Panafax UF-344 has a suggested retail price of \$2195. For further information, contact Panasonic Office Products Company, Two Panasonic Way, Secaucus, NJ 07094; Tel: 800-742-8086 or 201-348-7000; Web: <http://www.panasonic.com> office.

CIRCLE 83 ON FREE INFORMATION CARD

WIRELESS CURSOR CONTROLLER

InControl Solutions' MediaPoint Joy-Disk is a touch-sensitive cursor control that offers 360° proportional response for OEM wireless applications including WebTV; wireless keyboards; remote controls for PC/TVs, presentation systems, and Internet appliances; GPS systems; game pads; and industrial controls.

MediaPoint has just two parts—the sensor and the disk actuator. The sensor mounts directly to a circuit board, while the disk is typically supplied by the OEM based upon an InControl design. Pressing on the pliant disk surface converts touch to cursor movement with intuitive ease. One-finger control means instant cursor-speed and-direction response. The "Soft-Touch" wakeup feature leaves the microcontroller powered down until the user touches the joystick. The sensor offers 10-million-cycle reliability and a robust design with no moving parts.



Unused resources in an existing microcontroller can be used to support pointing. For instance, the microcontroller in a wireless keyboard can be shared between the MediaPoint and keyboard software. As an alternative, InControl offers a custom microcontroller that emulates a serial or PS/2 mouse and works with standard mouse drivers.

Sensor pricing in production volume is less than \$1 apiece. An evaluation kit, including circuit board and MediaPoint, costs \$100. For more informa-

tion, contact InControl Solutions, 4000 Kruse Way Place, Building 2, Suite 355, Lake Oswego, Oregon, 97035; Tel: 503-699-7700; Fax: 503-699-7800; Web: <http://www.blackdiamond.com/intctrl.com>.

CIRCLE 84 ON FREE INFORMATION CARD

SOLAR CAR KIT

The Triple-Action Solar Car Kit from OWI is an educational science project for children ages 9 and older. This futuristic solar car demonstrates the use of alternate energy. It features a 1.4 - volt, 350-mA solar cell, an aerodynamic sports car shell design, 4-wheel chassis, and a transparent plastic body. The body can either be painted or left clear to display the car's inner mechanical construction.

The kit has built-in flexibility, as the steerable front axle, rear wheels, and adjustable (directional/angle) solar panel are all independent components. Builders can take the original body parts and create their own solar projects.



The two-way energy source allows the car to be powered by either battery or solar power. The kit, featuring a multi-speed transmission, can be made into either a racer or a tractor, and sells for \$39.95. For further information, contact OWI Incorporated, 1160 Mahalo Place, Compton, CA 90220-5443; Tel: 310-638-4732; Fax: 310-638-8347

CIRCLE 85 ON FREE INFORMATION CARD

PERSONAL POWER STATION

Galaxy Audio's Far Outlet personal power station is a self-contained power source of 110-volt, 60-Hz household current. About the size of a lunch box and light enough to carry in one hand, it provides up to 250 watts continuous and 400 watts peak power.

Originally designed as a way to operate public-address systems, the Far Outlet is equally useful for powering virtually anything that runs on household current. Its "DigiScrub" digital fil-

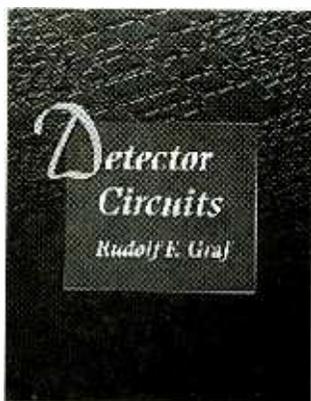
(Continued on page 58)

ELECTRONICS LIBRARY

DETECTOR CIRCUITS

by Rudolf F. Graf

Why waste time combing through huge encyclopedias when you can go directly to a book of specialized circuits already sorted by application? This book is part of a five book series on specialty circuits written by Rudolf F. Graf, a frequent contributor to this magazine and a well-known technical author. Providing fast, easy access to more than 300 ready-to-use detector circuits the volume is designed with the needs of the engineer, technician, student and hobbyist in mind.



Organized alphabetically, the book covers detector circuits from A to Z: Air-Flow to Zener-Crossing Detectors. Each chapter has detailed circuit drawings and explanatory text. References to the original sources accompany each schematic, and complete source information is found at the back of the book, along with an index.

Among the circuits included are Air-Flow Detectors; Electrostatic Detectors; Gas, Smoke, and Vapor Detectors; Lie Detectors; Liquid Detectors; Metal Detectors; Peak Detectors; Phase Detectors; Power Failure Detectors; Radar Detectors; Radiation Detectors; and Voice and Sound Detectors.

Detector Circuits costs \$19.95 and is published by Newnes, Butterworth-Heinemann, 313 Washington Street, Newton, MA 02158-1626; Tel. 617-928-2500; Fax: 617-928-2640; Web: <http://www.bh.com/newnes>.

CIRCLE 91 ON FREE INFORMATION CARD

ELECTRONICS PARTS AND ACCESSORIES CATALOG

from Parts Express

Geared toward the consumer-electronics industry and the technical hobbyist, this 244-page catalog features full lines of electronic parts and accessories. In addition to product information and photos, there are helpful technical tips, a fast index on the cover and a detailed index inside. Thousands of new products have been added. They include the ProMatrix Amplifier from Bogen, the Perfect 10 line of DSS antennas and accessories, plus home automation products from X-10, Tech-Key and DrapeBoss.



The catalog contains an impressive selection of loudspeaker drivers for home and automotive applications, CATV and VCR repair parts, semiconductors, tools and technical aids, home-theater and home-automation products, test equipment, alarm systems for home and car, computer accessories, chemicals, telephone products, wire, connectors, speaker-design software, cellular-phone accessories, stage lighting, professional sound equipment, and instructional books and videos.

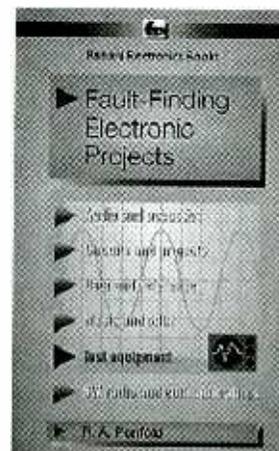
The Electronics Parts and Accessories Catalog from Parts Express is free upon request from Parts Express, 340 East First Street, Dayton, OH 45402-1257; Tel. 800-338-0531; Fax: 937-222-4644; e-mail: sales@parts-express.com; Web: <http://www.parts-express.com>.

CIRCLE 92 ON FREE INFORMATION CARD

FAULT-FINDING ELECTRONIC PROJECTS

by R. A. Penfold

Often people build circuits from magazines and books only to find that they do not work when switched on. The aim of this book is to help the reader overcome problems with building circuits, by explaining how to start looking for the common faults that are responsible for most project failures. Advice for "weeding out" the more difficult faults is also included.



In the first chapter, mechanical faults are covered, including tracing "dry" joints, broken p.c. board tracks, and solder joints. Chapter 2 discusses linear circuits and signal tracing techniques. Testing logic circuits and fault-finding methods for projects based on CMOS or TTL logic devices are the subject of the third chapter. The final chapter covers ways of testing resistors, capacitors, op-amps, and a wide variety of other electronic components.

In addition, tips on how to use a multimeter, the construction and use of a tri-state continuity tester, the design of a signal tracer, and the step-by-step construction of a logic probe are also discussed.

Fault-Finding Electronic Projects (order number BP391) is available for \$5.95 plus \$3 shipping and handling from Electronics Technology Today, P.O. Box 240, Massapequa, NY 11762-0240.

CIRCLE 93 ON FREE INFORMATION CARD



GIZMO

Holiday Gift Guide



A wealth of good ideas to simplify your holiday shopping!

Don't you just hate it that all the department stores have their Christmas decorations up before your kids have gobbled down their Halloween candy? After all, is it really necessary to get into the holiday spirit so early?

Just be grateful you're not a magazine writer. For us, Christmas begins in mid-summer. That's when we have to create our holiday buying guides and Christmas wish lists, so that you can read them in time to do some serious shopping in December. We have to drag ourselves in from the beach, pool, or garden and try to think cold, think snow, think eggnog and pine trees—and gift-giving.

It's not easy, but we're fortunate to have a world of inspiration right at our fingertips. The consumer-electronics industry literally offers something for everyone. We've rounded up a representative assortment of goodies, ranging from stocking stuffers to sheer luxury items. See if you can match our suggestions to some of the people on your holiday gift list!

TAKING CHARGE



It's not unusual in these days of plenty for people to feel out of control and overwhelmed by stuff. They have complex home-theater systems, and no easy way to operate half their fea-

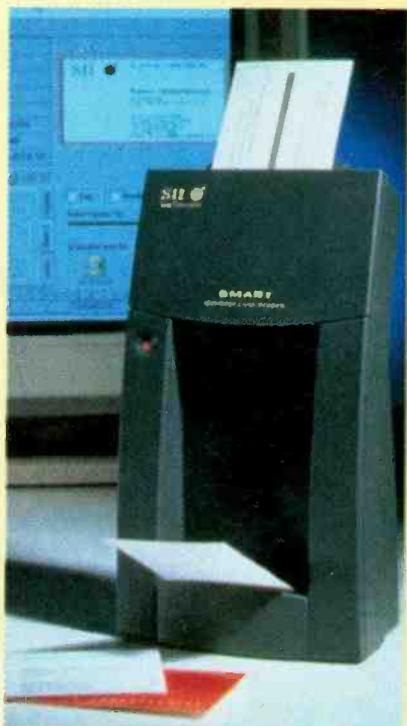
tures—let alone a convenient place to store all those videotapes and CDs. Home offices are awash in papers, diskettes, and other necessary paraphernalia. Even formerly simple tasks like making phone calls now have us in a sweat—how do we know we're getting the best rates? Perhaps one of

the kindest gifts you can give the people on your holiday list is a way to reduce the clutter, or to simplify the complex. Here are a few ideas.

Know someone who has a DSS system? How about giving them one-handed control of all their electronic gear? The RCUSAT2 universal remote control from Thomson Consumer Electronics is compatible with virtually every brand of DSS and DBS satellite system. It also can operate the RCA Home Control System, allowing the user to have lights and small appliances turn on and off. Easy-to-read buttons emit a luminescent blue glow when activated, making the remote control easy to use in a darkened room. Besides operating a satellite system, TV, VCR, and cable box, it can control one additional component—a CD or laser disc player, perhaps, or a second TV or VCR. The RCUSAT2 is compatible with more than 205 brands of TVs, 134 VCRs, 55 cable boxes, and 137 audio devices. It offers picture-in-picture control capabilities and a sleep timer. The device carries a suggested retail price of \$39.95.



The executive on your list can easily keep track of all of his or her contacts with Seiko's *Smart Business Card Reader* and, as a bonus, get rid of all those messy and disorganized stacks of paper cards. The small desktop accessory for PCs running Windows 3.1 or 95 scans individual business cards and stores the cards' images and information into its own full-featured database or into popular personal information manager (PIM) programs including Act!, Maximizer, and Goldmine. When a business card is inserted into the top of the reader, it takes only about 15 seconds for the reader's advanced optical character recognition software to capture the card's data and place it into the appropriate fields (name, title, company, etc.). The complete image of the card, or the contacts in database format or in a list, can be viewed on screen. Users can add notes to the cards and search for contacts based on those notes.



Cards can be saved in user-defined categories and sorted by a field or multiple fields. Contact lists can be printed in either address-book, phone-book, or label format. The Smart Business Card Reader has an estimated street price of \$199.



Do you wonder, every time you pick up your phone to make a long-distance call, whether some other phone company might charge you less money for it? Have you ever tried to make sense of all the various commercials for calling plans? If so, you know how difficult it can be to make the right choice.



For anyone on your list who has to pay a monthly phone bill, consider Media-Com's *PhoneMiser*, a PC add-on that ensures you the lowest rate possible on every long-distance phone call. The device requires a PC running Windows 95, but the PC is used only for setup and uploading and downloading information to and from the device. It doesn't even need to be located in the same room as the Phone Miser. The device provides consumers and SOHO users with call-by-call access to the carrier that offers the lowest rate for each intrastate, international, and long-distance call. According to Media-Com, it can save as much as 66% on such calls by instantly searching for the carrier with the lowest rate, and then automatically placing the call with that carrier. The included software features a database that stores rate information for carriers nationwide, as well as high-speed routines to find the lowest rate for any call. For further savings, calls are billed in six-second increments, instead of being rounded up to the next full minute. Users get a consolidated monthly bill and a detailed real-time log of all incoming and outgoing calls on their PC. PhoneMiser also tracks actual savings as compared to the user's designated carrier. It is priced at \$199, with a \$4.95 monthly service charge.



For the music-loving home-office worker on your list, consider Aztec

Audio's *Silencer*. The device plugs into a stereo or surround-sound system just like an audio cable and into a phone jack. When the phone rings, and while it is off hook, the Silencer mutes the sound system. Your friend can play loud music (or even watch a ball game) while working, and never have to worry about not hearing the phone ring or sounding unprofessional when answering a call. The device is easy to install and includes no relays, which can cause annoying pops and clicks that can harm amplifiers and speakers. A patented circuit controls the volume of line-level audio signals. It allows the silencer to be connected to preamp outputs, ahead of a sound processor, to control all the channels of any audio system. The circuit is passive at normal loudness, so it is noise- and distortion-free. It fades between high and low volume levels and offers a choice of either 20 or 30 dB of audio quieting to accommodate various listening environments. The Silencer, which costs about \$50, automatically monitors one or two telephone lines, is compatible with corded or cordless phones, and is powered by the telephone line.



A great gift for a dual-career couple might be Craig's Model *CR5013* AM/FM digital alarm-clock radio. Two separate alarm settings accommodate two separate schedules, making mornings a lot easier to handle. And a battery back-up system helps them get to work on time even if there's been a power outage—it preserves the time and alarm settings when power has been interrupted. The CR5013 wakes users to an alarm or to their favorite radio station; a 60-minute sleep timer lets them fall asleep to music as well. The \$19.95 clock radio features a snooze bar and an oversized readout.



Business travelers can store their itineraries, contact addresses and numbers, schedules, and appointments in their wallets—not on little scraps of paper, but on Franklin Electronic Publishers' *REX*. The $3\frac{1}{2} \times 2\frac{1}{2} \times \frac{1}{4}$ -inch PC card has a glare-free LCD screen that displays data from the user's personal information manager. Don't worry about trying to input data on



a miniature keyboard. REX plugs into a Type II PC-Card slot on any notebook computer or PC organizer; desktop users can download data through a docking station that connects to a PC's serial port. TrueSynch Information Manager software allows REX to accept data from most popular PIM programs, including Starfish's Sidekick, Microsoft's Schedule + and Outlook, and Lotus Organizer. Two models are available. REX-1 (\$129.95) stores up to 750 items (including names, addresses, phone numbers, appointments, notes, memos, and to-do items); REX-3 (\$149.95) holds 2500 items and includes a leather wallet with notepad. The docking station is offered bundled with the REX-3 for an additional \$30, or can be purchased separately for \$39.95.



A laptop computer can be used just about anywhere, as long as there is a steady surface—preferably not a (decidedly unstable) lap—on which to sit it. No one wants to risk dropping such an expensive piece of equipment. The *Legtop Podium* from Rach Inc. allows portable-computer users to keep their laptops securely under control virtually anywhere. The combination working platform and carrying case uses a Velcro strapping system and contoured foam padding to fasten the laptop to the user's leg, enabling working angles of up to 90 degrees. The common-sense device allows users to work in almost any position—reclining on a couch, lying in a hammock, or leaning against a tree (or even perched in its branches). The *Legtop Podium*, which also serves as a streamlined carrying case, has soft, ergonomically shaped cushioning on the bottom to hug the user's leg and provide added protection for the computer. It fits all notebooks and laptops except some ruggedized models, and leaves ports and drives unobstructed for easy access. The *Legtop Podium* has a suggested retail price of \$79.99.



Clutter-busters always make good gifts (as long as you don't try to give one to anyone with whom you're romantically involved—they lack the cachet of, say, jewelry). From Memorex, the \$39.95 *Vortex CD Holder* provides attractive shelf- or desk-top storage of up to 100 audio CDs or CD-ROMs. It rotates for full access to CDs on all four sides, and can be transformed from a vertical to a spiral shape with a simple twist of its top. Rubbermaid's *Model 286M Machine Stand* with drawers can hold a printer, fax machine, copier, scanner, or multifunction unit weighing up to 70 pounds. It features four drawers (two with locks) for holding paper and other supplies, freeing up desk or counter space and providing a convenient place for spare cartridges and extra paper. The *Machine Stand* has a suggested retail price of \$69.95.



SOUND AND VISION

Give the gift of music—or video, for that matter—and you're sure to please. From inexpensive portables to all-out home theaters, the possibilities are endless. Here's a small sampling of some of the audio/video gear that we wouldn't mind finding under our own tree on Christmas morning! We'll start with some of the big ticket items that you might really want for yourself, but certainly could call a "gift for the whole family" ...

You can mount a DSS satellite dish on your roof and not have to worry about it getting in Santa's way when he tries to land his sleigh and reindeer. The 18-inch dish, coupled with a DSS receiver/decoder, will provide your family with high-quality digital video and audio, and more programming choices than your local cable company can offer. Here, we show the *UltraVision HDS-220S* system from Hitachi. The D-VHS-compatible system offers a digital interface, which consists of a simplified digital audio/video bus and proprietary software, allows for digital bit stream recording and two-way communication with the company's *UltraVision D-VHS VCR*. Together, the DSS system and VCR allow digital recording and playback on digital video tape. The digital interface also allows the use of an on-screen "virtual keypad" for controlling the VCR. The *HDS-220S* has



a dual LNB for multi-room applications, an RF remote control, *StarSight* one-touch record capability, and an easy-to-use program guide. Shop around for the best DSS prices—we've seen complete systems advertised for as little as \$99 when a year's worth of programming is purchased along with it. Installation (or an installation kit) is additional.



The consumer-electronics industry is buzzing about a hot new product called DVD, and you can get in on the digital video action this Christmas. Toshiba's second-generation of DVD players includes the top-of-the-line *Model SD-3107*, whose 10-bit video D/A converters deliver an artifact-free image at all times. Gold-plated "ColorStream" component video outputs make it possible to route



A somewhat more affordable option is the Kenwood 1080VR A/V receiver, which features Dolby Digital and fully digital Dolby Pro Logic circuitry at a suggested retail price of \$800. The receiver

the DVD player's video signal directly to any of Toshiba's ColorStream input-equipped display devices. Video Black Level expander circuitry allows the viewer to change the reference black threshold cutoff to expand the overall contrast range. Spatializer 3-D Stereo circuitry creates wide surround-sound effects using only the DVD player and a stereo TV, and fills in the "gap" between discrete front-channel speakers and the rear-effects channel in a Pro-Logic environment. Software-selectable AC-3/PCM digital audio outputs make it easy to switch between DVD and CD playback. A pre-programmed universal remote operates select functions of DSS receivers, televisions, and cable boxes. The SD-3107 has a suggested retail price of \$799.



To get the most out of a DVD deck, you'll want to be able to take advantage of the Dolby Digital soundtracks that are standard on DVD movies. To do so, you'll need a DVD player with a digital output and a receiver with Dolby Digital decoder circuitry. One such unit is the Pioneer VSX-D906S, which offers five-channel, high-power amplification as well as Pioneer's MUCAP (Multi-Channel Audio Processor) one-chip solution for processing Dolby Digital. The receiver also handles Dolby Pro Logic surround sound, and features five digitally simulated sound fields. It comes with a "Heads Up" remote, and features a multi-operational control system with on-screen assistance and confirmation. The receiver delivers 100 watts per channel, 20 Hz to 20 kHz into 6 ohms, and surround sound to front center and rear channels. The tuner offers random presets for 30 AM/FM stations. Other features include a CD titler and tuner titler, five video and



audio inputs, four S-Video inputs, and preamp outputs for front channels speakers, center channel, rear channel, and subwoofer. The VSX-D906S has a suggested retail price of \$1210.



provides 120 watts per front channel in surround and stereo modes, and 60 watts per surround channel. Its "Future Set" remote control, which is easily upgradeable through a phone link, includes three macros that allow users to program several operations into one button push.



You can record digital video with Sharp's digital ViewCam Model VL-DX10. It's both a digital camcorder and a digital still-image camera in one compact unit. The camcorder's built-in 2-MB flash memory can hold up to 12 high-resolution still images in fine mode, 24 in standard, or 48 in economy mode. Pictures can be copied onto a digital video cassette for later retrieval, or "pulled" from recorded footage, stored, and then downloaded to compatible equipment. The still images can be used as photographs or as pictorial title screens for full-motion video recording. The wireless image transfer function lets users download pictures to a PC and then send them via e-mail to family and friends. The included EasyPhoto image transfer software simplifies editing, allowing users to combine several pictures to create one panoramic shot, for instance, or perform tasks such as retouching, superimposing, and enlarging images. In long-play mode, up to 90 minutes of recording can be done on a 60-minute tape, without sacrificing picture quality or stereo sound. The VL-DX10 digital ViewCam carries a suggested retail price of \$3399.



Sony's Digital Video Cassettes are designed for use in digital camcorders and VCRs. The line includes four different product types, ranging in suggested price from \$19.99 to \$39.95. The EXM series (Excellence with Memory), available in 30- and 60-minute lengths, includes a 4K memory chip that allows users to store information about the date and time of the recording. The EX series offers the same performance level, without the memory chip. The more economical PR (Premium) series, sans memory chip, is also available in 30- and 60-minute lengths. The MEM series of standard-size DV cassettes for VCRs includes the 4K memory chip and is available in 120- or 180-minute lengths.



An Arcadia Home Monitor from Princeton Graphic Systems will allow your family to surf the net on a large-screen TV. Available in 27- or 31-inch sizes, the monitors combine all the features of a television with the functionality of a VGA monitor. Designed for use with current and emerging technologies such as cable TV, VCRs, DVD, DSS, and WebTV, they let the whole family watch movies, play video games, or use the computer on a large screen. Prices start at \$799.



Setting up a home theater for your family doesn't have to set back your bank account too far. Aiiwa's Mini Theater Series, for instance, includes all the necessary ingredients for home-theater audio, right out of the box. The *NSX-AV900*, shown here, is a mini-system equipped with Dolby Pro Logic surround sound. It comes with five speakers (two front, two surround, and one center-channel unit), three-mode digital signal processing, a three-disc CD changer, a dual auto-reverse cassette deck, sound enhancement, bass enhancement, and a full-function remote control. It offers a total of 240 watts. Just add a TV and a VCR, and you're ready to watch. The *NSX-AV900* has a suggested retail price of \$700.



Is there one member of your family who likes his movies loud—much to the distraction of the rest of the household? If so, check out *AKG Acoustics' K 290* wireless surround headphones and *K 290* surround switchbox. The system allows the user to fully enjoy the surround-sound experience without disturbing anyone else. The headphones actively support four channels of sound. Each earpiece contains two transducers—a front transducer for the stereo channels and a rear transducer for the surround channels, angled to produce the appropriate depth perception. The center channel is output through both front transducers. The included 20-foot adapter cord for conventional headphone performance features eight channels, which means that each of the four transducers is driven indepen-

dently. The *K 290* Switchbox allows users to switch between the *K 290* headphones and loudspeakers at the press of a button. Up to five speakers can be switched. The box also matches the volume of the headphones to that of the loudspeakers. One switchbox will drive additional *K 290* headphones. The *K 290* headphones and switchbox cost \$267 and \$185, respectively. Packaged together, they cost \$415.

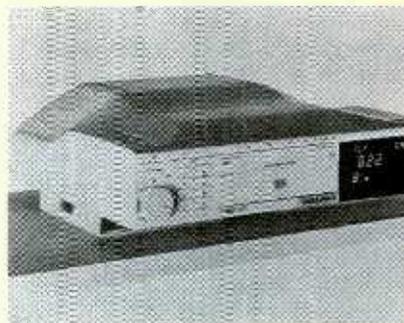


Add the sound of music to your kitchen, bedroom, or den without adding a full-size sound system. The *Bose Wave Radio*, now available in a graphite-gray finish as well as the classic pearl-white finish, produces high-quality sound from one small component. Measuring just 4.5 inches high by 14 inches wide by 8 inches deep, the *Wave* radio boasts a subtle, distinctive yet unobtrusive design. Its full, rich sound fills most home listening rooms, thanks to the 34-inch, single-ended "waveguide" inside the unit. The *Wave* radio provides excellent reproduction of speech and music at any volume level. Simple touch controls are found on the front panel and the credit-card-sized remote. The AM/FM radio offers 12 presets, mute, scan, and automatic sleep features. Users can fall asleep listening to one station, and wake to another as gradually as they like with a feature that starts at a low volume and automatically builds to the preferred setting. Other components such as a CD player or cassette deck can be added, and connecting a TV to the *Wave* radio can greatly enhance the sound quality of many TVs. The *Wave* radio costs \$349.



Another option for kitchen listening is Proton's *KS-530CD*, an AM/FM stereo radio with CD player and alarm clock that's designed for under-cabinet mounting. The sound system is designed to withstand the typical daily abuse to which a kitchen appliance is subjected, and comes with its own streamlined mounting

bracket for easy installation. The drawer-loading CD player allows the user to program the track order, listen to tracks sequentially, or select random play. The



radio offers 20 station presets and an "intuitive on" feature that turns the radio on automatically when any button is touched. The unit offers separate alarm memories, one for the radio and one for the beeping alarm, as well as a countdown timer that can be set for up to two hours. Two three-inch front-firing speakers are built into the base of the unit. The *KS-530* has a suggested retail price of \$250.



Apartment or dorm dwellers—or any teenager—would love to receive Sharp's *CD-C460 Mini System*. Besides the standard AM/FM receiver, double cassette deck, and CD changer, its Dolby Pro Logic surround sound, five speakers, and 70 watts total output power allow the sound system to double as a home-theater system in a tight space. The three-disc drawer-load CD carousel features 32-track APMS (automatic programmable music selector) and random/repeat play modes. The tuner offers 40 station presets and a built-in clock timer. An A/V function allows users to integrate the mini system with a TV and VCR for quick and easy home-theater setup. A headphone jack allows private listening without disturbing roommates, neighbors, or family members. The *CD-C460* has a suggested retail price of \$399.95.



For the audiophile on your list, consider Acoustic Research's *The Edge Series* of high-performance loudspeaker systems built around The Edge, a compact speaker concept. The Edge is a two-way, magnetically shielded satellite speaker with a power rating of 20-150 watts, sensitivity of 91 dB @ 2.83 volts/meter, and a fre-



quency response of 75 Hz - 20 kHz \pm 3 dB. The Edge's high efficiency allows the lower powered amplifiers found in multi-channel A/V receivers, multimedia systems, and personal stereos to produce dynamic, realistic sound. The Edge is sold separately (\$279/pair) for use in three-piece subwoofer/satellite applications or six-piece multi-channel A/V systems. It is also the cornerstone of the Leading Edge System, shown here. The Leading Edge combines five identical Edge satellites with a 12-inch subwoofer to form a Dolby Digital "home-theater-in-a-box" system. It features Dolby Digital processing using a proprietary 18-bit digital design, six channels of amplification, two digital inputs, two analog inputs, an on-screen graphic user interface, a full-function remote control, and is compatible with NTSC, PAL, and SECAM formats. The Leading Edge has a suggested retail price of \$1999.



TAKING IT ON THE ROAD

Listening to music—and even watching TV—shouldn't be confined to the house. The following gift ideas are intended to let people take music and video with them wherever they go, whatever they're doing.

The workout-aholic on your gift-giving list would be sure to like Aiwa's *Cross Trainer HS-SP500*, a headphone stereo that includes an exercise monitor that determines how far the user has walked or jogged, and how many calories have been burned. The rugged personal stereo features a digital AM/FM stereo tuner, a



water-resistant auto—reverse cassette player, Super Bass for enhanced low frequencies, and headphones with built-in LEDs that flash to make the wearer visible at night. To use the exercise monitor, the user enters some basic data, then sets a timing "beep" (heard through the headphones) so that its rate matches his or her walking or jogging pace. At the end of the workout, the monitor displays the distance travelled and the number of calories burned. The HS-SP500 has a suggested retail price of \$90.

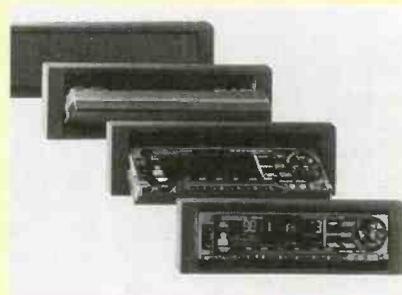


Panasonic Matsushita's *SL-S320* portable CD player uses the company's Anti-Shock Memory system to ensure smooth,



continuous disc play even in rough-and-tumble situations. The Anti-Shock Memory system spins discs faster than normal and stores extra sound data in memory. If a strong bump causes a skip, the CD player can continue playing music from its reserve without audible interruption. Up to 10 seconds of music can be stored in the audio buffer. The SL-S320 can run for up to 10 hours on two AA batteries. An AC adapter is included, and rechargeable batteries are available optionally. Sound quality is ensured by the unit's MASH 1-bit digital-to-analog converter with its exceptional signal linearity and by the XBS Extra Bass System

for improved bass response. The CD player offers 24-track random access programming and several other playback options. A hold switch prevents accidental button pushes from having any effect. A slightly different version, the SL-S321C, adds several features that make it well-suited for listening in the car, including a DC power cord. A backlit LCD makes it easy to see during night trips, and a car-cassette adapter enables the car's speakers to be used. The SL-S320 and SL-S321C cost \$119.95 and \$129.95, respectively.



Is there someone on your list who has been reluctant to invest in a car-audio system for fear of theft? Kenwood's *KDC-7007 "Mask"* car CD player/receiver has a self-hiding, revolving faceplate that completely conceals the unit when not in use. A security code system makes the unit inoperable for anyone who doesn't know the code. The KDC-7007 includes a tuner with 24 station presets, provides 35 watts of power to four channels, and can operate two optional multi-CD or MiniDisc changers that can be stored in the vehicle's glove compartment or trunk. For high-quality sound reproduction, the CD player features Kenwood's proprietary Precision Digital Timing and Digital Optimum Servo Control Technologies. The "Mask" has a suggested retail price of \$380.



Do you know someone who just can't bear to miss a ball game or a soap opera? TeleMania's *Jeep TV Boom Box* packs a

four-inch color LCD TV, a multifunction CD player, and an AM/FM stereo tuner into a rugged, weather- and shock-resistant durable case. Dual external video jacks allow it to be used with a satellite-TV system or VCR. The Jeep TV Boom Box, which costs under \$500, runs on eight "D" batteries, or with the included AC power cord. Three pockets under the lid provide CD storage.



For the ultimate in mobile listening—in fact, you might want to put this one at the top of the list in your letter to Santa Claus—how about a Corvette equipped with a Bose music system acoustically tailored to the car's environment? Now standard equipment in the Corvette, the music system uses the latest advancements in lightweight design and materials. Unique Timpani speaker technology provides powerful bass reproduction, dynamic range, and power handling from a light, thin speaker. Timpani woofers are mounted in the car's doors, effectively turning them into powered bass modules. The system includes two speakers and a patented 100-watt, two-state modulation amplifier in each door. In addition to the Timpani woofer, there is a 3.5-inch hybrid tweeter/midrange speaker to provide the rest of the musical spectrum, add realism, and enhance the acoustical image in the car. A 6.5-inch wide-range speaker is installed and precisely angled in each



of the rear quarter panels to ensure musical realism at all frequencies.

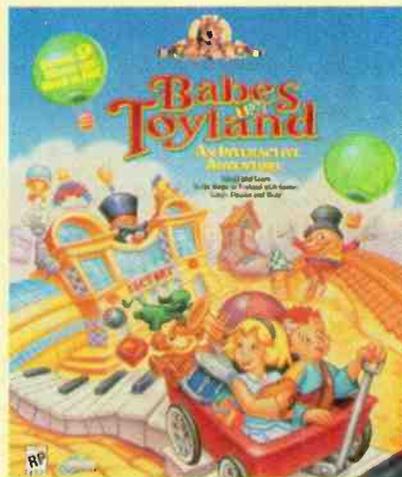
The sound system also offers Bose's patented signal processing and proprietary circuitry. The signal-processing module, located under the steering column, includes an active equalization network to electronically tailor the system's frequency response to the car's acoustic environment, signal processing to ensure accurate reproduction at any listening level, and compression circuitry to prevent sound distortion at maximum listening levels. See your local Chevrolet dealer for price (but only if you're expecting a *really* big bonus this year!).



FOR KIDS (OF ALL AGES)

Christmas is for children—and it brings out the child in all of us. Here are some fun, whimsical, or just plain silly gift ideas for kids "from one to 92."

What software could be more appropriate for the holidays than MGM Interactive's *Babes in Toyland*? Children help Jack and Jill find Santa's missing toys as they interact with legendary Mother Goose characters. The CD-ROM features 12 arcade, music-inspired, and puzzle games designed to help young players develop problem-solving skills. Working with shapes, colors, and numbers, kids perform entertaining tasks such as helping the Old Woman in the Shoe



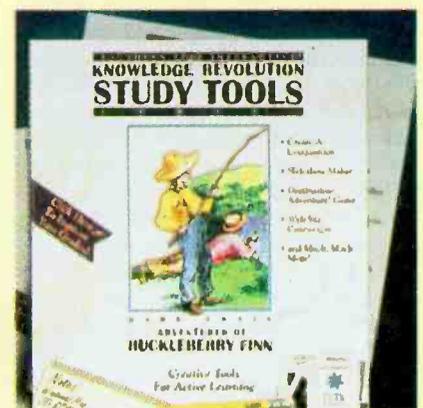
find her lost children and rescuing toys from a well. Upon completion of the game, players can print out a personalized color "thank you" certificate from Santa Claus himself. Three adjustable levels of difficulty accommodate different players of various ages. The software has a suggested retail price of \$29.95.



Toshiba's *Looney Tunes Tronics* line of personal electronics products all feature user-friendly technology and colorful Warner Brothers Cartoon characters. There are corded phones bearing the likenesses of Bugs Bunny and Marvin the Martian; a Taz clock radio; a Tweety Bird AM/FM radio with sing-along microphone; and a Bugs Bunny personal cassette player. Taz is also featured on a Looney Tunes Tronic electric pencil sharpener. Prices range from \$19.99 to \$49.99.



Nickelodeon's *TalkBlaster* telephone from Long Hall Technologies stands out from the crowd with its offbeat design and engaging sounds. Its "Green Slime" power rod flashes when the phone rings. A "Big Red Button" activates four wacky sounds: moo, honk, bell and "Nick Noise" (nick, nick, nick). The vibrantly colored phone has an easy-to-hold finger well, sure-grip rubber feet, flash and redial buttons, a five-choice ring selector, and a list price of \$49.95. But, please teach the little ones proper phone etiquette before they open this gift!



Have a hard time getting your kids to get into classic literature? Would they prefer to play on their computer than read a book? In the "if-you-can't-beat-em"

category, Southern Star Interactive offers *Knowledge Revolution Study Tools*—Windows and Macintosh CD-ROM versions of children's classics, including *The Adventures of Huckleberry Finn* and *The Adventures of Tom Sawyer*, *The Scarlet Letter*, *The Old Man and the Sea*, and *Romeo and Juliet*. Each program includes the full text of a book along with four unique tools designed to help students understand and interpret what they read. *Create-A-Composition* guides kids through book-report and analytic essay writing. *Slideshow Maker* allows students to add multimedia pictures and text passages along with their own notes to create in-class slide shows. The *Notebook* lets students "write in the margins," by attaching their own electronic notes to any element in the program. Each program also includes an adventure game made up of visual and audio puzzles, as well as multiple-choice, matching, and sequencing questions. The company's Web site offers additional educational resources, including access to the Mark Twain Museum. Retail price is \$29.95



For today's busy kids, consider Tiger Electronics' *game.com*, a portable cartridge-based video gaming system that's also a personal organizer and communications center. The device offers a cutting-edge touch-screen/stylus interface, actual speech, and optional text-based Internet/e-mail access (which requires an external modem and a subscription to Delphi's online services). Personal organizer functions include a phone directory, a calendar, and a calculator. The *game.com* has a built-in version of Solitaire, and comes bundled with *Lights Out*, Tiger's classic puzzle game. Launch titles include *Batman & Robin*, *Duke Nukem 3D*, *Mortal Combat Trilogy*, *Wheel of Fortune*, *Henry*, *Indy 500*, *The Lost World*, *Quiz Whiz*, and *Williams' Arcade Classics* (*Defender*, *Defender II*, *Joust*, *Robotron*, and *Sinistar*). The *game.com* costs \$69.95; additional cartridges retail for \$19.95 to \$29.95.



Kids age eight and older can travel through stunning 3D environments battling animated mythological foes as they play Virgin Interactive's *Disney's Hercules Action Game* for the Sony PlayStation. To make the game as close to the film as possible, several actors who "performed" in the film produced separate dialogue for their interactive roles. Danny DeVito, James Woods, Rip Torn, and others tease, taunt, and challenge players throughout the game. Following the film's storyline, the player (who takes on the role of Hercules) fights animated enemies and villains including the Hydra and the Cyclops, ever striving to become a hero and live on Mt. Olympus with Zeus. This game retails for \$54.95.



InterAct Accessories' *Arcade Shark* is a new "fighting stick" designed for games like "Killer Instinct" and "Wave Race." The arcade-style joystick lets players save all their vital game data and irreplaceable



moves with a memory card slot. The memory card is inserted right into the top of the joystick. Players can choose their style of game playing with the removable joystick that can be placed in either the analog or digital control port. In fighting games like "Mortal Combat Trilogy," the larger buttons on the *Arcade Shark* make tricky combination moves much easier. The joystick has a suggested retail price of \$59.99.



Have your kids been begging for a pet? Maybe this is the time to give in to the electronic-pet craze. Tiger's version, called the *Giga Pet*, comes in several models—the ever popular dog and cat as well as a Virtual Alien, a Microchimp, a Bit Critter, a Baby T-Rex (licensed from *The Lost World*), and a puppy from Disney's *101 Dalmatians*. Each virtual pet is attached to a key-chain with an LCD screen that is the pet's "home." It is the owner's responsibility to raise the pet



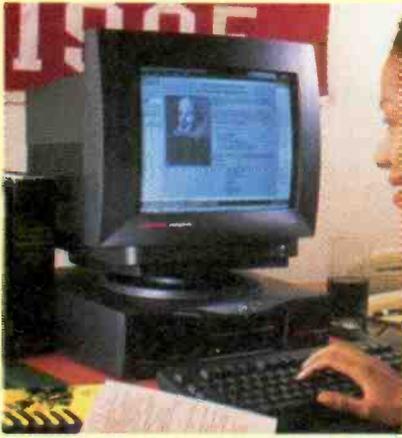
to be healthy and happy—which requires feeding, playing, clean up, bathing, and vet visits. Points are scored for keeping the pet content. And, unlike with a live pet, you won't have to walk or feed it. Prices range from \$9.99 to \$12.99.



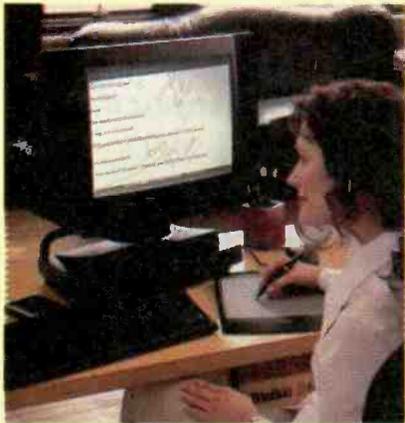
PRESENTING PC PRESENTS

'Tis the season for peace on earth ... and a PC under the tree. Here are some computers and accessories that might put smiles on the faces of your family and friends.

Compaq breaks the \$1000 price barrier with *Presario 2200*, which starts at \$799 with a 180-MHz Media GX processor. Add a 14-inch Compaq monitor, and the total price comes to \$999. The 2200 Series features 16 MB of total system memory, expandable to 80 MB; a 1.6-GB hard drive, an 8X CD-ROM, and a 33.6/14.4Kbps data/fax modem, upgradeable to 56K. Its software bundle includes Microsoft Windows 95, Works, Money, Internet Explorer, Creative Writer 2, Encarta 97 Encyclopedia, and Bookshelf; *Sim City 2000 Network Edition*; Compaq Internet Setup; *The Palace*; *Shockwave*; and *Sprynet*. The Epson 600Q color inkjet printer is included.



Don't give that college student a pen-and-pencil set—think 21st century and splurge on an electronic writing tool, such as the Cross *iPen*. The easy-to-use *iPen* extends the capabilities of the mouse and keyboard. Consisting of an electronic pen and tablet, the *iPen* connects to any standard 9-pin COM port and runs under Windows 95. Functioning in much the same manner as a mouse, it can move the cursor and activate all Windows 95 func-



tions. It is also an ideal tool for accessing the writing, annotation, and drawing capabilities of many popular applications, including computer faxing. A special elastomeric tablet surface and synthetic ruby tip provide users with a "pen-on-paper" feel. The *iPen* has a suggested retail price of \$149.99; bundled with Symantec's WinFax PRO fax software, it costs \$199.99.



No mobile professional can travel without a good portable computer. Sharp's PC9300 series multimedia notebooks feature 150-MHz Pentium processors, 16 megabytes of EDO memory (upgradeable to 48 megabytes of RAM), 256-kilobytes level 2 cache, a 1.44-giga-

byte hard disk, a 10-speed CD-ROM, a 3.5-inch floppy drive, and 16-bit stereo sound. The portable computers come with a GlidePad pointing device, a bright 11.3-inch color SVGA LCD screen, and fast infrared connectivity. The PC9300s are preloaded with Puma Technology TranXit for Windows, IntelliLink Import/Export, and Zaurus Application Partner software, making it easy to transfer files without cable to other IR-equipped PCs, PDAs, and handheld organizers such as Sharp's Zaurus. A Simultaneous Display video mode allows the LCD to be used at the



same time as an external monitor or projection system for delivering presentations. The notebooks offer an integrated 33.6-Kbps voice/data/fax modem, Microsoft Internet Explorer Web browser, America Online, and CompuServe access software. Prices range from \$2199 to \$3500.



A more compact solution for the traveling business person on your list is the *Velo 1* from Philips. The handheld PC provides a familiar solution for mobile computing, communications, and information management. Based on the Microsoft Windows CE platform, it comes equipped with Microsoft Pocket Word, Pocket Excel, and Pocket Internet Explorer. The *Velo 1* is configured with everything the busy professional needs,

including a low-power 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. The built-in data/fax modem and dual Miniature Card expansion slots allow users to expand their memory and upgrade the operating system without sacrificing communications ability. (The *Velo 1* also supports industry-standard PC Cards.) Prices start at \$599.



What to buy for the couch potato on your list? Well, there's always a gift certificate to BlockBuster. Or you can get him a remote control for his computer. InterAct's *Web.Remote Professional* allows any user to surf the Net wire-free, as easily as flipping through the channels



on a TV. It has a range of almost 25 feet, and plugs into any IBM-compatible PC via an available serial port. Trigger-style buttons for left and right buttons are found on the bottom of the unit for handheld use, or the device can rest on the desktop. The *Web.Remote Professional* also doubles as a presentation tool, allowing users to access programs like Microsoft's PowerPoint, Astound, or Lotus Freelance remotely. Microsoft Internet Explorer and Net meeting for Windows 95 are bundled with the remote Internet controller. The unit retails for \$79.99.

Well, that should give you at least a few ideas—if not for what to give this year, at least for what to ask for! Happy Holidays from all of us at Gizmo!

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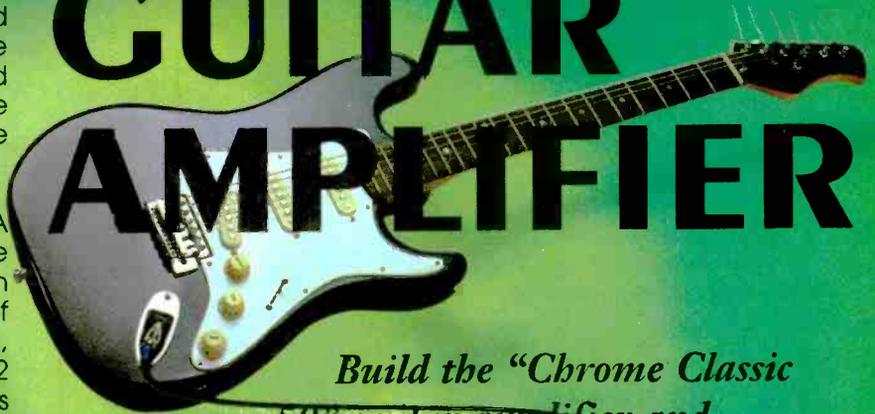
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If you are a guitar player, then you probably know all too well how expensive amplifiers and effects can be. It's easy to spend several hundred dollars on amplifiers and effects, but now you can build your own guitar amp and save big bucks! The *Chrome Classic 50* features a 50-watt amplifier, "clean" and "crunch" channels, adjustable tone and distortion controls, and a 10-inch, aluminum-cone speaker. But best of all, it can be built for under \$200!

GUITAR AMPLIFIER

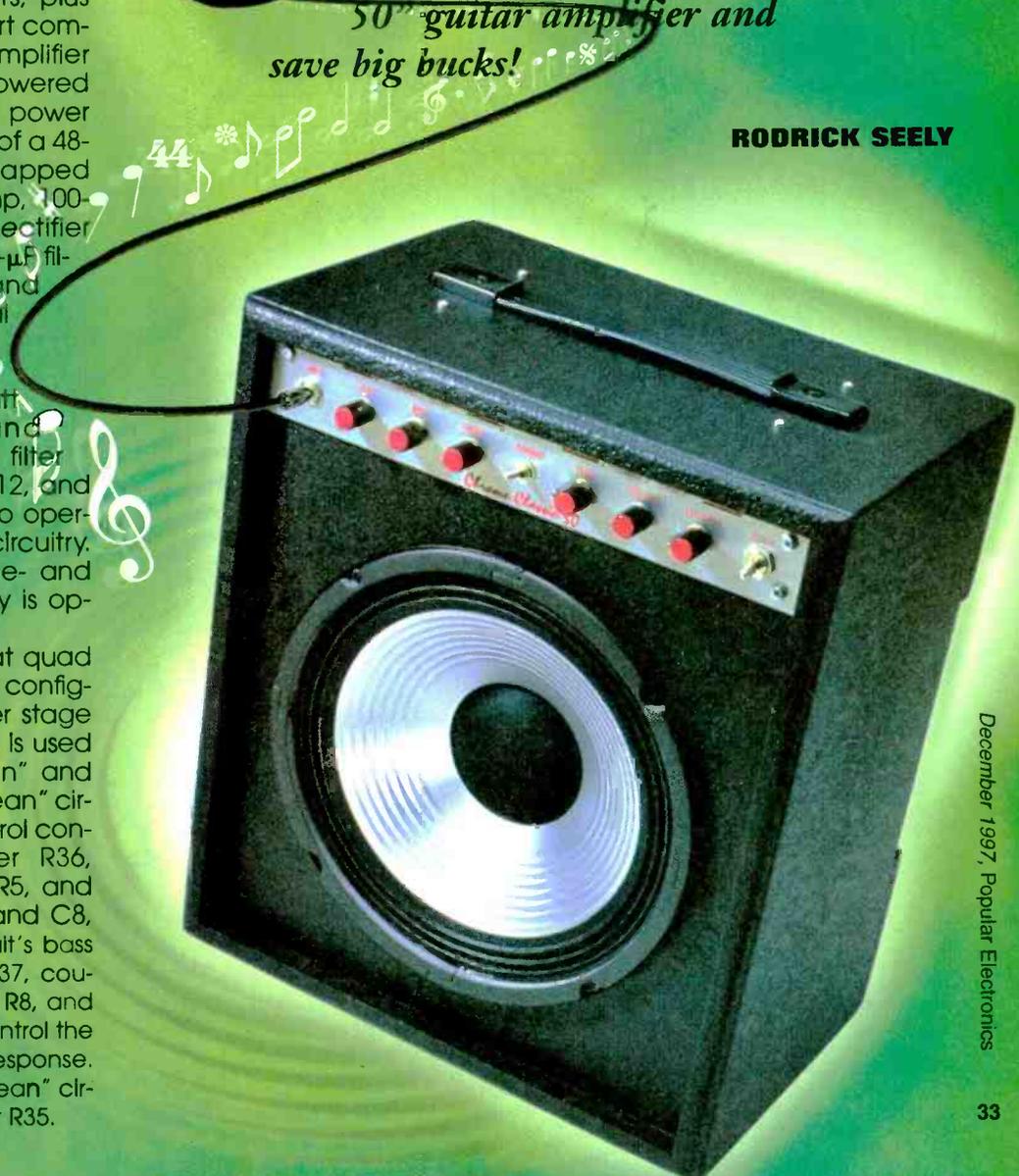


Build the "Chrome Classic 50" guitar amplifier and save big bucks!

RODRICK SEELY

Circuit Description. A schematic diagram of the *Chrome Classic 50* is shown in Fig. 1. The circuit is comprised of a single integrated circuit (IC1, a TL074A quad op-amp), 12 diodes and 12 transistors, plus several additional support components. The power amplifier portion of the circuit is powered from a dual (\pm) 35-volt power supply that is comprised of a 48-volt 1.2 -amp, center-tapped transformer (T1), a 4-amp, 100-PIV fullwave bridge rectifier (BR1), and a pair of 4700- μ F filter capacitors (C23 and C24). A secondary dual power source (\pm 12 volts)—which is comprised of a pair of 1-watt Zener diodes (D11 and D12), along with their filter capacitors (C10 and C12, and C11 and C13)—is used to operate the tone/distortion circuitry. At the heart of the tone- and distortion-control circuitry is op-amp IC1.

One op-amp from that quad package, IC1-a (which is configured as a buffer/amplifier stage with a gain of about 20), is used to drive both the "clean" and "crunch" circuits. The "clean" circuit is a classic tone-control configuration. Potentiometer R36, along with resistors R4, R5, and R6, and capacitors C7 and C8, controls the "clean" circuit's bass response. Potentiometer R37, coupled with resistors R7 and R8, and capacitor C6, is used to control the "clean" circuit's treble response. The output level of the "clean" circuit is set by potentiometer R35.



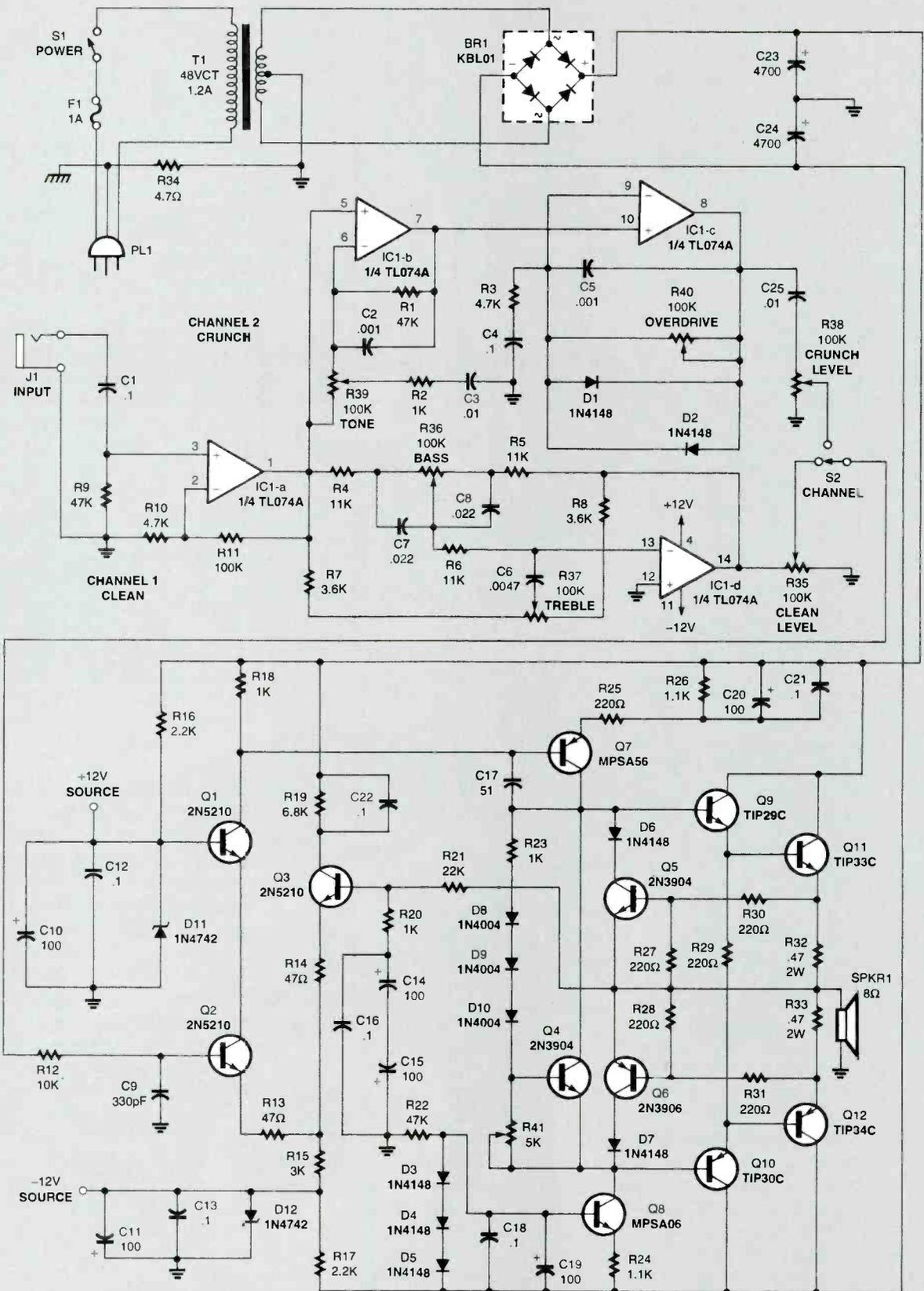


Fig. 1. The Chrome Classic 50 is comprised of a single integrated circuit (IC1, a TL074 quad op-amp), 12 diodes and 12 transistors, plus several additional support components. The circuit is powered by a pair of dual power supplies. The main power source is a ± 35 -volt supply that is comprised of a 48-volt, 1.2-amp, center-tapped transformer (T1), a bridge rectifier (BR1), and a pair of filter capacitors (C23 and C24). The other power source is a ± 12 -volt supply that's comprised of Zener diodes D11 and D12, along with their filter capacitors (C10 and C12, and C11 and C13). The secondary power source is used to operate the tone- and distortion-control circuitry.

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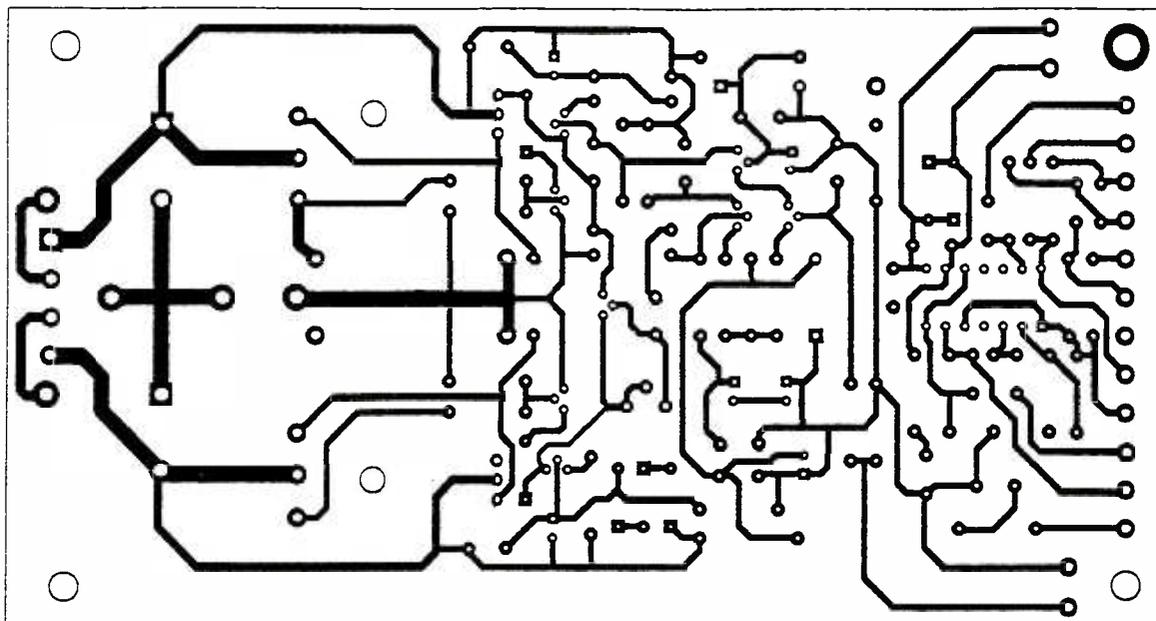
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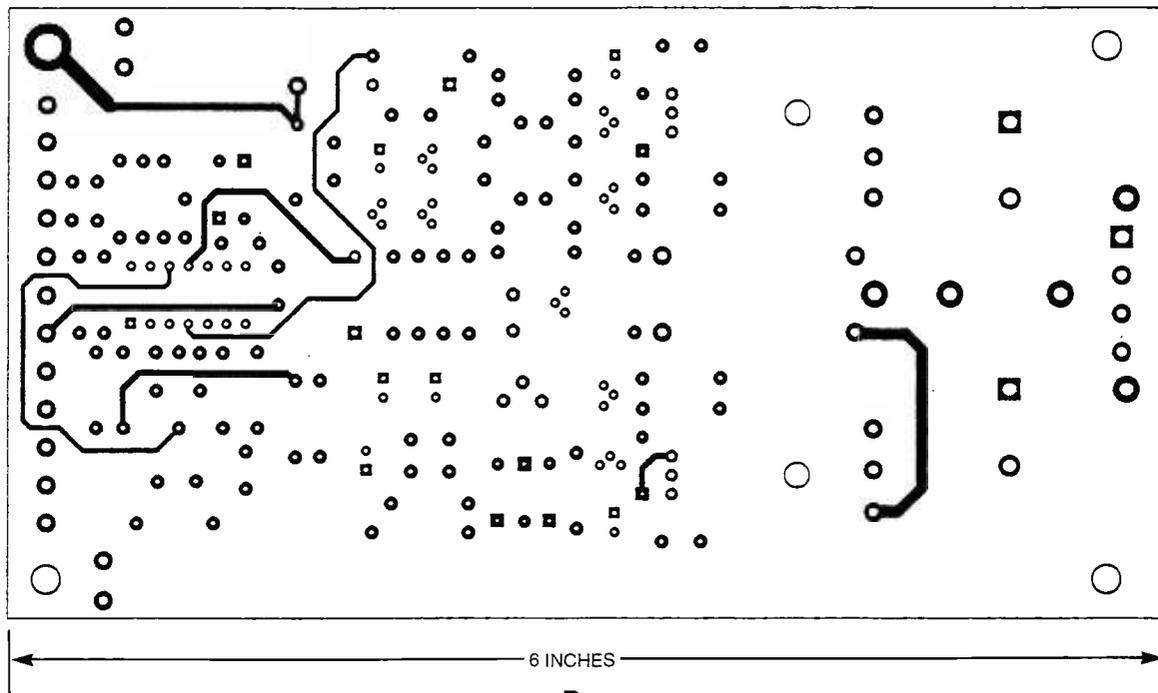
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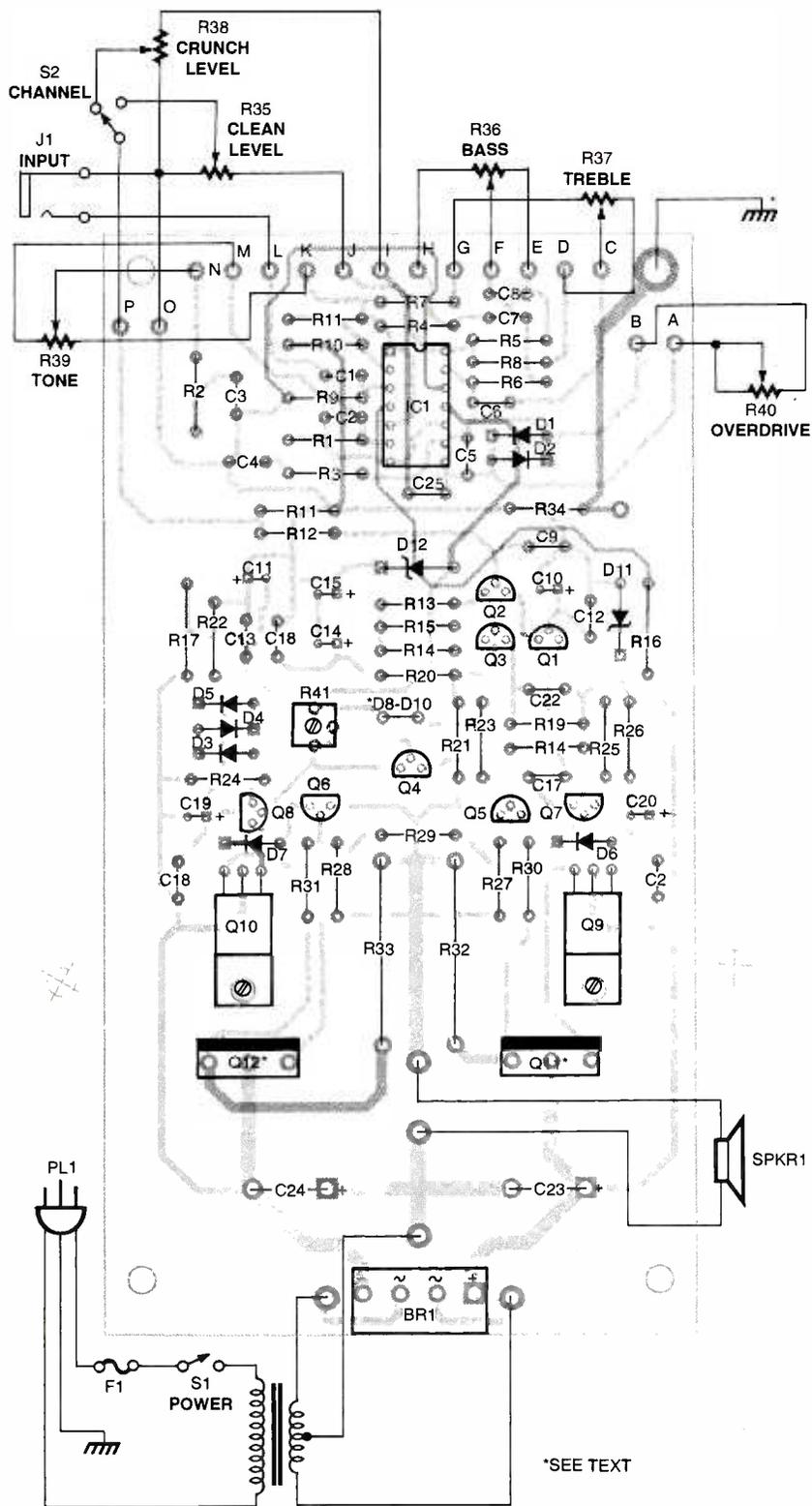
B

Fig. 2. The bulk of the guitar amplifier (comprising the tone and distortion circuits, the power amplifier, and portions of the power supply) was built on a double-sided printed circuit board. A template of that double-sided, printed-circuit layout is shown here at full scale: A shows the foil side of the board, while the component side is shown in B. The printed-circuit board is available separately or as part of a complete kit of parts from the supplier listed in the Parts List.

The "crunch" circuit is comprised of a variable TONE control and an adjustable distortion effect circuit. In the "crunch" circuit, op-amp IC1-b, along with resistors R1 and R2, capacitors C2 and C3, and potentiometer R39 (which functions as a

tone control), amplifies or attenuates frequencies above 1 kHz. Diodes D1, D2, and IC1-c are used to produce the distortion effect by clipping the signal at about 0.5 volts. The distortion effect can be altered slightly by substituting a pair of LEDs

for D1 and D2. Potentiometer R40 (OVERDRIVE) is used to adjust the amount of distortion applied to IC1-c, while potentiometer R38 controls the "crunch" circuit's output-volume level. Capacitor C25 is included in the circuit to help reduce unwanted



er portion of the circuit, potentiometer R41 is used to adjust the bias current applied to the power transistors to about 50 mA. Diodes D8-D10 are included in the circuit to provide temperature compensation, and as such must be located near the power transistors (Q11 and Q12). Transistors Q5 and Q6, along with resistors R27-R31, are used to provide short-circuit protection.

Construction. The power supply, tone and distortion circuits, and power amplifier are built on a double-sided, printed-circuit board. There are a couple of good reasons why a printed-circuit board is recommended for the project. One reason is to prevent the noise and self-oscillation problems that can occur in audio projects that are built using other construction techniques. In addition, using a printed-circuit board simplifies construction and usually has a better chance of working on the first try. A template of the author's double-sided, printed-circuit layout is shown in Fig. 2 (shown in A is the foil side of the board, while the component side is shown in B). The board for the circuit can be either etched from the printed-circuit templates, or purchased from the supplier listed in the Parts List.

Once you've obtained all of the parts listed in the Parts List, construction can begin. Start by assembling the printed-circuit board guided by the parts-placement/wiring diagram shown in Fig. 3. When assembling the board, be sure to pay close attention to the proper orientation of the polarized components (ICs, transistors, diodes, and electrolytic capacitors). In addition, notice that only a single set of mounting pads are provided for diodes D8-D10. Those three diodes were series connected to a small piece of perboard, which was then attached using epoxy to a heatsink panel (which we'll discuss shortly) near the power transistors. After that, the diode string was connected to the circuit board using short lengths of wire. When wiring the diode string into the circuit, be sure to observe the proper polarity. Also, care should be taken to prevent the metal connections on the diodes from touch-

Fig. 3. Assemble the printed-circuit board guided by this parts-placement/wiring diagram. Be sure to pay close attention to the proper orientation of the polarized components (ICs, transistors, diodes, electrolytic capacitors) when assembling the board. Caution: Only a single set of mounting pads are provided for diodes D8-D10: Those three units were series connected to a small piece of perboard, and connected to the circuit board using short lengths of wire.

low frequencies.

Switch S2 is used to determine whether either the "clean" or

"crunch" signal is to be sent to the power-amplifier stage—a 50-watt class AB circuit. In the power ampli-

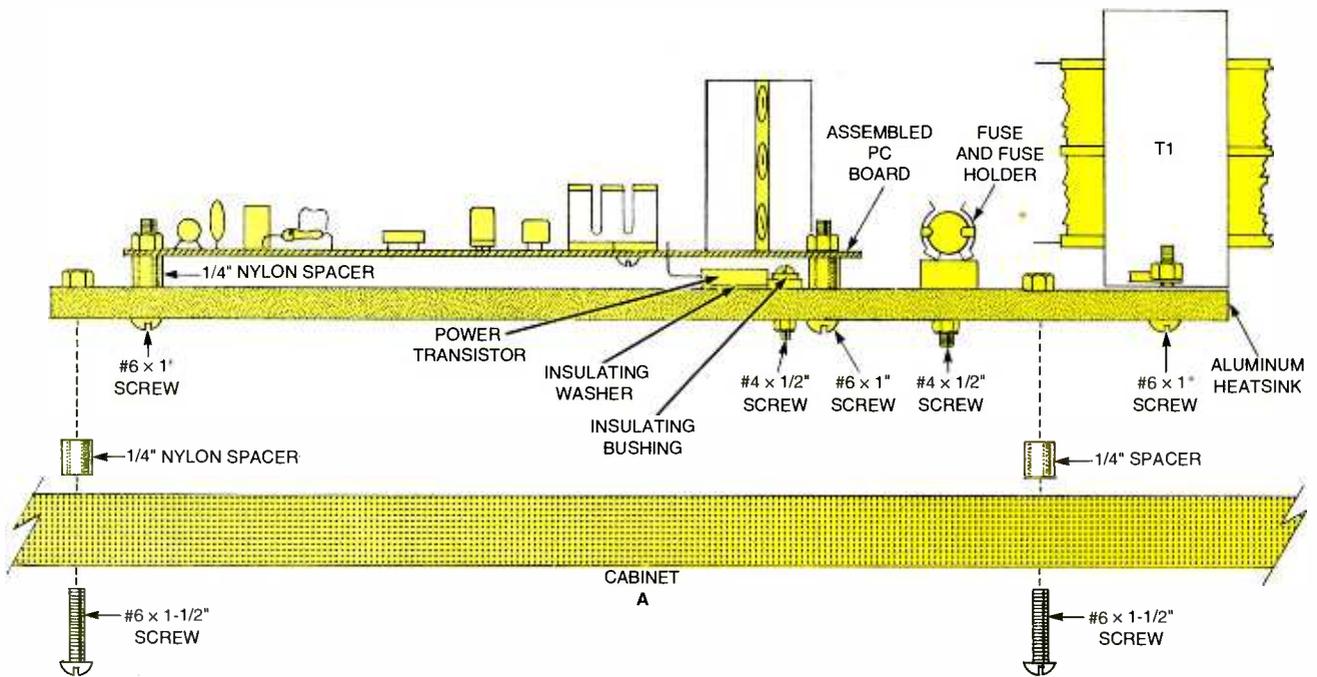


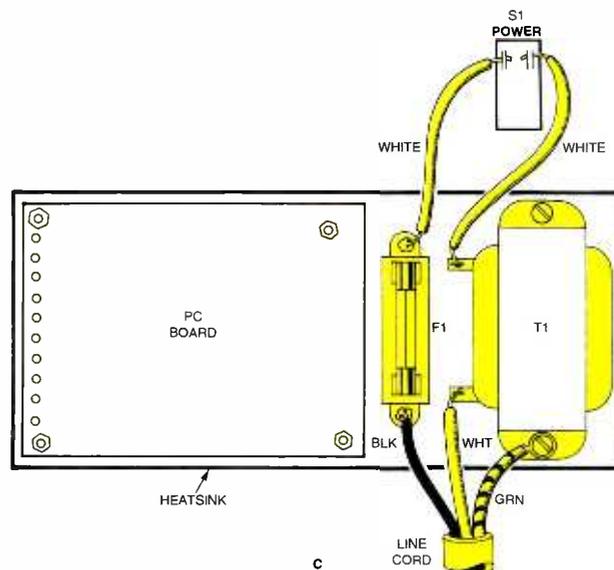
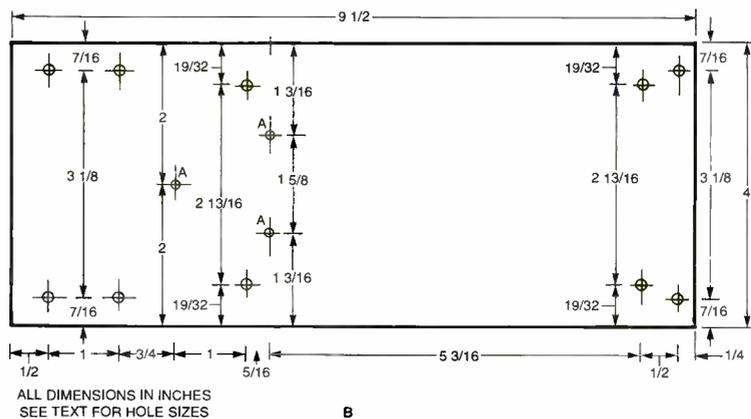
Fig. 4. The transformer, fuse holder for F1, and circuit board assembly are mounted to a heatsink that's little more than a 9-1/2- by 4-inch section of 1/4-inch thick aluminum flat bar. Note: Q11 and Q12 are mounted to the foil side of the board with their leads bent at a 90° angle so that their tabs can be secured to the heatsink panel, as illustrated in A. Details for drilling the heatsink panel are shown in B. Once the heatsink has been drilled, mount the circuit board, transformer, and fuse holder to the heatsink as shown in C.

ing the heatsink panel.

Note: Although Q11 and Q12 are shown as though they are mounted to the component side of the board, those transistors are actually mounted to the board's foil side, and the leads bent at a 90° angle, as illustrated in Fig. 4A, so that their tabs can be secured to the heatsink panel. The transformer, fuse holder, and circuit board assembly are mounted to the aforementioned heatsink panel, which is comprised of a 9-1/2- by 4-inch section of 1/4-inch thick aluminum flat bar. Details for drilling the heatsink panel are shown in Fig. 4B. Note: All of the holes in the heatsink panel should have a diameter of 5/16 inches except the one labeled A, which should be 1/8 inch.

Once the heatsink has been drilled, mount the circuit board, transformer, and fuse holder to the heatsink panel as shown in Fig. 4C.

As outlined in Fig. 4A, the tabs of



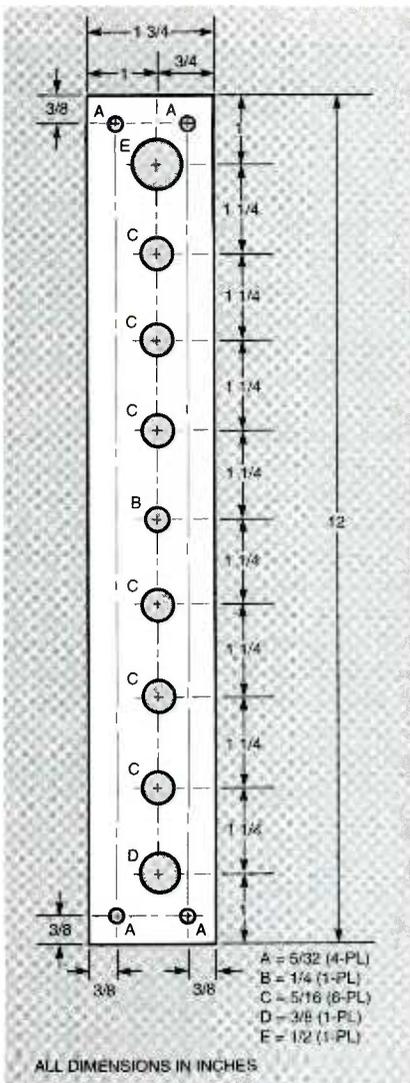


Fig. 5. The potentiometers, switches, and input jack are mounted to an $\frac{1}{8}$ -inch thick section of sheet metal, which serves as the control panel. Details for fabricating the control panel are shown here. Hole sizes (in inches) are given in the form of a table.

power transistors Q11 and Q12 are secured to the heatsink panel with appropriate hardware. Be sure to use insulators and bushings on Q11 and Q12 to prevent the tabs from shorting against the heatsink panel. Double check component placement and soldering before installing the fuse and connecting the line cord.

Several wires of various lengths are used to connect the panel-mounted and other off-board components (potentiometers R35–R40, SPKR1, J1, S1 and S2, and T1) to the printed-circuit board. It is a good idea to color-code your wiring to prevent wiring mistakes. The potentiometers, switches, and input jack

are mounted to an $\frac{1}{8}$ -inch thick piece of sheet metal, which serves as the control panel. Details for fabricating the control panel, which measures 12 by $1\frac{3}{4}$ inches, are shown in Fig. 5. Hole sizes (in inches) are given in the form of a table.

Testing. Before installing the amplifier assembly in the cabinet, the power supply should be tested, and the bias current must be set. Make sure that the line cord is installed properly, and component leads on the circuit board are trimmed so that they do not touch the metal heatsink. Also double check the wiring from the control panel to the circuit board. Before powering up the amplifier, turn potentiometer R41 (the only board-mounted potentiometer) fully counterclockwise. Apply power to the amplifier and check the power supply. Verify the presence of +35 volts DC at collector of Q11 and –35 volts at the collector of Q12. If those points check out, verify that ± 12 volts DC is connected across the power supply inputs to IC1 (+12 volts at pin 4 and –12 volts at pin 11). Also make sure that the DC voltage across the speaker (SPKR1) is less than 0.2 volts. If there is too much DC voltage on the speaker, or if other voltages are not correct, disconnect the power and double check the component placement.

To adjust the bias current, turn both level potentiometers (R35 and R38) all the way down—fully counterclockwise—and connect the probes of a DC voltmeter across the emitters of Q11 and Q12. Slowly adjust potentiometer R41 until the meter shows 0.025 volt (25 mV). As the amplifier gets warm, the temperature-compensation diodes should lower the bias current. If the voltage across R32 and R33 (located at the emitters of Q11 and Q12, respectively) does not decrease as temperature increases, make sure the diodes are fastened firmly to the heatsink near Q11 and Q12.

Cabinet Construction. The cabinet for the Chrome Classic 50 guitar amplifier measures about 15 inches (H) by 13 inches (W) by 8 inches (D) and was fabricated from $\frac{5}{8}$ -inch thick particle-board stock. Figures

6–8 give details on the construction of the enclosure for the Chrome Classic 50 guitar amp. Figure 6 gives dimensions for the enclosure's front panel. The front panel has a round cutout for a 10-inch speaker, and a rectangular cutout for the control panel. Begin by cutting a piece of particle board to $14\frac{5}{8}$ - by $12\frac{5}{8}$ -inches. Then mark off $1\frac{3}{16}$ -inch on both ends of one of the $12\frac{5}{8}$ -inch edges. Make an 11- by $1\frac{3}{4}$ -inch cutout between the two marks, as shown, for the control panel. After that, make a 9- $\frac{1}{8}$ -inch cutout midway between the bottom edge and the control-panel cutout. Once that's done, smooth out the rough edges to remove any splinters, and set the front panel to the side for now.

The next step is to prepare the top, bottom, and sides of the enclosure. Following the diagram shown in Fig. 7, cut the two side panels. The side panels are $15\frac{3}{8}$ -inches long and 8-inches wide, and beveled at a 45° angle along the width of the panel. Note: Only the width edges (which are used to form the basic box when the pieces are assembled) are beveled; the front and rear edges are not beveled. Once that portion of the enclosure's construction is completed, the next step is to cut dados, as illustrated in Fig. 7, in the four panels to accommodate the front panel only. That means that the dado goes around the entire inside surface of the

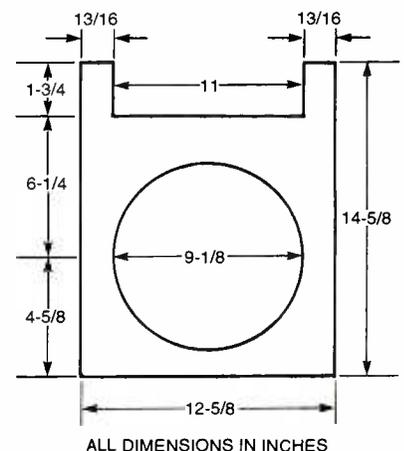


Fig. 6. The cabinet for the guitar amplifier—which was fabricated from $\frac{5}{8}$ -inch thick particle board—measures about 15 × 13 × 8 inches. Dimensions for the enclosure's front panel are shown here.

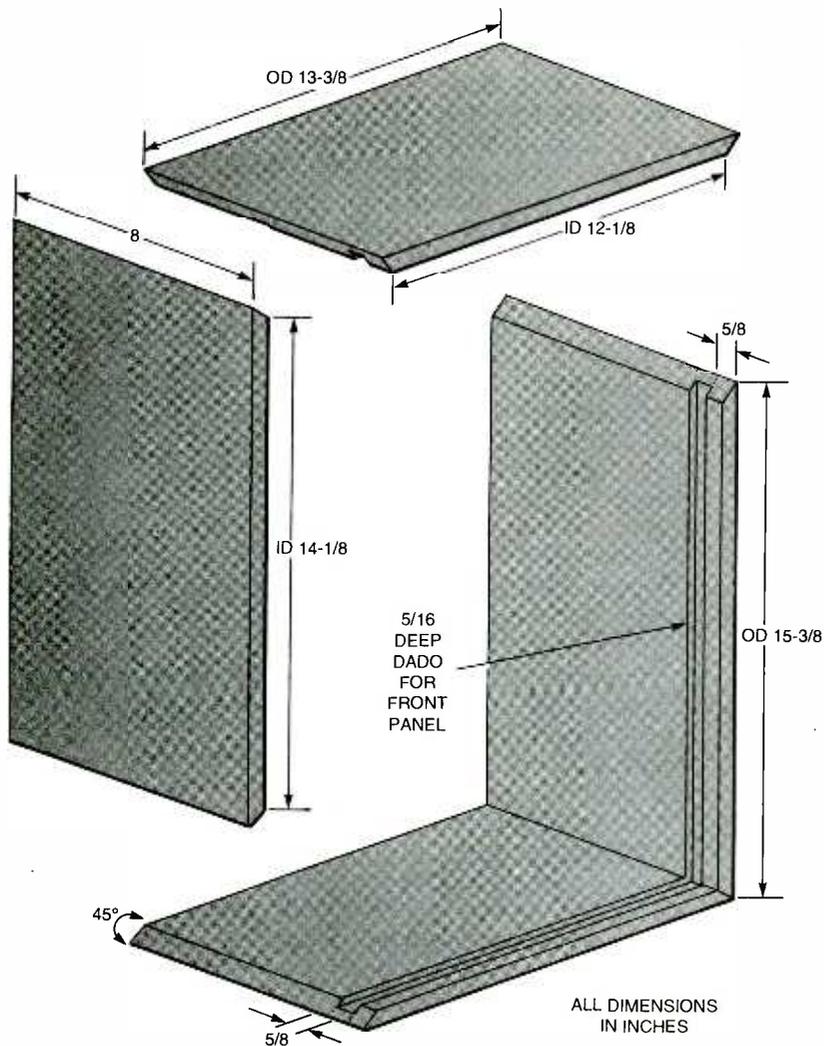


Fig. 7. Prepare the top, bottom, and sides panels of the enclosure guided by this diagram. Note that the four panels, whose measurements are given in the diagram, are beveled at a 45° angle. In addition, the four panels are dadoed to accommodate the front panel.

enclosure along one edge only; the other edge is left plain.

First lay out the top, bottom, and side panels of the enclosure, beveled edge to beveled edge, and determine the location of the dadoes. Mark the corresponding edges (on the inside surface) for easy identification. Measure 5/8-inch in from what will become the front edge, and draw a line from bevel edge along the panel's length. Locating a dado in that position makes the front panel recessed 5/8 inch when the enclosure is assembled, thereby providing protection for the control panel if the amp should ever be tipped over. Mark all four panels in the same manner. Then cut a 5/8-inch wide dado in each panel.

Next we come to the fabrication

of the rear portion of the enclosure. Like most guitar amplifiers, the back of the Chrome Classic 50 is partially open. The rear of the enclosure is comprised of two 4-1/2- × 13-3/8-inch pieces of particle board.

Once all of the components of the enclosure have been prepared, it is time to assemble the unit. Start by placing a healthy amount of wood glue evenly spread in the dado of the bottom panel. Place the front panel in the dado. Apply wood glue to one of the side-panel dadoes and along the bottom beveled edge as well, and put the side panel into position. Do the same for the remaining two dadoed panels. Clamp the enclosure together to maintain 90° corner angles while the glue cures. Once the glue has cured, use finish-

ing nails (or some other fastener) to give the beveled joints added stability. When completed, the enclosure should resemble the diagram shown in Fig. 8A. Do not install the rear panels at this point. They will be installed after the speaker, circuit board, and control panel are in place. If desired, a coat of black spray paint can be applied to the enclosure to enhance the project's appearance.

Final Assembly. Once the cabinet is complete, mount the heatsink with electronic assembly in the cabinet using #6 × 1-1/2-inch screws and 1/4-inch nylon spacers. The spacers are used to raise the heatsink/electronic assembly above the cabinet's inner surface, thereby allowing air to circulate under the heatsink for better cooling. With the heatsink/electronic assembly in place, install the control panel into the rectangular cutout. Secure the control panel to

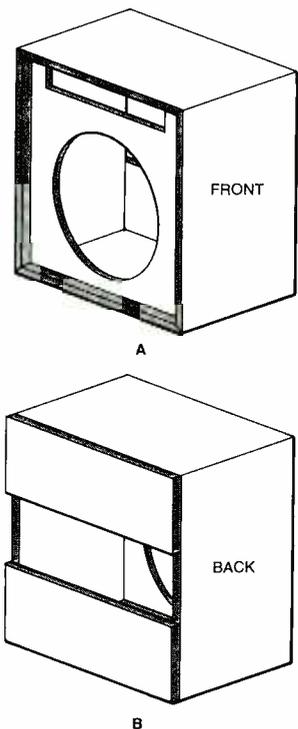


Fig. 8. Once the enclosure is complete, the front of the cabinet should resemble the diagram shown in A. The drawing in B illustrated the rear of the enclosure. However, that portion of the enclosure is **not** to be installed until after the speaker, circuit board, and control panel are in place. If desired, a coat of black spray paint can be applied to the enclosure at this time to enhance the project's appearance.

PARTS LIST FOR THE GUITAR AMPLIFIER

SEMICONDUCTORS

- IC1—TL074A quad JFET op-amp, integrated circuit
 Q1—Q3—2N5210 low-noise, NPN transistor
 Q4—Q5—2N3904 general-purpose, NPN transistor
 Q6—2N3906 general-purpose, PNP transistor
 Q7—MPSA56 medium-power, PNP transistor
 Q8—MPSA06 medium-power, NPN transistor
 Q9—TIP29B NPN power transistor
 Q10—TIP30B PNP power transistor
 Q11—TIP33C NPN power transistor
 Q12—TIP34C PNP power transistor
 BR1—KBL01 (or equivalent), 4-amp, 100-PIV, full-wave, bridge rectifier
 D1—D7—1N4148 small-signal diode
 D8—D10—1N4004 1-amp, 400-PIV, rectifier diode
 D11, D12—1N4742 12-volt, 1-watt, Zener diode

RESISTORS

(All fixed resistors are 1/4-watt, 5%, carbon-film units, unless otherwise noted.)

- R1, R9, R22—47,000-ohm
 R2, R18, R20, R23—1000-ohm
 R3, R10—4700-ohm
 R4, R5, R6—11,000-ohm
 R7, R8—3600-ohm
 R11—100,000-ohm
 R12—10,000-ohm
 R13, R14—47-ohm
 R15—3000-ohm
 R16, R17—2200-ohm, 1/2-watt, 5% carbon-film
 R19—6800-ohm
 R21—22,000-ohm
 R24, R26—1100-ohm
 R25, R27—R31—220-ohm
 R32, R33—0.47-ohm, 3-watt, wire-wound, power resistor
 R34—4.7-ohm
 R35—R40—100,000-ohm, chassis-mount, potentiometer
 R41—5000-ohm, miniature, PC-mount potentiometer

CAPACITORS

- C1, C4, C12, C13, C16, C18, C21, C22—0.1- μ F, Mylar or metallized polyester

- C2, C5—0.001- μ F, Mylar or metallized polyester
 C3, C25—0.01- μ F, Mylar or metallized polyester
 C6—0.0047- μ F, Mylar or metallized polyester
 C7, C8—0.022- μ F, Mylar or metallized polyester
 C9—330-pF, ceramic-disc
 C10, C11, C14, C15, C19, C20—100- μ F, 35-WVDC, electrolytic
 C17—56-pF, ceramic-disc
 C23, C24—4700- μ F, 50-WVDC, electrolytic

ADDITIONAL PARTS AND MATERIALS

- J1—1/4-inch, chassis-mount, mono phone jack
 S1—SPST, 1-amp, 250-volt, toggle switch
 S—SPDT, miniature, toggle switch
 T1—48-volt, 1.2-amp, center-tapped, transformer
 F1—1-amp, 250-volt fuse
 PL1—Three-conductor, AC line cord with molded plug
 SPKR1—10-inch, 8-ohm aluminum speaker
 PC board, particle board stock, strain-relief bushing, fuse holder, TO-220 heatsinks, aluminum heatsink panel, front panel, nylon spacers, handle, wire, hardware, etc.

NOTE: The following items are available from Lynn-Eren Electronics (17093 SW Lynnly Way, Sherwood, OR 97140; Tel. 503-625-2205); e-mail: lynneren@teleport.com; Website: <http://www.teleport.com/~lynneren>.

A complete kit of parts including an etched, drilled and plated-through PC-board, heatsinks, front panel, all electronic components, 10-inch aluminum speaker, and assembled cabinet for \$169; Printed-circuit board only for \$20; cabinet only for \$89; front panel and heatsink panel only for \$40. An assembled and tested unit is also available for \$199. Check, money order, VISA, or MasterCard are accepted. Add \$10 shipping and handling to orders that include cabinets or speakers. Assembled units have textured black lacquer finish.

the enclosure with short wood screws.

The next step is to solder the speaker wires to the 10-inch, 8-ohm speaker (SPKR1), and then mount the speaker to the cabinet cutout using short wood screws. The speak-

er should be mounted from the outside in; e.g., the speaker's narrow mounting edge should be on the outside surface of the front panel. An aluminum cone speaker produces a very bright, crisp tone, and makes the amp look great!

Checkout and Use. Make sure a 1-amp fuse (F1) has been installed in the fuse holder, and that the power switch (S1) is in the off position. Plug the power cord into a 117-volt AC outlet, and plug your guitar into the input jack (J1). Turn both volume controls (CRUNCH LEVEL and CLEAN LEVEL, R35 and R38, respectively) all the way down, put the selector switch in the "clean" position, and turn the POWER switch on. Slowly turn up the CLEAN LEVEL control while playing the guitar. If no sound is heard, turn the power off immediately, and check all wiring and component placement. If the amplifier is working, try adjusting the BASS and TREBLE controls. Move the selector switch to the "crunch" position, and test the TONE and OVERDRIVE controls. The TONE control should change the distortion tone, and the OVERDRIVE control should change the amount of distortion. If everything is working properly, you should be able to adjust the controls to customize your "clean" and "crunch" sounds.

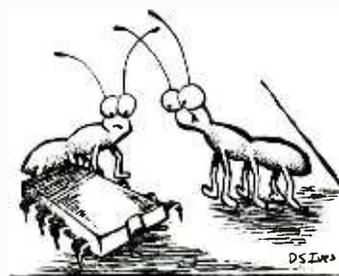
The power and versatility of the Chrome Classic 50 makes it ideal for practice or performance. However, with a 50-watt amp, the Chrome Classic 50 can be very loud, so be careful not to disturb your neighbors!

Picture the Seven
Dwarfs without
a forest.

Only You Can Prevent Forest Fires.

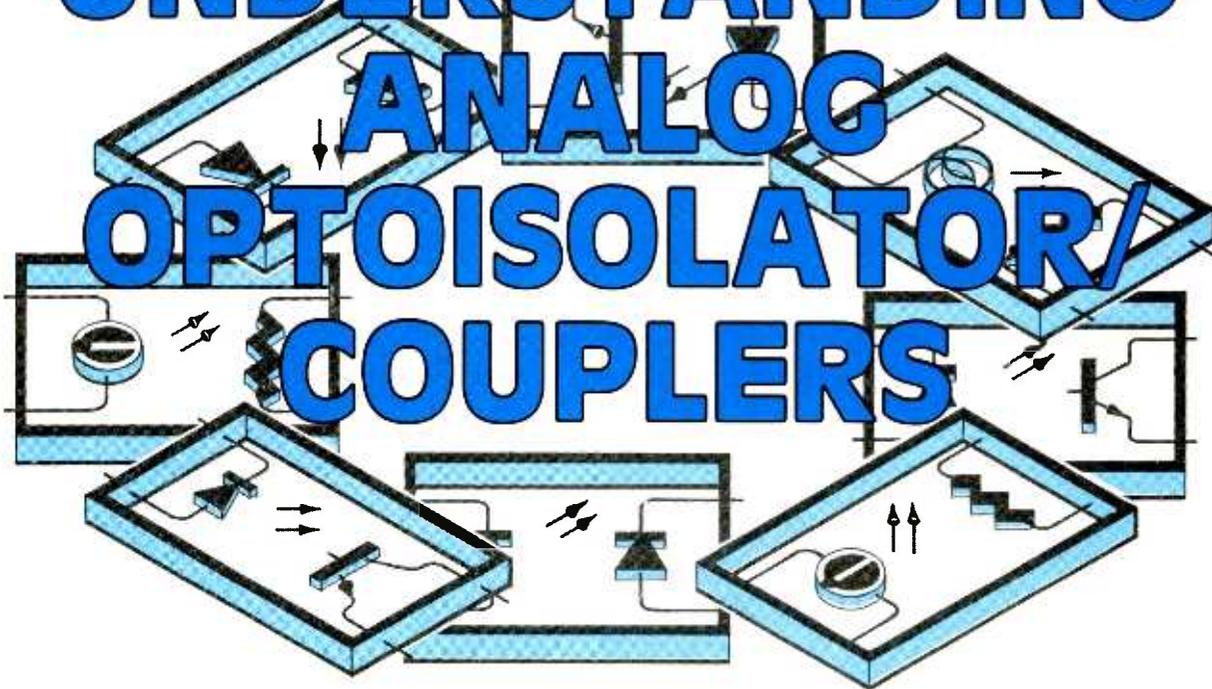


USA Forest Service and your State Forester.



SHE MAY NOT BE PRETTY... But
SHE SURE IS SMART.

UNDERSTANDING ANALOG OPTOISOLATOR/ COUPLERS



In this article, we'll cover some of the basics of analog optoisolator/couplers, as we explore a few circuits that you can experiment with on your own or, perhaps, incorporate into your next project.

Digital optoisolator/couplers are very common today, and most people involved in electronics are aware of their purpose and application. Optoisolator/couplers are used to provide a "visual" path (optical coupling) between two circuits or devices, while keeping them electrically separated (isolated) from each other. The optical path eliminates ground loops and electrical interface problems that can occur when two circuits are physically connected to one another. And in many situations optoisolator/couplers are used to satisfy safety concerns.

Analog optoisolator/couplers are not nearly as common as the digital type, but they provide the same advantages for analog circuits as digital units provide for digital circuits. Analog optoisolator/couplers

DENNIS EICHENBERG

eliminate ground loops and noise problems, provide an additional level of safety through electrical isolation, and, in addition, have characteristics that can be used to their best advantage in certain circuit configurations.

Analog optoisolator/couplers can also be used for switching operations in certain digital applications where they are better suited to a particular operation than digital types. Analog optoisolator/couplers, which are available in many different configurations, are inexpensive, reliable, and fairly readily available. In addition, they can also be fabricated by the hobbyist, allowing their characteristics to be tailored to specific applications.

What's An Analog Optoisolator/Coupler? Analog optoisolator/couplers are comprised of a light source (input device) and a light detector (output device), which are housed in a light-tight package. There are several different light sources and several detectors that can be used in this application, one of which may be better suited to a specific application than the others.

Figure 1A is a schematic representation of a typical analog optoisolator/coupler that uses an incandescent lamp as the input device and a photocell as the output device. Although an incandescent lamp is used as the input device in that illustration, a neon lamp, light-emitting diode (LED), or any other light source could have easily been used. The light source has a great impact on the optoisolator/coupler's characteristics.

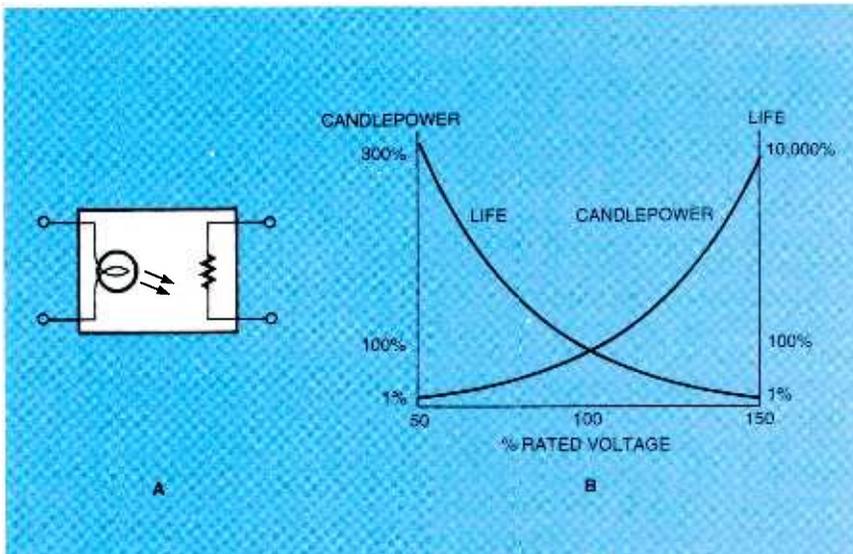


Fig. 1. Analog optoisolator/couplers are comprised of selected input device and output devices that are housed in light-tight packages, as shown in A. The relationship between lamp life and light output is illustrated in B.

lator/coupler's characteristics and must be selected to optimize the unit's desired traits.

Incandescent Lamp. Incandescent lamps may be operated from either AC or DC sources. The radiated light is proportional to the temperature of the filament. That thermal dependence makes an incandescent lamp a true rms (root mean squared) sensor. The response time for an incandescent lamp depends on the driving circuit and the mass of the filament. Small lamps can turn on in 20 milliseconds or less if the mass of the filament is low. The lamp's inrush current can be as much as 15 times the steady-state current of the device, so the driving circuit must be capable of providing a great deal of current if the fastest possible turn-on time is desired. The turn-off time for incandescent lamps can be as fast as 20 milliseconds. If the inrush current is limited, the turn-on time may increase by a second or more, but the turn-off time will be unaffected.

The life of an incandescent lamp depends on the operating temperature of the filament and the tungsten evaporation rate. Manufacturing variations in the cross-sectional area of the filament and anomalies in the tungsten composition can cause hot spots in the filament. Excessive evaporation in any of the hot spots, coupled with the tungsten recrystallization produced, reduces lamp life to below theoretical val-

ues. That phenomenon is exaggerated when the lamp is operated from a DC source. Since filament temperature is determined by the applied voltage, the lamp life and light output can be related to that voltage, as illustrated in Fig. 1B.

Incandescent lamps are sensitive to shock and vibration. Mechanical impact can reduce lamp life significantly. The output of an analog optoisolator/coupler can be affected by motion of the lamp, and is most apparent when the input signal is low and the lamp is barely on.

Neon Lamp. Neon lamps are primarily used as the light source of an analog optoisolator/coupler that's intended for AC input voltage applications because of the lamp's bi-directional characteristics. Neon lamps may also be used for DC applications of either polarity, because the volt-amp characteristic is symmetrical. Neon lamps have a high standoff voltage with a very high input resistance prior to breakdown. After breakdown, they require a lower sustaining voltage and the series resistance of the lamp drops significantly. Breakdown voltage may be as low as 60 volts, but it is typically 90 to 110 volts. The sustaining voltage is typically 45 to 55 volts.

Ambient light is required to partially ionize the gas in a neon lamp so that it breaks down at a reasonable voltage level. Because analog optoisolator/couplers are housed in light-tight packages, a small

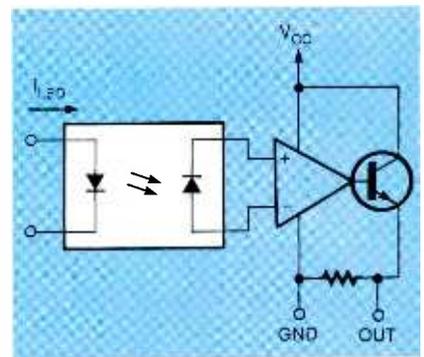


Fig. 2. Shown here is a schematic diagram for analog optoisolator/coupler with an LED input and a photodiode output. Signals applied to the device's LED input are transmitted via light radiation to the photodiode.

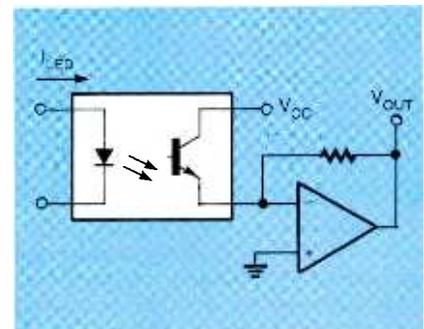


Fig. 3. A diode/transistor version of the analog optoisolator/coupler is shown here. The LED is optically coupled to a phototransistor, whose output is used to drive the inverting input of an amplifier.

amount of radioactive material is usually used to produce the slight ionization that is required for reliable breakdown. The turn-on voltage would be 300 volts or more without the radioactive material. All neon lamps require a series resistor to limit lamp current once the breakdown voltage has been exceeded.

LED. Light-emitting diodes (LEDs) are the ideal light source for many analog optoisolator/coupler applications. LEDs require low drive current and voltage, and have a fast response time. In addition, they are rugged—they're unaffected by shock and vibration—and they are very reliable and inexpensive. LEDs conduct in one direction only, so they are best suited for DC applications. However, circuit modifications can be made so that they can be used relatively easily for AC applications as well. The LED must be protected from excessive current by a series-connected, current-limiting resistor.

Like the input device of an ana-

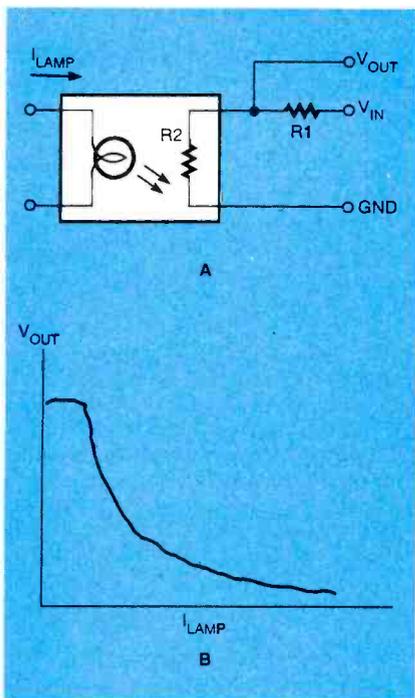


Fig. 4. The photocell type analog optoisolator/coupler is well suited to attenuation applications. In A, the unit's photocell output serves as a shunt resistor. The V_{OUT} vs. I_{LAMP} characteristics of this circuit is shown in B.

log optoisolator/coupler, the output device (or detector) can be anyone of several different devices; for example, a photocell, photodiode, or phototransistor. The type of detector selected depends on the type of circuit to be driven by the optoisolator/coupler's output.

Photocell. By far the most common type of output (detector) device used in an analog optoisolator/coupler is the photocell. A photocell is a light-dependent resistor or LDR (also known as a photoresistor). The resistance of the photocell can be altered by varying the input current or voltage applied to the light source, and thus the intensity of the light produced by the input device. Aside from the obvious variable resistance applications—where the unit could be made to track the input signal in an analog fashion—the photocell can be made to switch between an on and off state, in a similar manner to a digital switch. Other attributes of the photocell are its very low harmonic distortion characteristic (making it an ideal candidate for controlling audio systems), in addition to being very rugged and extremely easy to use.

Photocells are usually composed of either cadmium sulfide or cadmium selenide. The photocell output of an analog optoisolator/coupler acts as an electrically variable resistor (potentiometer). Since the output device is essentially a resistor, the voltage applied to the output can be DC or AC. The amplitude of the applied voltage can be as low as zero or as high as the maximum voltage rating of the device. The light source and the photocell must be selected properly for the specific application, since there are many trade-offs to consider. Some of the parameters to consider are input voltage, input current, output voltage, output current, and response time.

Since the photocell is a resistor, it must be treated accordingly. The resistance of the photocell depends on the amount of light that strikes its light-sensitive area. Because the photocell is essentially a light-variable resistor, its output current depends on the intensity of the light that falls on the photocell, plus the voltage applied to it.

The dark resistance of a photocell (typically ranging from 500k ohms to 200 megohms) is its resistance with no illumination. The dark

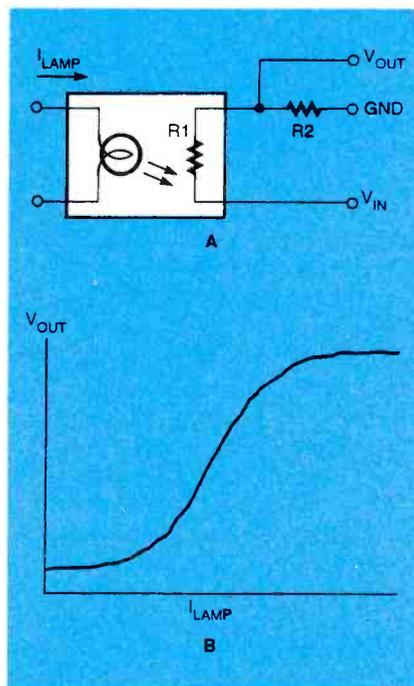


Fig. 5. Here is another optoisolator/coupler attenuation circuit. In A, the photocell is connected as the series resistor. The V_{OUT} vs. I_{LAMP} characteristics of this circuit is shown in B.

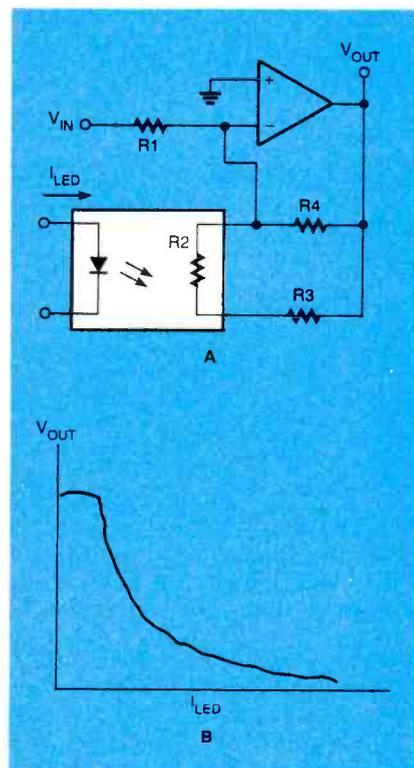


Fig. 6. Analog optoisolator/couplers can also be used as gain controls as shown in A. The gain of the op-amp is affected by changes in the resistance of the photocell caused by light radiation. The V_{OUT} vs. I_{LED} characteristics of this gain-control circuit is shown in B.

resistance is important because it produces leakage current, which can lead to false triggering in some applications.

Photocells are affected, to some extent, by temperature. In order to minimize temperature-related variations, it is best to operate the photocells at the highest reasonable light level. Cadmium sulfide photocells are usually less affected by temperature and a bit slower than the cadmium selenide type. All photocells have a longer response time in cold environments.

Typically, the response time of a photocell ranges from 5 to 100 milliseconds, and can be even faster at higher light levels. A short response time can cause the photocell to exhibit light modulation when the analog optoisolator/coupler is operated from an AC source. However, higher current lamps can help to reduce the modulation.

Photocells also exhibit a light history effect; e.g., they tend to remember their most recent storage condition and their instantaneous conductance is a function of its pre-

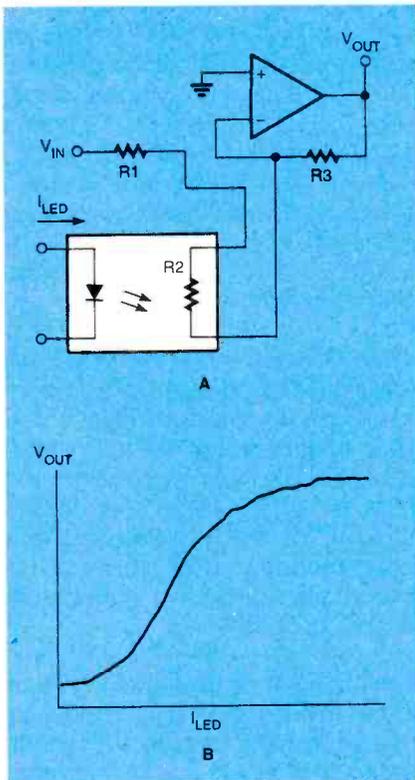


Fig. 7. In the gain-control circuit shown in A, the gain of the op-amp is affected by varying the magnitude of the input signal. The V_{OUT} vs. I_{LED} characteristics of the gain control circuit is shown in B.

vious condition. The magnitude of the light history effect depends, on the new light level being sensed, the difference between the new and immediately previous light level, and the time spent at each light level. That effect is reversible. The magnitude of this effect is larger for cadmium selenide units than for cadmium selenide photocells, and can be minimized by keeping the photocell exposed to a constant low level of illumination rather than total darkness.

The photocell can be considered as a resistor in parallel with a small capacitance. The value of the capacitance is a function of the size of the photocell base. The capacitance is usually about 3 picofarads, which is negligible in most applications, but should be considered where high frequencies are involved.

The electrical noise generated in a photocell is the same as for any other type of resistor. One form of noise is *thermal noise*, which is caused by the random motion of free electrons within the photocell material. Thermal noise is indepen-

dent of frequency, but increases with temperature and is greater in high-resistance photocells. Another form of noise is *shot noise*. Shot noise is caused by random variation in the cell due to photon absorption within the photocell material. A third form of noise is *flicker noise*, which is caused by the photocell material itself, and has the greatest effect at low frequencies. In most applications, the actual noise level of an analog optoisolator/coupler is irrelevant when the voltage level exceeds 80 volts.

Photodiode and Phototransistor. A schematic diagram for the typical photodiode-type analog optoisolator/coupler is shown in Fig. 2. It consists of an LED or other light source optically coupled to a photodiode, which is at the input of an amplifier. The amplifier converts the photodiode current variation to an output voltage variation. There are commercially available devices manufactured for this application.

To use digital optoisolator/couplers in linear applications, the LED must be forward biased to a suitable current level, typically 5 to 20 milliamps. Modulating signals can then be impressed on the DC bias. For good high-frequency performance, the phototransistor should be operated into a low-impedance input,

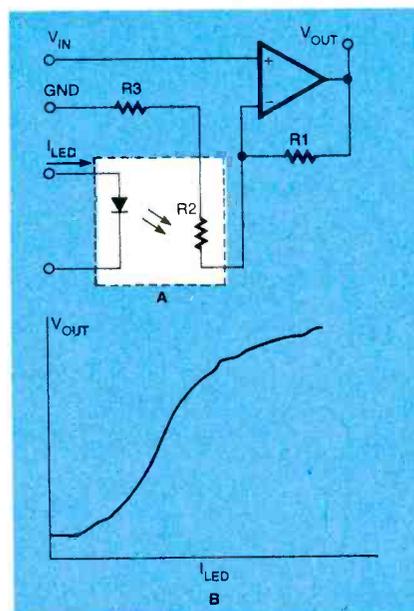


Fig. 8. A typical non-inverting amplifier circuit controlled by an analog optoisolator/coupler is shown in A, while its V_{OUT} vs. I_{LED} characteristics is illustrated in B.

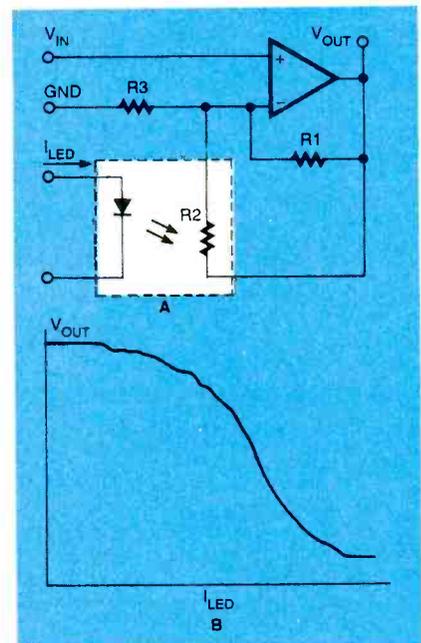


Fig. 9. A non-inverting amplifier with an analog optoisolator/coupler connected in the feedback loop is shown in Fig. 9A, and its V_{OUT} vs. I_{LED} characteristics is illustrated in B.

current amplifier. A high-speed operational amplifier, as shown in Fig. 3, can be used with excellent results. The output of the optoisolator/coupler can be taken from either the collector or the emitter of the phototransistor, depending on the desired polarity. The operating speed is the same in either case.

Attenuators. Analog optoisolator/couplers are well suited to attenuation applications. But when the attenuator is located a great distance from an active circuit, it can pick up noise. Because of that, it is best to keep the attenuator as close as possible to the active circuit. A photocell type optoisolator/coupler is recommended for attenuator applications, particularly for use in audio circuits, because of its low harmonic distortion and insensitivity to polarity. Figure 4A shows an analog optoisolator/coupler configured as an attenuator, where the unit's photocell output serves as a shunt resistor. In this case $V_{OUT} = V_{IN} \times R2 / (R1 + R2)$. The characteristics of this circuit are shown in Fig. 4B.

Figure 5A shows an analog optoisolator/coupler configured as an attenuator with the optoisolator/coupler as the series resistor. In this case $V_{OUT} = V_{IN} \times R2 / (R1 + R2)$.

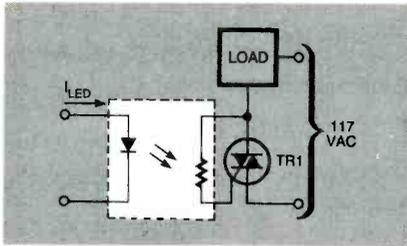


Fig. 10. Analog optoisolator/couplers can be used to control Triacs as shown here. The Triac turns on when the LED is illuminated and turns off when it extinguishes.

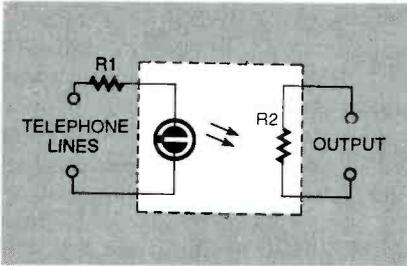


Fig. 11. In the telephone ring detector, an analog optoisolator/coupler serves as a sensor. Note that the input device in this coupler is a neon lamp, which is very compatible with the high voltage AC telephone line.

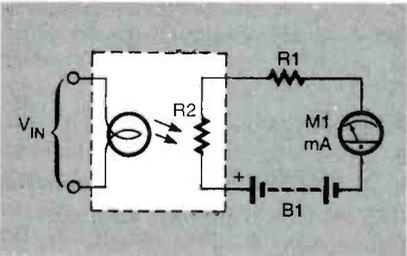


Fig. 12. A photocell type of analog optoisolator/coupler is ideal for true rms (root mean squared) measurement.

The characteristics of this circuit are shown in Fig. 5B.

Gain Control. An inverting operational amplifier can be controlled by an analog optoisolator/coupler as shown in Fig. 6A. For that circuit $V_{out} = -V_{in} \times \{(R4 \times (R2 + R3)) / (R1 \times (R2 + R3 + R4))\}$. Resistor R4 sets the maximum gain of the amplifier and stabilizes the DC output voltage. Resistor R3 sets the minimum gain of the amplifier. The output characteristics are shown in Fig. 6B.

An inverting operational amplifier can also be controlled with an analog optoisolator/coupler as shown in Fig. 7A. In that circuit, $V_{out} = -V_{in} \times R3 / (R1 + R2)$. Resistor R2 limits the maximum gain of the amplifier. The characteristics of this circuit are shown in Fig. 7B.

Non-inverting amplifiers can also

ANALOG OPTOISOLATOR/COUPLER MANUFACTURERS

EG&G Reticon Corp.
345 Potrero Ave.
Sunnyvale, CA 94088-4197
Tel. 408-245-2060

Hewlett Packard
Optoelectronics Division
350-370 W. Trimble Rd.
San Jose, CA 95131-1008
Tel. 800-235-0312

International Rectifier Corp.
223 Kansas St.
El Segundo, CA 90245
Tel. 310-322-3331

Motorola Semiconductor
Products Sector
2100 E. Elliot
Tempe, AZ 85284
Tel. 602-244-6900

NEC Electronics, Inc.
475 Elis St.
Mountain View, CA 94039
Tel. 415-960-6000

NTE Electronics Inc.
44 Farrand Street
Bloomfield, NJ 07003
Tel. 800-631-1520

Optotek Limited
62 Steacie Drive
Kanata Ontario, Canada K2K 2A9
Tel. 613-591-0336

Philips Semiconductors
Philips Electronics N. A. Corp.
811 E. Arques Ave.
PO Box 3409
Sunnyvale, CA 94088-3409
Tel. 800-234-7381

Siemens Components Inc.
Optoelectronics Division
19000 Homestead Rd.
Cupertino, CA 95014
Tel. 408-257-7910

Silonex Inc.
2 Cogan Ave.
Plattsburgh, NY 12901
Tel. 518-561-3160

Texas Instruments, Inc.
Semiconductor Group
PO Box 655303
Dallas, TX 75265
Tel. 214-995-2011

typical non-inverting amplifier circuit controlled by an analog optoisolator/coupler (Fig. 8A). For this circuit $V_{out} = V_{in} \times (1 + R1 / (R2 + R3))$. The characteristics are shown in Fig. 8B.

A non-inverting amplifier can also be controlled as shown in Fig. 9A. In this case $V_{out} = V_{in} \times (1 + (R1 \times R2) / (R3 \times (R1 + R2)))$. The characteristics are shown in Fig. 9B.

Triac Control. An analog optoisolator/coupler can be used to control Triacs as shown in Fig. 10. The Triac turns on when the lamp is illuminated and turns off when the lamp is extinguished. Be certain that all of the components are rated properly as this circuit can be hazardous when used in high voltage applications.

Telephone Ring Detector. A neon lamp analog optoisolator/coupler makes an ideal telephone ring indicator as shown in Fig. 11. The neon lamp is very compatible with the high voltage ac telephone line. The output goes to a low resistance state whenever the telephone rings.

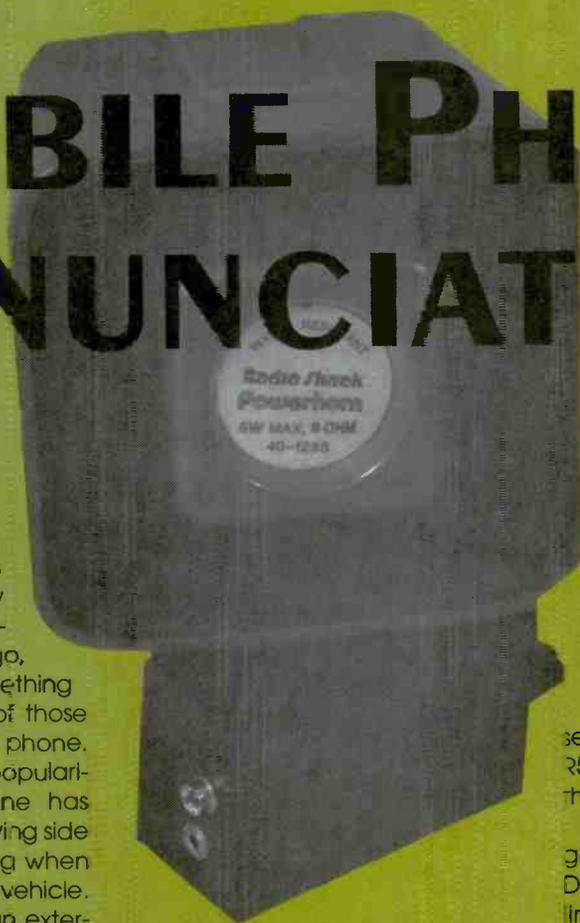
True RMS Measurement. A photocell type of analog optoisolator/coupler is ideal for true rms (root mean squared) measurement. Since the light output of an incandescent lamp is directly related to the rms value of the applied voltage, the resistance of the photocell viewing the lamp is an accurate measure of the rms voltage applied to the lamp. A typical rms measurement circuit is shown in Fig. 12.

Conclusion. Analog optoisolator/couplers are available commercially from several manufacturers. A list of manufacturers is provided. The manufacturers can provide specifications and additional data.

Analog optoisolator/couplers can easily be made up from readily available components. Simply select the input and output devices from the many available. Add extension leads to the devices and couple them together optically within electrical tape or a piece of heat shrink tubing. Experiment with different configurations until you find one that exactly meets your needs.

be controlled with analog optoisolator/couplers. Figure 8A shows a

MOBILE PHONE ANNUNCIATOR



Advancements in micro-electronics have given us many conveniences through gadgets that, just a few years ago, seemed little more than something out of a sci-fi movie. One of those conveniences is the mobile phone. Unfortunately, the growing popularity of the mobile telephone has spawned at least one annoying side effect; e.g., the horn honking when the driver is away from the vehicle. The problem is caused by an external alert option that is designed to make that driver aware of an incoming call when he/she is out of the vehicle. Imagine just how annoyed people can become when your horn starts blaring during the early morning hours in a residential area—a circumstance that is bound to generate unfavorable (to say the least) comments.

The simple circuit presented here—the *Mobile Phone Annunciator*—is designed to eliminate that problem by simulating the soft tones of a normal telephone, while producing enough volume to get your attention. No...you're not just trading one loud noise for another. The circuit includes a volume control, allowing you to tailor the output to a level suitable to your surroundings. In addition to offering the user control over the audio level, the circuit has the added advantage of drawing no current until the mobile phone's ring signal turns it on.

The car phone's external alert mode is activated by keying in a code before turning off the ignition.

Before you get into another unpleasant conversation with your valued neighbors, give your car phone a more pleasant way to announce that you have an incoming call.

CURT JENO

In a normal car phone setup, the external alert uses the vehicle's horn to get your attention. The *Mobile Phone Annunciator* takes the place of the vehicle's horn.

Circuit Description. A schematic diagram of the *Mobile Phone Annunciator* is shown in Fig. 1. The circuit is built around a relay (RY1), a 556 dual oscillator/timer (IC1), a Darlington transistor (Q1), a speaker (SPKR1), and a few additional com-

ponents. The dual oscillator/timer is configured as a warble-tone generator. The warble tone is produced by feeding the output of one oscillator (composed of R1, R2, C2, and half of IC1) to the threshold input of the second oscillator (composed of R4, R5, C3, and the other half of IC1) through R3.

The output of the warble-tone generator is fed to the base of the Darlington transistor (Q1). The Darlington transistor amplifies the output of the warble-tone generator to a level sufficient to drive SPKR1, a 5-watt speaker. Potentiometer R7 is used as a volume control.

Diode D1 is used as a blocking diode to protect the circuit from an incorrect polarity contact. Capacitor C1 is used to stabilize the input DC, so that IC1 can oscillate properly. Changing the value of C2 a few microfarads changes the rate of output warble, while changing the value of C3 a few microfarads changes the pitch of the output tone, which comes in handy if you have more than one vehicle. Components R8 and LED1 are optional.

Construction. The *Mobile Phone Annunciator* was assembled on a small section of perfboard, and housed in a plastic enclosure measuring 3-1/4 by 2-1/16 by 1-5/16 inches. Because interference is not a problem, perfboard construction and point-to-point wiring works well for the project. When assembling the board, it's a good idea to lay out all

Monitor Clean-Up

BY MARTY KNIGHT

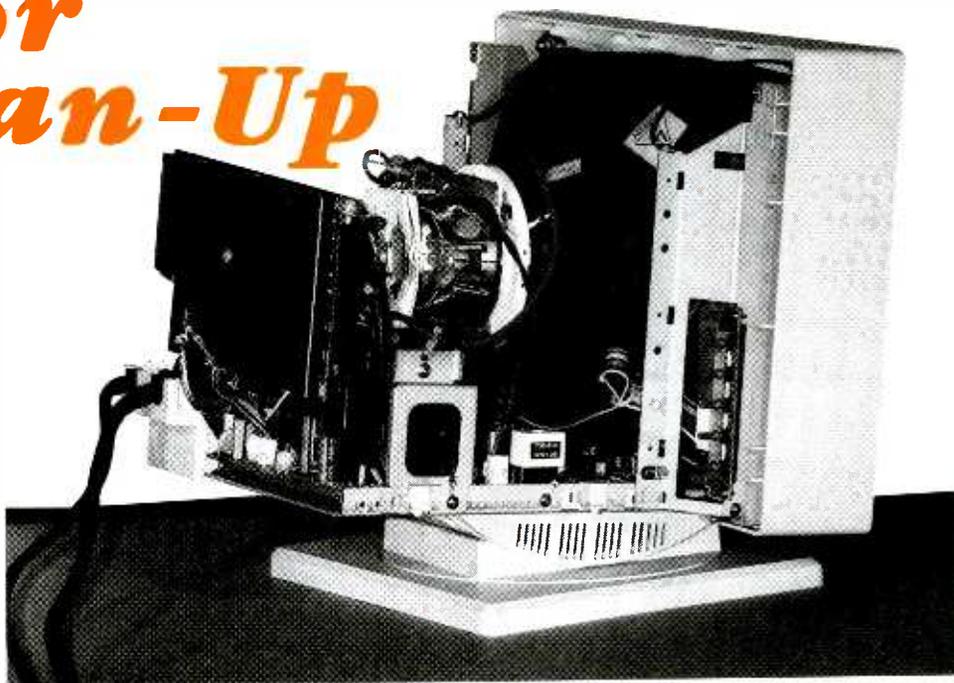
Take a close look at your computer's monitor and your television set. Notice that the TV is clean but the monitor is dirty. And not just the monitor's picture-tube face, the entire cabinet. You see, in many households, the TV is dusted once a day or so, whereas the monitor is paid less attention.

However, cleaning should be a part of a preventive-maintenance program that will ensure the maximum life possible for your monitor. The outside grime is seedy looking, however it will not cause the monitor to fail prematurely. The inside layer of dust is the killer. This unnoticed dust inside your monitor is an excellent heat shield. It causes components that give off heat to bake themselves and cause accelerated failure of that part; these quick-to-fail parts are usually resistors and transformers. Additionally, the layer of dust provides a conductive path for high voltage. Not much might occur at low voltages, however the cathode-ray tube's high-voltage circuit can experience unnecessary arc-over, which usually promotes the self destruction of expensive parts in that circuit. Let's examine what's involved in keeping your monitor from such a mishap.

Take It Apart. Each monitor type is alike and not alike! By that I mean you will discover differences in your monitor from the one I cleaned as you follow my general instructions. Nevertheless, with a slight variation in cleaning procedure, you should have no problem. Color monitors require the same treatment as monochrome units, and the clean-up procedure is usually the same.

First and foremost, remove the AC and signal cable connections from the monitor and let it sit unused for 24 hours. The sitting time should allow the high-voltage circuit to fully discharge, but continue to treat it as if it were hot! Keep that in mind as you proceed to take the monitor apart.

Now transport the monitor to a



Extend the life, usability, and appearance of your monitor with a little elbow grease and this sound advice.

clean table top for disassembly. The work surface must be non-conductive and soft so that it does not scratch the cathode-ray tube's face or the plastic case. It is a good idea to place an old blanket or heavy bath towel on wood or other hard surfaces. I was lucky, I had a foam-padded surface to work on.

Remove the back cover from the monitor. To do so requires some inspection to find the screws that hold the plastic case together. There is usually a hidden screw, or two. I found two "hidden" screws in the handle that is used to grip and carry the monitor. Another monitor that I cleaned hid one screw under a metallic-foil that warned the owner that the warranty will be voided. (Fortunately, the warranty for that two-year-old monitor applied only to the first three months of ownership.) The last color monitor I worked on came apart after removing four highly visible screws. You never know what you will find until you get started.

Remove the Killer Voltage. Once the rear cover is removed, you must discharge the monitor's high-voltage

circuit even though it may have been sitting unused and unpowered for several hours to several days. Never trust a high-voltage circuit.

You can make a very simple and inexpensive tool to discharge the high voltage from your monitor (see Fig. 1). Use a 1-watt, 10,000-ohm fixed resistor; insulated test-lead wire; alligator clip; $\frac{1}{4}$ to $\frac{3}{8}$ -inch diameter plastic rod, 18-inches long or longer; and some electrical tape. The purpose of the resistor is to limit the current flow so that the arc drawn by the tool will not damage the recessed contact on the cathode-ray tube. The test-lead is soldered to one end of the resistor and then the resistor is taped to the plastic rod so that the unsoldered lead of the resistor protrudes. If you have trouble finding a plastic rod, use one from a window blind (but be sure to return it after you are finished with it). Solder the alligator clip to the unused end of the test-lead wire and the discharge tool is complete.

Now you must connect the alligator clip to the metallic ground in the monitor. Select one of the metal straps or spring wire used to hold the cathode-ray tube in place. Check

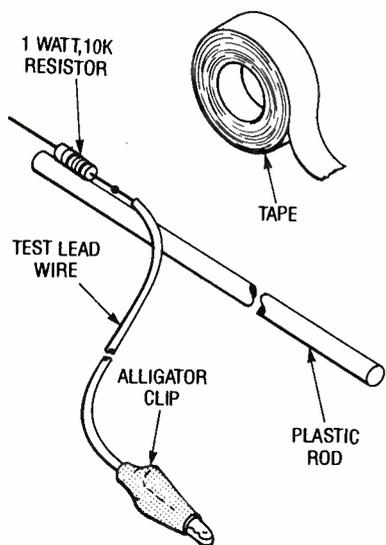
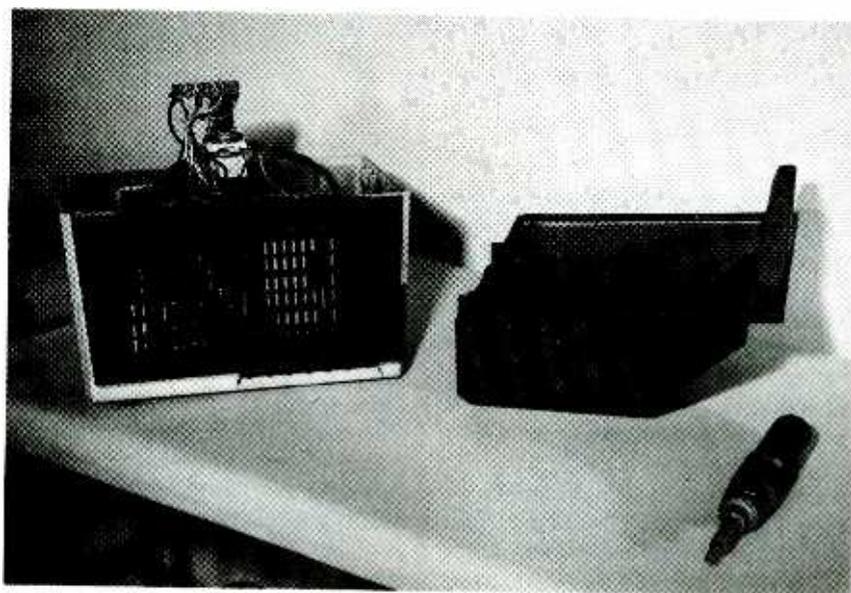


Fig. 1. A high-voltage discharge probe is easy to make and use. Be sure to make one and use it to remove the high voltage stored in the circuit.



Here's the monitor with the cover removed. Note the air vents in the bottom of the cabinet that need to be sealed before cleaning the unit.

that the connection is a true ground with an ohmmeter; measure from the point of connection to the obvious grounds in the monitor. Never seek a ground on a printed-circuit board. An incorrect selection here will most probably blow the board away.

Once convinced that the tool is correctly grounded, hold it with one hand at the end furthest from the resistor. Place your other hand in your pocket and attempt to touch the high-voltage connection on the cathode-ray tube with the free resistor

lead. Usually, you will have to work the resistor lead under a plastic or rubber seal that presses against the glass where the high-voltage cable from the circuit board connects to the cathode-ray tube. Be sure to make contact with the connection point for several consecutive seconds. The tube is now completely discharged of all high voltage.

If you waited a day after the monitor was last used, the discharge procedure will draw no spark, at most you might hear a weak "snapping" sound. A fully charged tube will draw a bright spark and a sharp "crack." In either case, be sure the contact is maintained until the high voltage is dissipated. Now it is safe to proceed with the cleaning, however always assume that the circuit is "hot" and act accordingly. It's solid common sense to do so.

Light Vacuuming. With the cover off the monitor revealing the "guts" inside, proceed to remove the dust that's accumulated on the circuit board, cathode-ray tube and other surfaces inside the monitor's plastic housing. Use a 1-inch paintbrush to stir up the dust and the snout of a vacuum cleaner held nearby to suck it in. Don't try to lift the dust with the vacuum alone. The vacuum's low pressure could possibly move a part or wire causing a short or open circuit. Gently stir the dust off the board with the

paintbrush. Clean the entire external surface of the tube cautiously, assuming that the circuit is still electrically hot for safety sake.

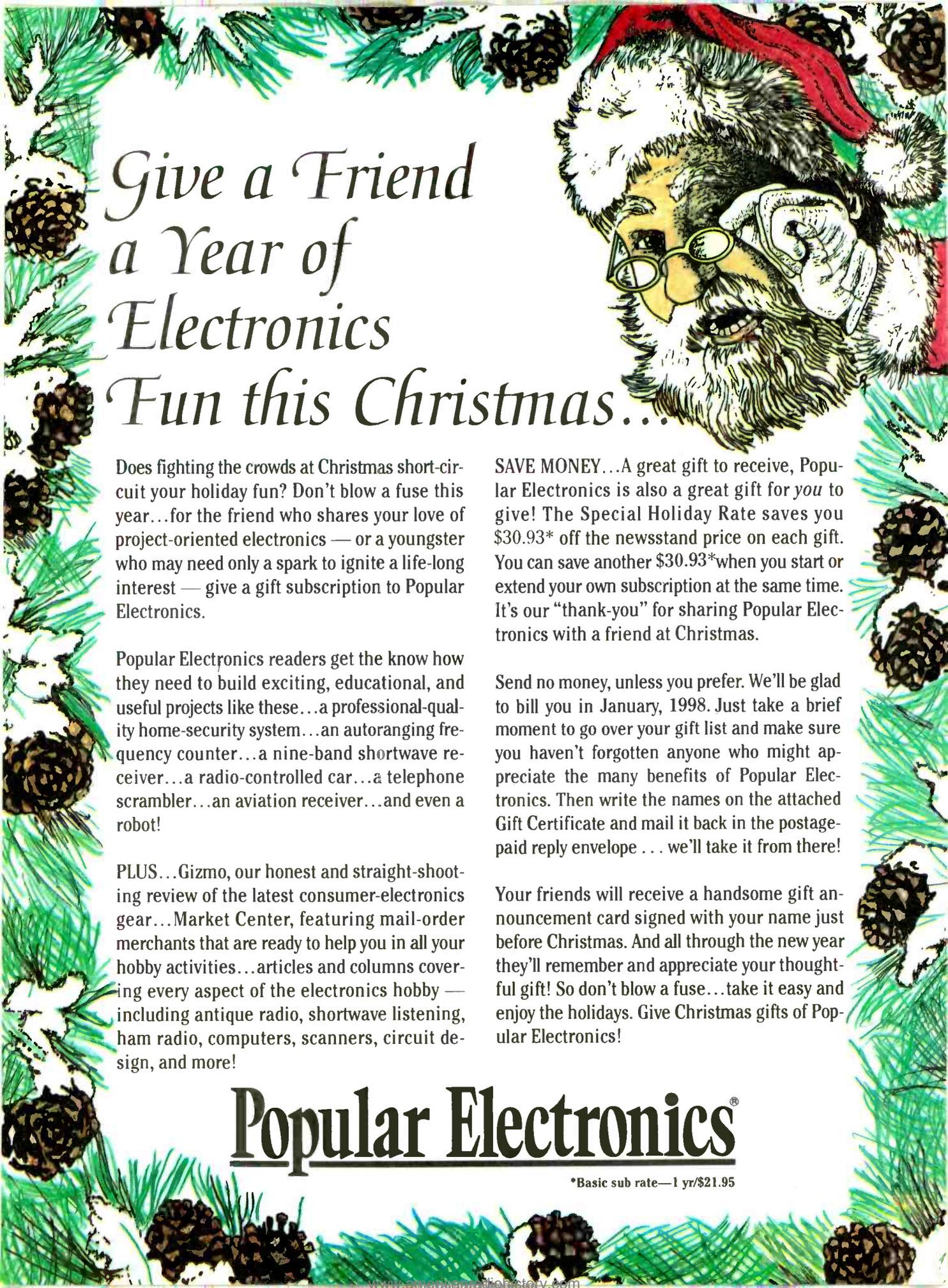
Check to see if there are any vents or openings in the bottom of the cabinet. If so, place the monitor on its side and vacuum the openings to remove dust particles, hair, and crumbs from yesterday's cookies.

After all the dust has been lifted off the interior of the monitor, reverse the flow of the air in the vacuum nozzle so that air is blowing out. Use this flow of air to stir up and blow out the remaining dust you can't suck out. If possible, do this outdoors or in the garage—not in your living room, den, or kitchen. Keep the nozzle about three inches from the surface being cleaned. A strong flow of air could possibly bend a part or move something that can later affect the operation of the monitor. Easy does it.

Soap Suds. You can now scrub the plastic rear cover of the monitor provided it has no electronic parts attached. Use ordinary face soap, a nail brush, wash cloth, and lukewarm water. Clean both the inside and outside surfaces. The nail brush comes in handy in sharp corners and grille surfaces. Some cabinets have sharp points that can scratch or break the skin, so use the wash cloth and not your hand to clean the plastic. Rinse the soap suds off with lukewarm running water and set the cover aside to dry. It's okay to towel the surfaces, but do not dry the cover using a hair drier or other heat sources. The plastic cover may warp or melt.

The main part of the monitor is a bit more difficult. It is wise not to remove the cathode-ray tube from the cabinet, so the outside surfaces must be scrubbed with a good deal of care. What I did was cover the rear of the cabinet with a plastic sheet cut from a kitchen garbage bag. With liberal use of masking tape, the plastic sheet covered the rear opening. There were no vents in the side of the cabinet to be concerned about. However, if there were, masking tape on the inside surfaces would have sealed the opening. Keep in mind that masking tape sticks poorly, if at all, to dusty surfaces, so wipe the surfaces clean before applying tape.

(Continued on page 96)



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HAM Radio

Dealing With 2-Meter Intermods

JOSEPH J. CARR, K4IPV

Intermodulation interference or "intermods" are one of the real disadvantages of operating two-way radios—ham radios included—in crowded areas. Even good quality radios can be overcome when the front-end dynamic range is taken up by a large number of in-band and out-of-band signals. The front-end selectivity on superheterodyne receivers is a lot worse than the IF selectivity, so a larger number of signals will get past the filtering.

What are intermods? It is basically unwanted heterodyning. If you place two signals of different frequencies (f_1 and f_2) in the same circuit, and the circuit is nonlinear, then the circuit will generate harmonics and other spurious products. These new frequencies are described by:

$$f_x = mf_1 \pm nf_2$$

Where f_1 and f_2 are the two frequencies, f_x is the spurious signals generated in the circuit, m and n are integers or zero. If you do a little arithmetic, you will find that a huge number of spurious frequencies can be generated and cause unwanted frequencies to appear in your radio, or cause intermodulation distortion (IMD) to in-band signals. If you feel like a little exercise, then assume that f_1 is a 2-meter amateur radio repeater at 146.91 MHz, and f_2 is an FM broadcast band (FM BCB) signal at, say, 94.1 MHz. Do the arithmetic for $0 \leq m \leq 5$ and $0 \leq n \leq 5$. Wow! It's a wonder that the radio works at all!

In most cases it is the second order IMD ($f_1 \pm f_2$), or third order IMD ($2f_1 \pm f_2$) or ($2f_2 \pm f_1$) that are the hardest to eliminate in receiver design. In our previous example, these frequencies are calculated to be 41.29, 52.81, 199.72, 241.01, 335.11, and 387.92 MHz. The closer the two input signals are in frequency, the more likely that they will fall within the input bandwidth of the receiver and cause problems.

Now consider the situation where there are a lot more signals than just

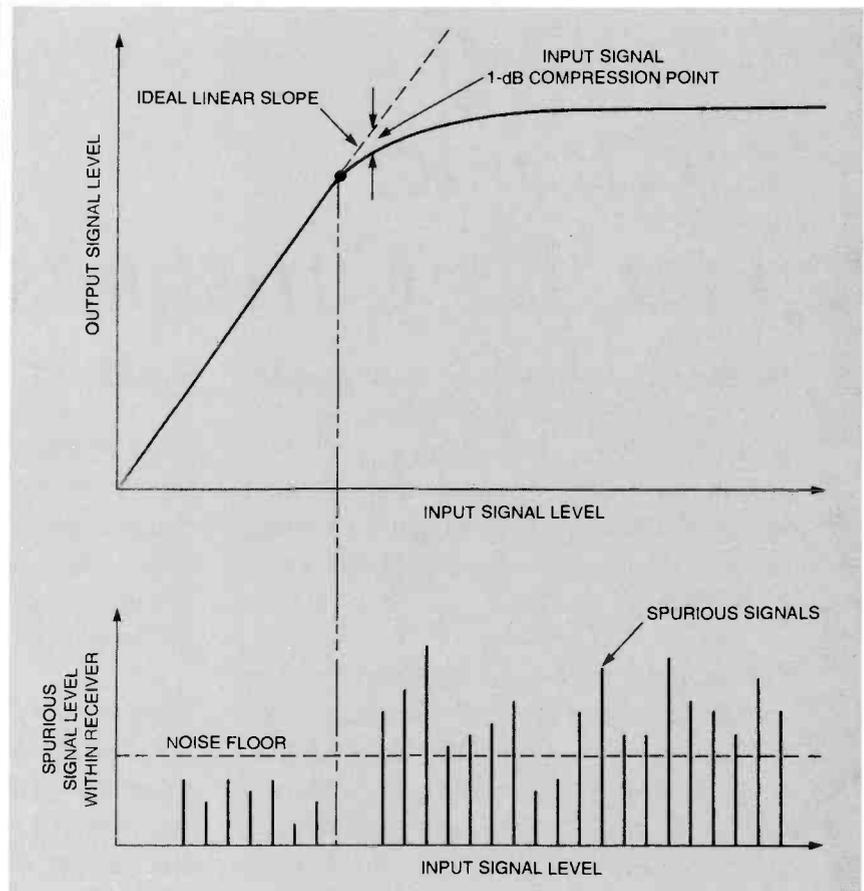


Fig. 1. As the input signal increases in amplitude, (A) illustrates that the resulting output becomes non-linear. When the input signal becomes large, (B) shows that the spurious level of signals generated by the receiver exceed the noise level and appear as real signals in the radio.

two. There is a hill near my QTH that local hams call "Intermod Hill." Located on the hill are: 1) FM BCB1 at 105.1 MHz; 2) FM BCB2 at 91.1 MHz; 3) AM BCB1 at 780 kHz; 4) forty or fifty land mobile transmitters that rent space on the AM/FM BCB towers, an AT&T microwave tower; 5) a hospital with its own communications and paging transmitter; and 6) half a dozen land mobile transmitters not on the tower. The FM BCB stations are 50,000-watts each and the AM BCB is 5,000-watts. It's a really nightmarish 2-meter situation!

A number of years ago I would wait at the hospital entrance for my wife to get off work. My *Heathkit* 2-meter transceiver (it was stolen out of the car on that same parking lot a short time later),

which was tuned to 146.91-MHz, would pick up the VHF telephone transmissions that were used commonly used before the cellular revolution. As soon as I got a block away, the receiver front-end was no longer driven into non-linearity, and the telephone conversations would fade to nothing.

One time, I was trying to raise a friend of mine who was clearly heard on 146.31/146.91-MHz repeater. After a number of attempts to raise him I was ready to give up, figuring that there was something wrong with my transmitter (that *Heathkit* had a habit of blowing final amplifier transistors). Another ham operator broke in and told me Bill was actually on the 146.19/146.79-MHz repeater. The severe intermod

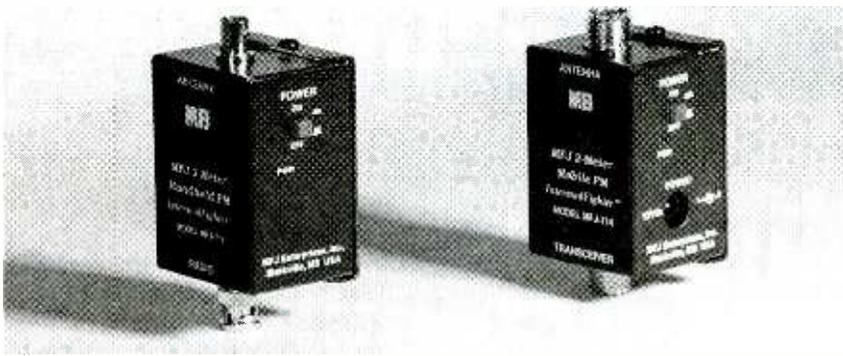


Fig. 2. MFJ-713 and MFJ-714 2-meter intermodulation filters.

situation caused translation of the output of the '79 repeater into the '31 receive frequency!

Figure 1 shows the problem in graphical form. The curve in Fig. 1A is the output signal level vs. input signal level. The response is linear as long as the input signal level is below a critical point. Above that point, however, the receiver input stage (whether it is an RF amplifier or direct mixer) becomes non-linear. The output level is no longer a linear function of the input signal level. This critical point is usually the "−1 dB compression point," that is, the input signal level at which the output is depressed −1 dB from the linear slope.

Spurious signals always exist in radios and amplifiers, but below the −1 dB compression point they are typically below the noise level (see dotted line in Fig. 1B). When the input signal pushes the circuit into nonlinearity, however, the level of the spurious signals or "spurs" comes up dramatically—and they are heard in the output. Unless you can get a radio front-end with rock crusher dynamic range, you will experience intermods. The other alternative, the practical alternative, is to eliminate the out-of-band signals before they get into the receiver front-end.

Figure 2 shows a pair of filters, called *IntermodFighters*, made by MFJ Enterprises. Two models are available, the MFJ-713 with BNC connectors for handheld 2-meter rigs, and MFJ-714 with SO-239 connectors for mobile 2-meter rigs. These *IntermodFighters* include three high-Q bandpass filters and two L-section filters. Signals outside the 144–148 MHz 2-meter ham band are severely attenuated, while in-band 2-meter signals pass through unaffected. The MFJ-713 uses an internal 9-volt battery, while MFJ-714 uses a 12-volt external DC power sup-

ply. Both units have an ON/OFF switch, LED indicator, and power jack, as well as input and output connectors. Prices for the units are \$59.95 each plus shipping.

NEW ARRL PRODUCTS

Last summer I visited a friend of mine in Connecticut. He is an Irish ham operator who pops over to the USA to visit his family every summer. During the time I was in Connecticut I went up to the American Radio Relay League (ARRL) headquarters. They had a number of new products in their line of publications on display in the lobby. Some of these publications are ideal Christmas presents for ham operators.

Most hams have fond memories of ARRL publications through which we studied for our licenses. In the late 1950s I used the three-manual set called *Gateway to Amateur Radio*. And of course, everyone remembers *The 1997 ARRL Handbook for Radio Amateurs* (now in its 74th edition) and *The ARRL Antenna Book* (now in its 18th edition). Both the antenna book and handbook are available in newly published editions.

In *The ARRL Antenna Book* you will find:

- Designing, building and installing almost any imaginable type of antenna.
- Selecting and using the proper feed line and antenna tuner.
- Expanded coverage of low frequency antennas.
- Greatly expanded coverage of elevation angles needed for world-wide HF propagation.
- New chapters on the fundamentals, including the effects of irregular local terrain.
- Expanded information on mobile and maritime antennas.

The 18th Edition of *The ARRL Antenna Book* includes a diskette with antenna-related software for IBM-compatible PCs. Included is a sophisticated Yagi Analysis program by Brian Beezley, K6ST1. Beezley has written a number of fine antenna modeling programs based on the miniNEC program, which he sells on his own. *The ARRL Antenna Book* software also includes versatile transmission-line, antenna-tuner and terrain-assessment programs by editor Dean Straw, N6BV. There's also a really nice MOBILE program by Leon Braskamp, AA6GL. Want to know if your favorite HF band is supposed to be open during the ARRL International DX Contest in February? The disk contains immensely detailed data tables of month-by-month worldwide propagation predictions from US sites for the entire 11-year solar cycle! The Antenna Book is priced at \$30.

The 1997 *ARRL Handbook for Radio Amateurs* is now available in two forms: the traditional printed version and a new CD-ROM version for Windows computers. I bought a copy of the printed version for my Irish friend (\$38), and a copy of the CD-ROM version (\$49.95) for me. After I finish reviewing it on my computer, I will review it in this column.

(Continued on page 58)

FOR MORE INFORMATION

MFJ Enterprises, Inc.

P.O. Box 494
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Tel. 800-647-1800 (orders or information) or
601-323-5869
Fax: 601-323-6551
Web: <http://www.mfjenterprises.com>

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ISBN: 0-87259-613-3
Price: \$30 plus shipping

The 1997 ARRL Handbook for Radio Amateurs

Text format: ARRL Publication No. 1743
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Price: \$38 plus shipping
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ANTIQUE Radio

"B" and "C" Power For Our 3-Dialer

MARC ELLIS

Last month, we began preparations for powering up the *Freed-Eisemann Neutrodyne Model NR-5*, a "3-dialer" that is our current restoration project. I reported on putting together the "A" battery eliminator portion based upon Dr. Fred Archibald's "An Inexpensive Power Supply For Battery Radios Using Off-The-Shelf Parts" (from the November, 1989 *Old-Timer's Bulletin* of the Antique Wireless Association). That section of the power supply will light the filaments of NR-5's five 01-A tubes (negative 5- to 6-volts DC at 1.25-amp)—substituting for the 6-volt automobile-type storage battery originally used for that purpose.

The "A" eliminator seemed to work very well, so for this month's column I turned my attention to the "B" and "C" battery section of the supply. That section will replace the batteries originally used for plate and grid bias voltages, respectively. It is actually an entirely separate supply (or more accurately two entirely separate supplies), completely independent of the "A" unit, except for sharing a power transformer in an unusual hookup explained last month but worth reviewing again.

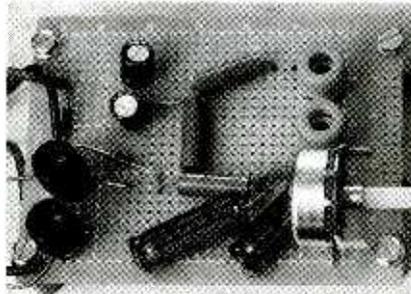
POWER REQUIREMENTS

Before getting into circuit details, let's just recall what power was required to operate the NR-5. The necessary voltages (obtained from batteries, of course, in the 1920s) were noted in the schematic shown in my July *Antique Radio*, and are summarized as follows. The RF and amplifier tube plates require 90 volts ("B+"). The plate of the detector tube needs 45 volts ("DET+"). The filament and plate connection is indicated as ("-B, +6"), while ("+C, -6") is the filament voltage to the five 01-A tubes (our "A" supply), and serves as the return for the grid bias ("C") voltage. Grid bias voltage (at approximately -4.5 volts) is required to the two audio amplifier tubes ("-C").

TRANSFORMER HOOKUP

In a review from last month's *Antique Radio*, the power transformer

for the "A" filament supply, as built by Dr. Archibald was a converted 12-volt, center-tapped, 1.2-amp RadioShack unit. Enough turns were removed from one end of the winding to make the overall voltage 9 volts instead of 12. The nine volts available from the entire winding was used to provide the required AC input into a power supply, resulting in a rectified DC output for the "A" filaments.



Parts layout on "B" and "C" supply board is strictly point-to-point. Binding posts at left are for R1; those at right for R2. Bias adjust potentiometer is below R2's posts.

Never being one to do any extra work if I don't have to, I avoided this transformer rewinding job by digging out a dual 6.3-volt transformer (each winding with a center tap) from the junk box. Series-connecting the two windings gave me the approximately nine volts AC input (available between the end of one winding and the center-tap of the other) for the "A" power supply input.

In Dr. Archibald's circuit, a full six volts was still available between the unmodified end of the winding and the center tap. This six volt winding was fed to the secondary (now used as a primary) of a 6-volt to 115-volt, 0.3-amp transformer, also from RadioShack. The 115-volt primary (now the secondary of this reverse-connected transformer) then delivered AC at the approximately 115 volts required for the input to a "B" and "C" supply. The reason for this convoluted hookup is simply that transformers with high-voltage secondaries are now hard to come by, while transformers with low-voltage secondaries

are commonly available.

In the present circuit, shown in Fig. 1, I also had my choice of 6 or 12 volts to operate a reverse-connected transformer of either secondary voltage to provide the 115 volts for the "B" and "C" supply. In fact, I used a small RadioShack 12-volt transformer because I had it on hand.

POWER SUPPLY CIRCUITRY

The "B" and "C" supply are actually two separate supplies sharing a common transformer (the reverse-connected 6- or 12-volt transformer mentioned above). The negative bus (B-) of the "B" supply is also the positive bus (C+) of the "C" supply (which delivers a negative output to be used as grid bias). Each supply employs half-wave rectification provided by a 1N4004 diode.

The "C" supply uses a filter network consisting of two resistors and two capacitors. The input resistor (470k-ohms) drops the rectified voltage down to the point where it can be regulated at 6.2 volts by the Zener diode. The capacitors are 35-volt units. A 1-megohm potentiometer connected across the output of the supply serves as a voltage divider for selecting the desired bias voltage.

In the "B" supply, rectified voltage passes through filter choke L1. Dr. Archibald suggested that L1 can be the primary of an audio output transformer taken from a junked tube-type radio—and that is what I used. However, he also tried other types of inductors taken from his junk box, and all gave hum-free B+.

Small high-voltage filter capacitors are difficult to come by, so the filtering is done by two 100- μ F, 50-volt units connected in series to give the required 100-volt rating. The 100k-ohm resistors connected across the capacitors equalize the voltage drops across them, ensuring that the voltage divides evenly and does not exceed the rating of either one.

Resistors R1 and R2 are selected to provide the desired B+ voltages for the

amplifier and detector tubes respectively, in this case 90 and 45 volts. These values may vary for different sets. R1 should vary between 0.5 to 2.5k-ohms, and R2 from 5 to 18k-ohms, depending on desired voltage and the NR-5's current draw. R1 must be rated at least 1 watt. The 10- μ F capacitor shown bypassing the "DET+" terminal is optional, in some cases providing a cleaner signal. I left it out for starters.

CONSTRUCTION DETAILS

The "B" and "C" supply was built on a small (2 $\frac{3}{4}$ x 3 $\frac{3}{4}$ inches) project perf board (RadioShack 276-1683). The underside of the board has convenient foil traces for making solder connections between components—including two different busses, each accessible from almost any point. These worked very well for the B+ and B-/C+ lines. Of course, the filter choke and power transformer were too large for the board and required separate mounting.

"Ugly" or point-to-point wiring techniques were used throughout. You'll notice in the photos that some of the resistors seem a little large. These came from the junk box. Were I purchasing new, I would have used more conventional 1- and $\frac{1}{2}$ -watt units. The junk box also yielded an excellent bias-adjust potentiometer, a 1-megohm unit set up for PC board mounting. However, the leads were too large for this PC board; and I had to drill the perfs a bit bigger to accommodate them.

Notice the two sets of binding posts mounted on the board. They are for resistors R1 and R2. As mentioned earlier, these resistors need to be selected to accommodate the specific set being powered. Required B+ voltages may vary, as will the B+ currents (and hence the voltages dropped across the resistors). So, I thought it would be a good move to make the resistors removable rather than soldering them in.

With the board completed, I was ready to assemble all of the components for the "A," "B," and "C" power supply. This I decided to do breadboard style (I warned you, I'm lazy!), cutting a piece of $\frac{3}{4}$ -inch pine to the appropriate dimensions (about 7 by 11 inches).

Looking at the photo of the finished supply, you'll see the "A" board (completed last month) at the top. Under that is the just-completed "B" and "C" board. The large transformer at upper left is

the dual 6.3-volt junk box unit. Below it are (left) the reverse-connected 12-volt transformer, and (right) the junker audio transformer. At the lower right is a terminal strip for "B" and "C" connections to the set being powered. It's another junk box component, and I used only four of the six screw terminals on it. The boards and strip were mounted using long screws and some $\frac{3}{4}$ -inch spacers I had on hand.

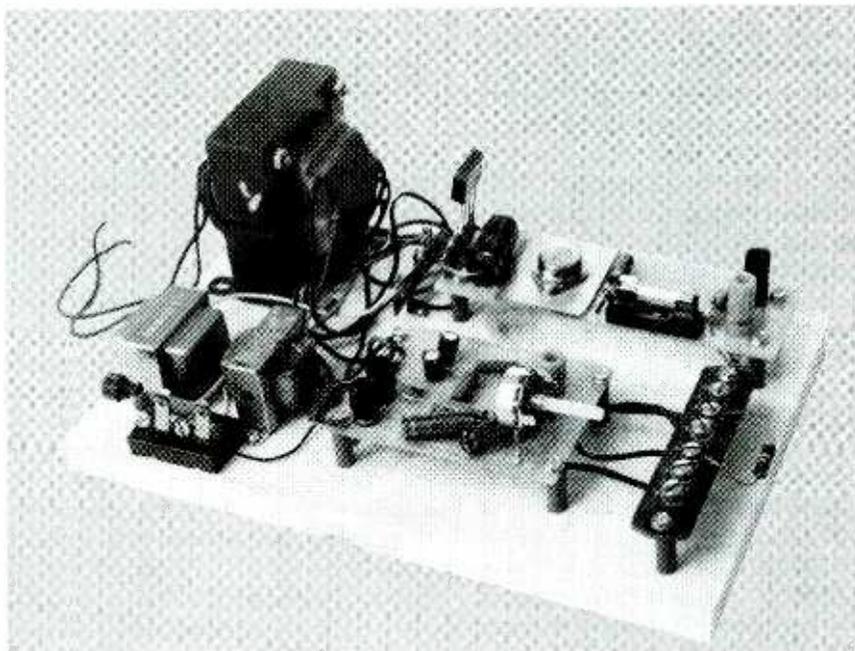
The little knife switch squeezed onto the board below the small transformers was an afterthought. It cuts the power to the "B" and "C" power supply. It occurred to me that I needed a way to kill this supply until the tube filaments of the set being powered reached operating temperature, and B+ current was being drawn. Without the B+ load, I

feared that the voltage across the filter capacitors in the B+ supply might exceed the 100-volt rating.

THE SMOKE TEST

Prior to powering up the supply for testing, I connected a 10k-ohm resistor from the B+ terminal to the B-/C+ terminal. This drew a current equivalent to about four 01-A tubes at the required voltage of 90 volts. The fifth 01-A in the Freed-Eisemann (the detector) would be connected to the separate "DET+" binding post, which I was not going to activate for this test. I connected a 2.5k-ohm resistor across the "R1" binding posts, leaving the "R2" posts open.

Closing the knife switch, I was gratified to see nothing was going up in smoke. However, there was no DC out-



Completed "A," "B," and "C" supply. See text for identification of components.

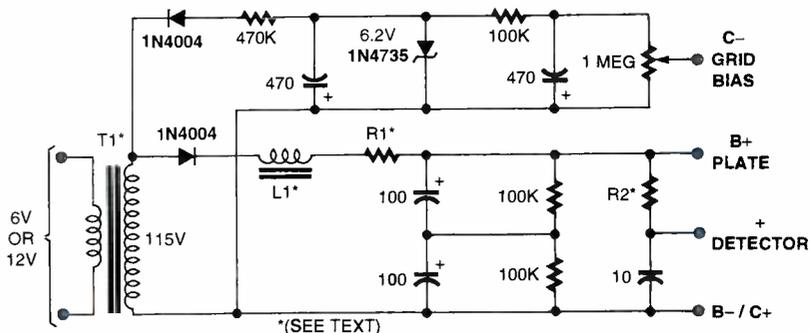


Fig.1. Here's the schematic of the "B" and "C" supply. The "A" supply was covered last month.

put from the supply. Checking the voltage across the 120-volt winding of the power transformer, I found only about 60 volts. Inserting an AC milliammeter in series with the winding, I found a large current drain. Then the transformer began to get very hot.

Methodically disconnecting parts of the circuit to pin-point the short, I finally eliminated everything but the power transformer and the two diodes. But the short was still present! Then I found the problem. It was just a minute whisker of solder accidentally connecting a couple of foil traces on the board. I had been checking each connection with a magnifying glass as I made it, but somehow missed the solder splash across the foil traces. A flick of a small screwdriver cleared the short, and I reassembled the supply.

Now I measured about 50 volts of B+ output. To get closer to the required 90 volts, I reduced R1 to 1.5k-ohms. This brought me up to about 70 volts, which I decided was adequate for initial tests on the Freed-Eisemann. I'd further adjust the value of R1 after the set was connected. The DET+ terminal would also be set to provide 45 volts (by installing the proper value at R2) under actual operating conditions.

Turning my attention to the bias supply, I connected a voltmeter between C- and B-/C+, turning the potentiometer up full. The voltage slowly rose to 4.5 volts, after which the value could be smoothly adjusted from zero to maximum by rotating the control. Some adjustment of the filter resistors would be required to reach the specified 6-volts, but I think 4.5 volts might be adequate. I'll play with this further, if necessary, during actual set testing. The NR-5 schematic I have doesn't specify the required bias voltage.

With everything neatly reassembled on the board, I was patting myself on the back for a job well done—that is until I tested the "A" supply (which had been working perfectly at the end of last month's session). Now that it was screwed down and permanently wired in, there was no output! Making a few quick checks, I found that the 6.2-volt Zener in the base circuit of the 2N3055 was blown. Replacing it gave me a little output from the supply (about a volt), but there are obviously more problems. Good old Murphy's law strikes again. Well, more on that later.

58 Bye for now!

HAM RADIO

(continued from page 55)

VISITING THE ARRL

If you are in New England sometime, then you might want to visit ARRL headquarters. Guided tours are available several times a day, and if you arrive at an odd hour the receptionist can arrange one for you. If you have your ham license with you, then you can operate the League's ham station, W1AW. This station uses the call sign of ARRL founder Hiram Percy Maxim, and is located in a small building in front of the main building. W1AW has two guest operator positions and one "dyn-nomite" antenna array. They also have a bank of Harris kilowatt transmitters for their normal operations. An attendant on duty at W1AW will assist you in learning how to use the equipment.

Finding the ARRL is rather simple. It is located near West Hartford, CT off Interstate Route 91. Follow the "Newington" exit signs until you reach Main Street. The ARRL building is at 225 Main Street, which is a few blocks from where you enter the town. There will be absolutely no doubt when you arrive at headquarters—the beam antenna array is, to say the least, *imposing*. Look to the left side of Main Street for the antenna.

I trust that all my readers will have a very good holiday season, and may we see a rise in sunspots in the New Year! I can be reached by snail mail at P.O. Box 1099, Falls Church, VA, 22041, or by e-mail at carrjj@aol.com. ■

NEW PRODUCTS

(continued from page 21)

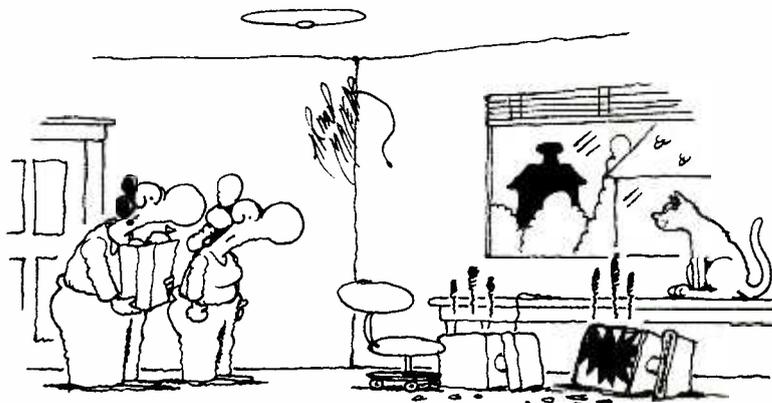
tering circuitry produces extremely low-noise AC power that will not introduce discernible noise into computers and audio devices. It provides power as clean as that from a standard wall outlet.



Campers, in particular, will find the Far Outlet to be a useful device. With a standard deep-cycle battery, the power station will, depending on the load, provide hours of service between charges. The self-contained charger allows the Far Outlet to be used as an uninterrupted power source in case of power failure. It can be charged by plugging it into any wall outlet, or, with an optional converter, into a car's cigarette-lighter receptacle.

The Far Outlet has a suggested retail price of less than \$300, battery not included. For additional information, contact Galaxy Audio, 601 East Pawnee, Wichita, KS 67211; Tel: 316-263-2852; Fax: 316-263-0642; Web: <http://www.galaxyaudio.com>.

CIRCLE 86 ON FREE INFORMATION CARD ■



"I told you we shouldn't have used the tropical fish screen savers."

SCANNER SCENE

High Flying Scanner

MARC SAXON

Here's an exciting new handheld scanner that you may not yet have heard about. It's the *JD-100*, manufactured exclusively for Sporty's Shops by JAL Data, a division of Japan Airlines. This scanner is rather unique in a number of ways, and Sporty's was kind enough to loan us one of the first to try out.

The *JD-100* was designed with the idea of appealing to monitoring enthusiasts who attend air shows or enjoy visiting their local airport. Of course, it's suited to all scanning fans. One of the more interesting features of the *JD-100* is that it is a specialized AM mode scanner intended to cover *only* aero communications frequencies! That's right! It receives 1000 channels between 118.00 and 142.975 MHz, and 7200 channels from 220.00 to 399.975 MHz. In other words, all VHF/UHF channels used by civil and military aircraft are covered.

There are 20 memory channels that may be programmed into the *JD-100*, including one that can be designated as "Priority." Inasmuch as all aeronautical channels use simplex (stations in contact use the same channel), there is a built-in 2 second delay before scanning resumes. You have the choice of either scanning the memory channels (up or down), putting the *JD-100* into *Search Mode*, search/scanning them, stepping through the bands channel-by-channel (up or down), or entering specific frequencies manually. The frequency being received is displayed on an LCD screen, which you can backlight by pressing a button.

Essentially, this scanner has been designed with a minimum of panel controls to make it go through its paces. It's one of the easiest-to-operate scanners you'll find. Yet, it operates like a pro and managed to produce lots of activity on both VHF and UHF using its rubberized antenna (with BNC connector).

Well made and attractive, the *JD-100* comes complete with a keyboard lock, an earphone jack, and a hand strap. It should find a ready audience, especially in the growing band of hobbyists who

have discovered these frequencies and specialize in monitoring them.

Its sensitivity is rated at 1.0 μ V for 6 dB SN (with 1 kHz, 30% modulation), while selectivity is better than -60 dB at \pm 25 kHz. Adjacent channel rejection is more than -50 dB. The *JD-100* operates from 4 "AA" batteries or optional power adapters—115 or 230 VAC, also 12/24 VDC, or vehicle cigarette lighter. Other optional supplies include a metal belt clip, nylon carrying case, and antenna kits for vehicle or aircraft installation.

The basic Sporty's *JD-100* scanner costs about \$150. For ordering or more information, contact Sporty's Shops,

Clermont County Airport, Batavia, OH 45103-9747, Tel. 800-543-8633.

FEELING THE PINCH

You can squeeze only so many stations onto a frequency in a local area—any additional stations would result in so much activity or interference that communications would break down. So, you put newbies on other frequencies that can absorb them. All well and good, except the communications revolution has put so many new stations on the air (in many areas) that all the assignable frequencies for public safety and business stations are nearly filled to capacity. The FCC solution was to create many new frequencies.

This is good and bad. It's good because you will have more and new frequencies to monitor. On the flip side of the coin, you may not like where the hundreds of newly created frequencies have been established. They're wedged in between the previously existing VHF and UHF band frequencies.

For instance, between 150–170 MHz, the land mobile services no longer have 15 kHz separation between assignable channels. Now it's 7.5 kHz. Example: The next assignable frequency above 155.52 MHz used to be 155.535 MHz. Now 155.5275 MHz is a new frequency situated between the two previously existing channels. Stations using the new channels between 150-170 MHz are required to occupy a narrower 11.25 kHz bandwidth for their signals instead of the customary 15 kHz.

In the 421–512 MHz band, channels are now as close as 6.25 kHz apart instead of 12.5 kHz, as before. The next assignable frequency above 453.25 MHz had been 453.2625 MHz. Now the frequency 453.25625 MHz has been added between them. Stations on 453.25 MHz can occupy a 20kHz bandwidth. Stations on 453.2625 MHz must use 11.25 kHz bandwidth, with those on the 6.25 kHz split channel restricted to signals of 6 kHz bandwidth. Some sta-

(Continued on page 61)



The *JD-100* by JAL Data is a specialized aircraft communications scanner.

COMPUTER BITS

Uses for Old PCs

JEFF HOLTZMAN

What can you do with an obsolete PC? I've got computers going back almost 20 years. Some of them might be interesting as museum pieces, but most probably aren't worth the energy it would cost to crate them up. Nonetheless, it's hard to watch them sitting there gathering dust. It's even harder contemplating getting rid of them. But something has to be done. For now I'm going to ignore anything pre-PC; it's the collection of XTs, ATs, and 386s that takes up most of the space. I can think of seven options for an old computer:

- Sell it
- Trade it
- Scavenge it for parts
- Donate it to a school or charity
- Give it away
- Dispose of it
- Find a way to use it

Actually there are a few other options, but they're self-explanatory—use as boat anchor, use for landfill, use as doorstop, or use as counterweight! On second thought, those might be the most viable options. Anyway, here are a few ideas I've come up with so far for using old PCs:

- Game machine for kids
- Dedicated network device server
- Telephony controller
- USB concentrator
- Java machine
- Data sensor/controller
- Learning machine

Drop me a line with your additions, and I'll publish a list here.

GAME MACHINE

The game machine idea doesn't work very well for kids who've been exposed to something better (that is a high-powered multimedia machine). Load up a bunch of out-of-date games, and then donate the machine to your local school.

DEDICATED NETWORK

The dedicated network device server idea is quite intriguing, at least for 386 and better machines. If a computer can run Windows 95, even slowly, it

may be valuable as a print or remote-access server. Even if it can't run Windows 95, there is another option, and what I believe is a significant market opportunity. Microsoft sells a piece of software called the *WorkGroup Add-On for MS-DOS*. It is basically a minimal network client and server that runs on DOS-only machines dating all the

used. Anyway, I think a better version of this software would sell. I have no illusion that it would become a mass-market hit. But on the level of shareware, I think it could be successful. There are an awful lots of old machines out there gathering dust, and I'm sure people would love to be able to put them to use.



Here's an oldie, but a goodie—that old PC, XT, or AT is not good for nothing. So what is it good for?

way back to 8088s. It's poorly documented, poorly executed, a memory hog, and almost no one knows of its availability. I've been using it for years to connect an old 386 laptop to my network. The software is sold by itself, and also comes with NT Server, although legal use of the latter would require purchase of a license for each client on which it was

TELEPHONY

It is possible to buy simple telephone line switches for around \$100. These are dedicated units with very prescribed functionality. I would pay the same price for a plug-in card that could accept two incoming analog lines or a single ISDN line, and provide connectors for fax, modem, and voice. Software control would automatically route

both incoming and outgoing calls. In addition, software modules would provide voice mail, fax scheduling and broadcasting, and line usage logs for billing and tracking purposes. I'd shove the PC in a corner of the basement where the incoming lines terminate, then splice it in. By adding some extra connectors and a small amount of software logic, such a system could easily provide true extensions, line roll-over, conference calling, and intercom service. An open application programming interface (API) would provide a market for add-ons. Hmm...

USB HUB

USB (Universal Serial Bus) seems to be continually on the verge of becoming real. If it ever does, it could be useful for lots of things of interest to people with old PCs. For example, a USB-equipped PC could serve as the hub of a complete home control system, including all the telephony items mentioned above, as well as an alarm system, lighting control, home entertainment control, and more. When the "peripherals" become smart enough, you could even program safety measures, such as ensuring the clothes iron is turned off, or running the clothes dryer only as long as necessary.

The questions for now are 1) What is the interconnect scheme and network protocol, and 2) How can existing homes be retrofitted? New homes can have slick built-in control centers. But an AT-class machine should suffice to handle everything mentioned here. There are industrial networking schemes used primarily in manufacturing that could be adapted to this space, but the vendors have their heads in the sand as far as the consumer market goes. USB, if it ever takes off, may be just the ticket.

JAVA MACHINE

I find all the hype about Java thoroughly annoying, but the language does have potential, particularly if we can arrive at a reasonable compromise between the desire for platform independence and the desire to improve performance and enhance features by exploiting platform-specific functions. Anyway, an old PC might make a good Java machine for doing things like low-end web browsing, e-mail, and low-end applications (such as word processing, spreadsheet, etc.). In

other words, rather than a Network Computer or a Net PC (concepts currently being competitively ballyhooed by Sun and Microsoft respectively)—just use an old PC.

At one point Sun Microsystems announced it was working on a plug-in card for PCs that would sell for around \$100 and provide a dedicated Java-based CPU. I'm not sure what happened to that initiative, but I think it's a great idea, and hope that someone, Sun or otherwise, follows up on it.

DATA SENSOR/CONTROLLER

An old PC could also be used as a data sensor or controller for practical or experimental purposes. For example, you could run a cable outdoors and monitor the level of water in your well. There are lots of similar dedicated applications that could be useful for home monitoring and control.

LEARNING MACHINE

Last, there are science-fair projects that smart kids could build. And there are plenty of reward-based projects kids could perform on an "obsolete" machine. For example, give the kids a challenge—"I'll reward you with a new game for the Windows machine if you use the old machine to build a rain/humidity sensor."

What do you do with your old machines? Let me know at jkh@acm.org. ■

SCANNER SCENE

(continued from page 59)

tions on the new channels might use new special narrowband voice modes, such as ACSB, which your scanner won't be able to copy.

These are just a couple of typical examples of the new channels already added to virtually all the land mobile radio services. When you attempt to program a 7.5 kHz split frequency like 155.5275 MHz into your scanner, you'll be in for a surprise. The scanner will refuse to accept that exact frequency, but will give you 155.525 MHz, which is 2.5 kHz away. Even so, you'll be able to copy any FM transmissions that take place on 155.5275 MHz. But local stations using adjacent channels will cause interference. Your scanner also will not accept programming for

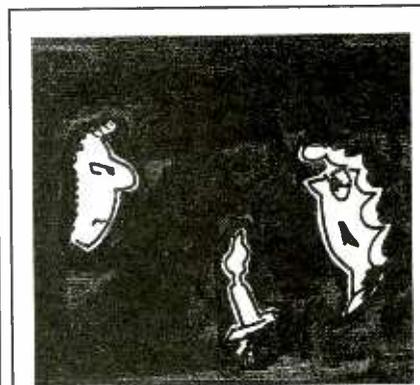
453.25625 MHz, it will come out as 453.255 MHz. A 6 kHz FM you hear isn't going to sound so great, I'm afraid.

Communications requirements forcing technological changes that brought closer spaced channels and narrower FM bandwidths (unfortunately) weren't made with scanner owners in mind. Our current generation scanning equipment simply wasn't designed for these technological parameters. Activity in reasonable amounts on these new channels is not yet pounding loudly at our door, and so current scanners should still serve us well for the immediate future.

Even the VHF aeronautical band is most likely going to get a reworking. Presently, channels in the 118.000 to 136.975 MHz band are spaced at 25 kHz apart. Note, however, that the Boeing Co., in Seattle, WA, just received an experimental license (WA2 XIE) to operate on 123.1583 and 123.333 MHz in order to test 8.33 kHz channel spacing for aircraft (so far only) in Europe.

Scanner manufacturers will have to work at producing a new generation of equipment with sufficient selectivity to deal with these closely-spaced channels. It should accept programming for 8.33, 7.5 and 6.25 kHz frequency splits. It may need to offer additional receiving modes beyond AM, WFM, and one-size-fits-all NFM.

If you have comments and thoughts on this, e-mail me at: sigintt@aol.com. Let's also hear from you with additional thoughts, plus loggings, local frequencies, and whatever. Our address is: **Scanner Scene, Popular Electronics**, 500 Bi-County Blvd., Farmingdale, NY 11735. ■



"Well, your plan to stop the power meter seems to have worked!"

Think Tank

A Mixed Bag of Circuits

JOHN J. YACONO
TECHNICAL EDITOR
COMPUTER RESELLER NEWS, IEEE

This month we've got letters about power-supplies, battery chargers, phone circuits and all sorts of interesting gadgets. We will get to them after continuing our discussion of power supplies and filters. In last month's column we left off by stating that a smaller value of filter capacitor could be used to partially smooth the pulsating DC, providing this capacitor filter is followed by a linear regulator. Let's now explore this concept.

Most circuits, especially digital ones, require power supplies that produce less ripple than the simple capacitor filters. To reduce ripple to a negligible level—without having to purchase a capacitor the size of a house—a voltage regulator stage is often placed between the filter stage and the device being powered, or load. The stage can be composed of discrete components, but there are many "solution-in-a-can" ICs to reduce the number of components needed to a minimum.

The most popular voltage regulator IC family is the 7XXX family. They come in TO-220 and TO-3 three-lead cases for low and high-current loads respectively. The series is divided into two classes: regulators for positive voltage (denoted 78XX), and ones for negative voltage (denoted 79XX). The last two digits indicate the voltage to expect at the output. Commonly, you'll see regulators where the last two digits are 05, 06, 09, 12, or 15, representing 5, 6, 9, 12, or 15-volt outputs. Sometimes you'll see regulators with an L between the 7X prefix and the two voltage digits. The L is for low power. Those regulators are usually supplied in TO-92 packages, so they look like small discrete transistors.

Deploying this family of regulators is very easy. Looking at Fig. 1, you can see the device has only three terminals: an input (I), a ground (G) and an output (O). Filtered DC with moderate ripple enters the input (at I) and is regulated to a fixed voltage with minimal ripple for use by the load R_{LOAD} connected at the output. A small capacitor,

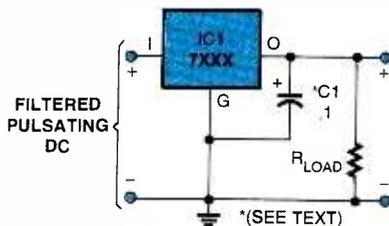


Fig. 1. A three-terminal voltage regulator can be used to fix the output voltage and adequately smooth the partially filtered pulsating DC voltage.

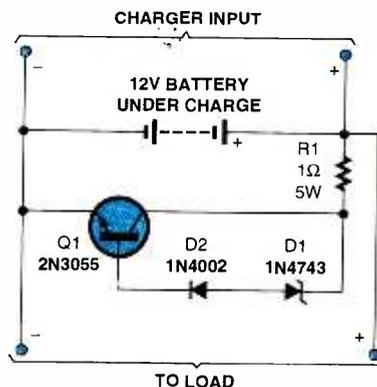


Fig. 2. Use this circuit to protect against overcharging lead-acid batteries.

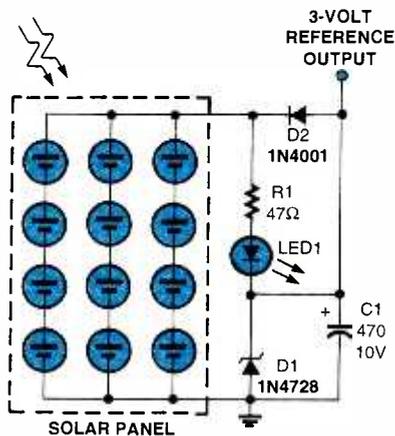


Fig. 3. This little circuit will regulate the output from a solar panel to levels useful for low-voltage applications.

C1, (tantalum-type, around 1- μ F) at the output helps the IC deal with transients from the load. It should be con-

nected as close to the regulator terminals as possible. In some cases a similar bypass capacitor at the input is required for stable operation.

Because of voltage drops within the IC, the input voltage should be about 4 volts higher than the desired output voltage, and can be as high as 35 volts for most units. Regulators in the TO-220 case can handle up to 1.5 amps when used with a heat sink. The TO-3 case style raises that to over 3 amps with an adequate heat sink. Next month we'll look at adjustable regulators—units that can supply a range of output voltages. Now let's read the mail!

BATTERY PROTECTOR

Use the circuit in Fig. 2 to protect against overcharging small-to-moderate sized lead-acid batteries (2–30 Ah) in "float" applications (that is, charging from low-cost automotive trickle charges, solar panel, etc.). The 2N3055 transistor (equivalent RadioShack 276-204) starts to conduct at about 14 volts, shunting excess current from the battery to prevent electrolyte boil-off. As a minimum, mount the transistor on a moderate sized heat-sink. The Zener diode should be a 13-volt device with a 1-watt minimum rating (use a 1N4743 or NTE143A).

—Fred Nachbaur, Nelson, Canada

Short, sweet and a nice addition to a home-brew charger. Note that by varying the Zener diode's voltage rating, you can easily modify the circuit to protect NiCd's, too.

SOLAR REGULATOR

If you own a solar battery and need a simple circuit to regulate power to things like a Walkman or other low-power devices, then try the circuit in Fig 3. When light falls on the solar cells, current passes through resistor R1 into LED1 (a current indicator), and reverse biases Zener diode D2 to produce a 3-volt reference voltage. Capacitor C1 filters out any ripple voltage.

—Amose K. Anie, Ghana, West Africa
Very nice. Of course, higher volt-

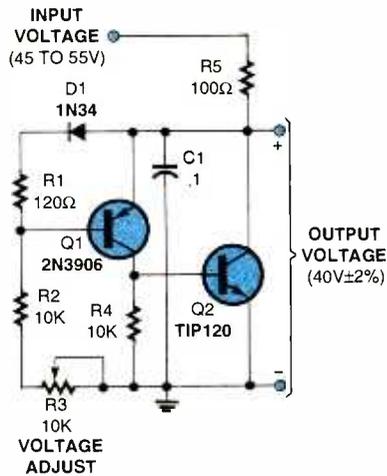


Fig. 4. Here's a circuit that can replace high-power Zener diodes. The output voltage can be made adjustable and the circuit has impedance characteristics better than a Zener.

ages can be obtained with larger panels and different Zener diodes. Should you have difficulty locating the indicated 1N4728 Zener diode (3.3-volt, 1-watt rating), substitute a NTE5066A or Thomson SK3V3.

HOME-BREW ZENER

I'm building a regulated supply for low frequency/audio frequency amplifier, and I needed a low-impedance, high-power regulator. I came up with the circuit in Fig. 4, and since the output voltage is adjustable, it can replace a pile of high-power Zener diodes, and has an order of magnitude better dynamic impedance than a standard Zener.

Diode D1 and R1 hold the base of Q1 at about 220 mV over a wide range of input voltages. Transistor Q1 drives Q2 just at the right level to hold the output voltage constant. This output

voltage can be varied with potentiometer R3, which should be set around 6000 ohms for a 40-volt output. Measurements show that diode D1 draws about 1 mA and the collector current of transistor Q1 is 2 mA. This current can go much higher with a 1/2-inch heat sink glued-on. With transistor Q2, I used a 3/4 - x 1-inch steel scrap as a heat sink, and the device ran at about 120-130°F.

—Craig Fawcett CET, Downers Grove, IL

Nice circuit! Interesting characteristics, too. Since the output voltage is adjustable, this could be modified to make a hobbyist power supply. The 2N3906 transistor can be replaced with a NTE159 or SK3466. An equivalent part for the TIP120 transistor is the RadioShack 276-2068.

IMPROVED POWER SUPPLY

By adding a bridge rectifier to a transformer-less DC power supply, you can double the output current capability and cut the ripple voltage in half, without changing other components. Fig. 5A is a capacitor pump-type power supply. I have used this type before but always with resistors. I saw this version in the January 1997 issue of **Electronics Now**, on page 12, and started to think of how it works. On the first positive half cycle, capacitor C1 charges up through the load and rectifier; any excess charge that would raise the output voltage above the Zener voltage is shunted through the Zener. On the negative half cycle, C1 charges to the opposite polarity through the forward-conducting Zener, which has a 0.7-volt drop. The size of C1 determines the maximum output current.

Fig. 5B shows the changes that were made to build my circuit. The rectifier was replaced by a bridge, BR1, and the 11-volt Zener (1N4741 equivalent is a NTE5074A) was moved to the output. That allows the charging current of C1 to flow through the load on both half cycles. For safety, a line-isolation transformer was used when the circuits were breadboarded and tested. Table 1 shows the measured output voltage and ripple voltage vs. the load current, as the load resistance is made smaller. Notice that the original circuit of Fig. 5A has a maximum load current of about 8 mA and a ripple voltage of 360 mV, while my final circuit of Fig. 5B has a higher maximum load current of 16 mA and a lower ripple voltage of 190 mV. Also note that there is a very sharp drop off in output voltage as the maximum current is reached. The values of C1 and C2 in Fig. 5B can be one-half what they are in the first circuit, which could result in a nice saving, especially when larger load currents are desired.

—Richard W. Johnston, Troy, MI

Such circuits also save money by dispensing with the transformer typically used in other configurations. Of course, caution must be used with such circuits. All wiring from PL1 should be well insulated—and I'd also recommend a fuse!

RING INDICATOR

The November 1996 edition of *Think Tank* printed some good telephone circuits—here's another. With each ring of the telephone, the circuit in Fig. 6 can drive a piezo buzzer, light an LED, trigger a optocoupler, etc.—all activated through 117 VAC outlet SO1. The ring detector (IC1) guards against false trig-

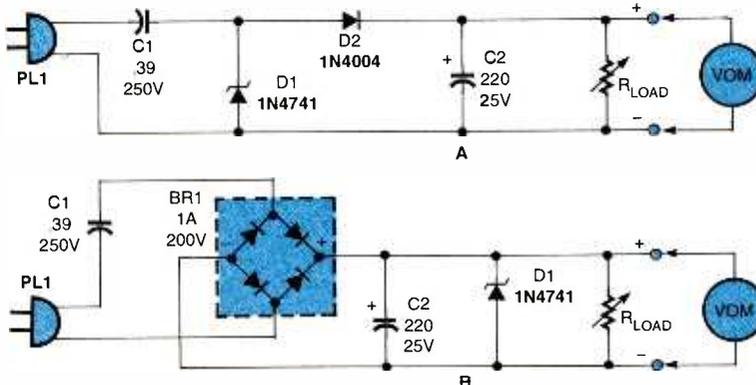


Fig. 5. The original "pump"-type DC power supply (A) has been modified with changes that double the output current capability (B). The table on the right shows measured test results at R_{LOAD} .

LOAD I mA	FIG. 5A		FIG. 5B	
	OUTPUT VDC	RIPPLE VRMS	OUTPUT VDC	RIPPLE VRMS
3.0	10.28	.15	11.17	.17
5.0	10.10	.25	11.10	.17
8.0	9.18	.36	10.94	.18
8.14	0.	0.	—	—
10.0			10.79	.185
13.0			10.50	.185
15.0			10.12	.19
16.05			0.	0.

gering from the dial pulses of phones on the same line. My original component for IC1 was a telephone ringer IC obtained at RadioShack, which went under the designation, TCM1512A. I later used a TCM1536. The equivalent part is sold as a NTE1649. Check pin-outs for corresponding connections. Resistor R2 can be any standard value between 100k-ohms and 200k-ohms. Capacitor C1 should be chosen depending upon the ring voltage, while for C3 use the smallest capacitor that will hold the triac, TR1, on. Too much capacitance may trigger the triac from power-line spikes. The triac selected can be any 6-amp, 400-volt device (namely RadioShack 276-1000). An equivalent part for the MOC3010 optotriac is a NTE3047.

—Jay Hawthorne, Claresholm, Canada

Thanks for all the part numbers and values, Jay. With all the variations of telephones across the country, it's no wonder that one circuit cannot be used in every location. Usually the green telephone wire (Tip) is positive and the red wire (Ring) is negative.

TELEPHONE HOLD

The following circuit was designed to add a hold function to a telephone in my basement. A call in the basement for some reason typically requires a trip upstairs to complete. This circuit eliminates the run back to the basement to hang up the second phone.

The telephone line in my house operates at approximately 40–48 volts. When a telephone receiver is picked up, this voltage usually drops to about 5 volts. It doesn't take that much of a line voltage drop to hold the line open. The hold circuit (shown in Fig. 7) pulls the telephone line voltage down to about 20 volts, and is adequate to hold the line open and give enough drop range for disengagement when the other phone is taken off the hook.

The 2N5064 SCR (RadioShack equivalent 276-1067) is the key to this circuit. Once the gate is triggered, the SCR will conduct until the "hold" current drops below a minimum value. When the current drops below this threshold of the SCR, it turns off and can be turned back on only through a small positive voltage on the gate. Resistor R3 is a "drain" resistor that keeps the gate from picking up stray noise and switching unexpectedly. The exact value is not critical. Resistor R2 keeps

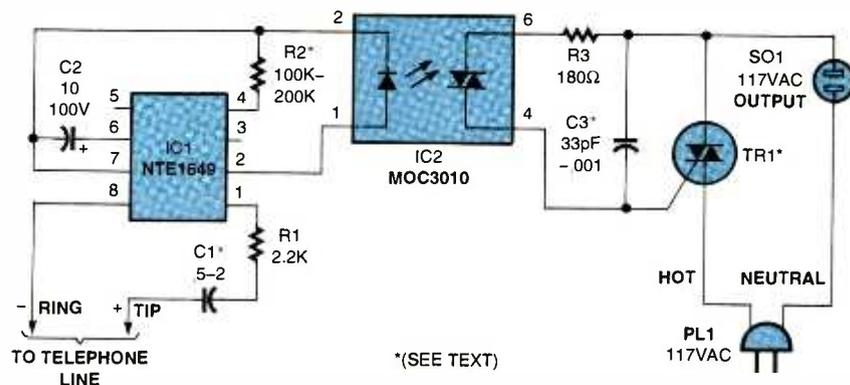


Fig. 6. With this circuit, you will always know when the telephone is ringing. The outlet can drive most types of indicator devices.

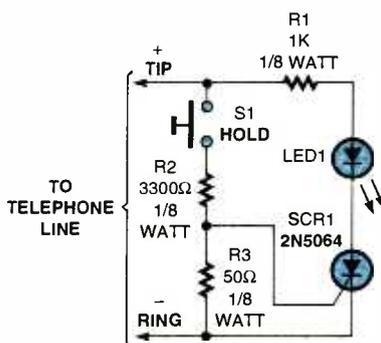


Fig. 7. Here's a handy little circuit that adds a hold function into an existing telephone.

the line voltage from "spiking" the gate. Again, the exact value is not critical.

To operate the hold circuit, press and hold the momentary switch S1 (HOLD button) until you have hung up the phone. The LED glows dimly until the phone is placed on hook, at which point it glows normally and you can release S1. The phone is now on hold. When you pick up the other phone, the hold circuit releases and the phone line returns to normal.

On a telephone line, Tip is supposed to be the green wire, positive polarity, and Ring, the red, negative wire. But sometimes telephone wiring is not done to standard and the polarity is reversed. That can destroy the SCR, so use a meter to determine the line polarity and wire accordingly. The circuit is small enough to put inside the phone, and is a lot cheaper than the add-on hold devices you can buy in the store. It requires no outside power and is a cinch to build. Enjoy!

—Fitz Wood, Marietta, GA

It would be neat to build one of these around a phone-line coupler. Then you could move the hold feature from room

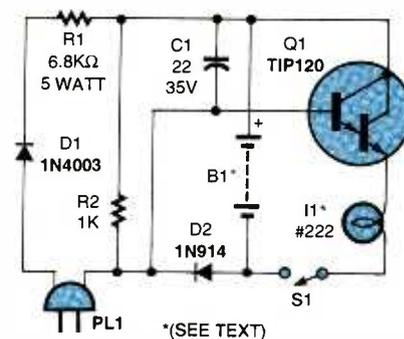


Fig. 8. Build this power failure light circuit and never be in the dark! When the power fails, or the unit is removed from the wall, the light automatically comes on.

to room with you, or take it on vacation.

POWER FAILURE LIGHT

Although I have been experimenting with electronics since second grade, it was only recently, at the age of fifteen, that I finally began to understand transistors. Using my newfound knowledge, I devised the power-failure light circuit in Fig. 8. When the unit is plugged in, the internal battery charges. When it is removed from the wall or the power fails, the light automatically comes on and can be shut off by opening S1. Here's how it works.

When power is applied, diode D1 rectifies the input AC; and resistors R1 and R2 divide this down. A voltage divider was chosen here over a transformer because of its low weight and small size. This voltage then provides a low-current, low-voltage trickle charge for the battery B1. During charging, the voltage at transistor Q1's base is far below its turn-on voltage, keeping lamp I1 turned off. When power is removed, D2 isolates Q1's base from ground, and R2 brings it

(Continued on page 68)

Circuit Circus

Don't Fence Me In!

CHARLES D. RAKES

This time around we're going to look over some circuits that are designed to help Farmer McGregor keep Peter Cottontail out of his garden. Mr. McGregor took my advice and installed an electric fence around his garden. From that day on the farmer enjoyed the fruit of his labor and spent his spare time watching Peter's family feast and grow on a single row of vegetables he planted outside the fenced-in area. For those who don't have to worry about "fencing-out" some critters, you might be more interested in building some electric fence circuits to confine your pets to your property without injuring them. Either way—read on!

REAL SIMPLE FENCERS

Electric fence circuits are the main attraction for this month's column. The fenced-in area can be a separate enclosure within an existing fence, or a separate wire perimeter fence as part of an existing enclosure. A typical installation is shown pictorially in Fig. 1. The high voltage wire must be insulated from the fence posts. A common "do-it-yourself" approach is to use soda bottles mounted on top of angle brackets which are secured to the fence posts. The electrified wire is routed around, secured and supported by the bottles. The soda bottles offer good dielectric insulating properties, even under damp conditions. The wire should be at a height above ground, approximately two-thirds the height of the animal which you want to keep in (or keep out). Connection to the wire from the fencer circuit should be made with high voltage-type wire—keep the run as short as practical.

Figure 2 shows a circuit commonly used as a igniter for a gas grill or gas welder and found in a majority of basic fencer circuits. The heart of these circuits consists of a large turns ratio step-up transformer that supplies the high voltage to the electric fence. Some start out with a 6- or 12-volt battery as the fencer's power supply, and others may use the local 117-VAC power. Some even are operated with solar energy as a charging source for

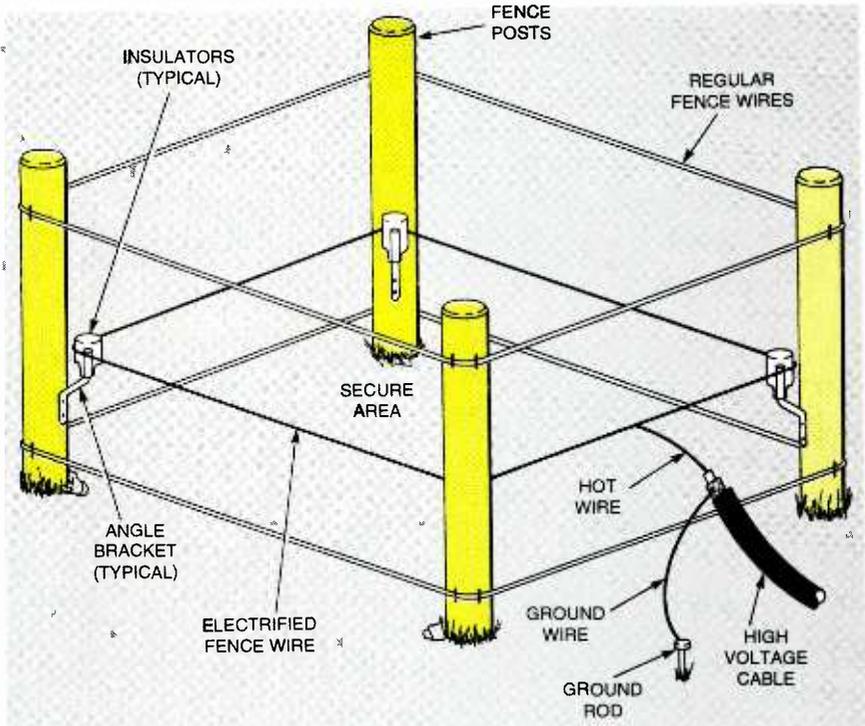


Fig. 1. Typical electric fence installation with single high voltage wire around the enclosure perimeter.

the fencer's batteries. But no matter what power source is used, the output that connects to the electric fence is always an AC voltage.

With momentary switch S1 in its normally open position, no current flows in the circuit. Pressing S1 causes current to flow from the battery through the primary winding of transformer T1, and after a very short time the current reaches its maximum level. At this point S1 is released, stopping the current flow into the primary winding of T1. The magnetic field then collapses producing a high voltage pulse across the secondary winding of T1. The 0.1 μF capacitor serves two important functions in the circuit. It prevents S1 from arcing when released, and it offers a return path for T1's collapsing field current. The transformer can be any high voltage step-up type or even the ignition coil from an automobile. You will have to experiment as to what transformer works best for your application. Some people have told me that the ignition mechanism from an old gas-

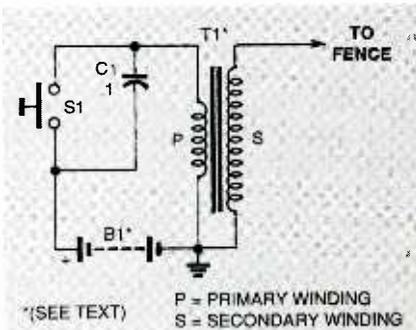


Fig. 2. Basic circuit used in majority of simple "do-it-yourself" electrified fence circuits.

PARTS LIST FOR SIMPLE FENCER CIRCUIT (FIG. 2)

- B1—6- or 12-volt battery
- C1—0.1- μF , 200-WVDC mylar or similar capacitor
- S1—Normally open push-button switch
- T1—High-voltage step-up transformer, automobile ignition coil, etc. (see text)

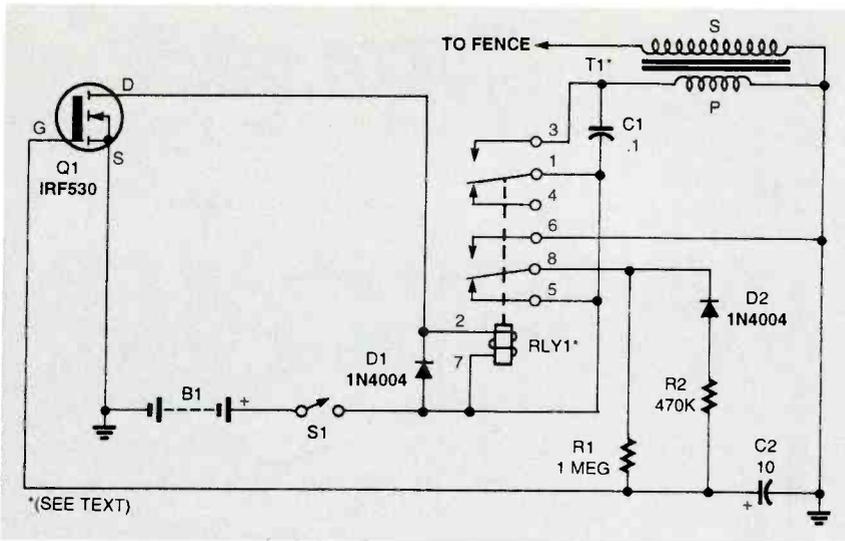


Fig. 3. Automated version of basic circuit.

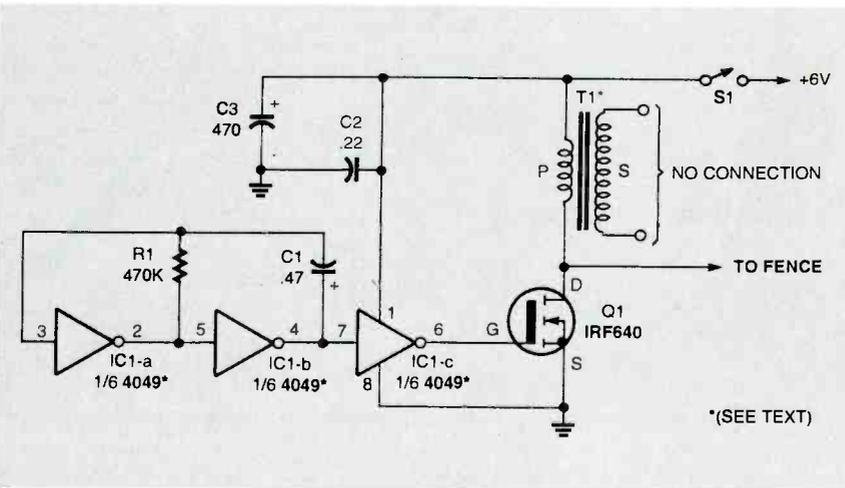


Fig. 4. Total solid-state low-impedance fencer circuit.

powered lawnmower worked well for them. High voltage at low (microamp) current is required.

Our next fencer circuit, in Fig. 3, is an automated version of our basic circuit. Here we've replaced the manual switch in the basic circuit with a 12-volt relay to do the primary current switching. The IRF530 N-channel MOSFET is connected in an electro-mechanical oscillator circuit that operated the relay.

Turning SPST switch S1 on supplies power to the circuit and starts charging C2 through R1, and the relay's, RLY1, normally closed contacts 5 and 8. When the voltage across C2 reaches about 8 volts, Q1 turns on pulling in the relay. The relay remains operated until C2 is discharged through R1, R2, diode D2, and relay contacts 6 and 8. Once the capacitor discharges below Q1's turn-on voltage, the relay drops out and the cycle repeats. The value of R2, which is paralleled with R1 through D2

during the discharge cycle, determines the relay's operated on-time. This time should be set to allow T1's primary current to reach its maximum level, and then allow the relay to drop out. If the on time is set too short, the transformer's output voltage will not reach its maximum level, and if the on time is set too long, energy will be wasted in T1's primary terminal. Relay contacts 1 and 3 replace the switch contacts of the basic circuit.

The circuit's timing can be changed by varying the values of C2, R1 and R2. To speed up or increase the number of output pulses per minute, lower the values of R1 and R2, and to reduce the number, increase these values. Also the value of C2 can be increased to slow down the pulse rate, or decreased to increase the pulse rate. The relay's on time can be changed by varying the value of R2. Larger resistors here will increase the on time and

PARTS LIST FOR AUTOMATIC SIMPLE FENCER CIRCUIT (FIG. 3)

- B1—12-volt battery
- C1—0.1-µF, 200-volt mylar or similar capacitor
- C2—10-µF, 25-WVDC electrolytic capacitor
- D1, D2—1N4004 diode
- Q1—IRF530 N-channel MOSFET transistor (equivalent NTE66)
- R1—1-megohm, ¼-watt, 5% resistor
- R2—470,000-ohm, ¼-watt, 5% resistor
- RLY1—DPDT relay, Potter and Brumfield, type KRPA-11DG-12
- S1—SPST power switch
- T1—See text

PARTS LIST FOR SOLID-STATE LOW-IMPEDANCE FENCER CIRCUIT (FIG. 4)

- C1—0.47-µF, 25-WVDC, electrolytic capacitor
- C2—0.22-µF, 50-WVDC, disc-ceramic or mylar capacitor
- C3—470-µF, 25-WVDC, electrolytic capacitor
- IC1—4049 hex-inverting buffer IC (equivalent NTE4049)
- Q1—IRF640 high voltage N-channel MOSFET transistor (equivalent NTE2388)
- S1—SPST power switch
- T1—117-VAC transformer (see text)

smaller values will shorten the on time. Always choose a good quality low leakage capacitor for C2. This is a working circuit and is similar to some early commercial fencer chargers. But read on before deciding on a circuit to build.

SOLID-STATE LOW-IMPEDANCE FENCER

Our next entry, Fig. 4, is a total solid-state low-impedance fencer circuit. The low-impedance fencer is normally used in areas where weeds tend to grow to heights that come in contact with the fence wire. The commercial version of the low-impedance fencer is also known as the "weed burner". This feature helps to keep the fence "hot" in weedy areas—and has been known to start fires in some instances! *So be cautious when using this type of fence charger.*

Our low-impedance circuit uses the primary winding of a standard 117-volt

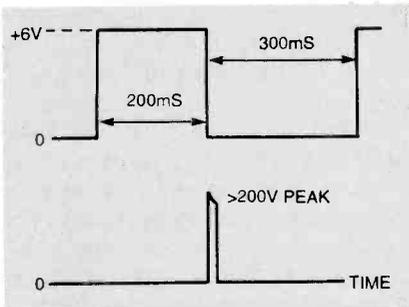


Fig. 5. In (A) is the waveform at the gate of Q1, and in (B) is the resulting high-voltage pulse generated as output to fence.

to 6-volt, 3- to 5-amp power transformer to supply the sting to the fence wire. Three stages of a 4049 CMOS hex-inverting buffer IC are connected in an oscillator and driver circuit. The oscillator's buffered output, at pin 6 of IC1-c, drives Q1, a IRF640 high voltage N-channel MOSFET. During the positive portion of the waveform, Q1 turns on like a low-impedance switch, taking the low end of T1's primary to ground. This places the transformer's primary across the 6-volt supply. When IC1-c's gate voltage goes back low, Q1 switches off, the current through T1's

primary stops, and the magnetic field collapses to produce a healthy 200 plus volt positive pulse. Fig. 5 shows the expected time waveform at Q1's gate and the output pulse that makes the fence "hot".

If you have any doubts about this type of fencer being a good shocker, try the following example. Take about any 25 watt or larger 117-VAC transformer and connect one of the primary leads to a 6-volt DC power source terminal that's capable of supplying at least 10 amps. Take the other primary lead and wipe it across the other terminal from the power source, and note the bright blue flame that follows the wire. One thing for sure is *you don't want to be touching both leads at the time you make the disconnect*—it will be a shocking experience that you won't soon forget!

If you build the low-impedance fencer circuit, be sure to ground the inputs of the unused inverters (pins 9, 11, and 14). Real strange circuit operations can occur if any unused gates or inverters are not tied to either battery positive or battery negative supply. What usually happens is the circuit

works great at first and then slowly declines into a Murphy's holiday.

COMMERCIAL-TYPE OF FENCERS

Our next two fencer circuits are of the high-voltage pulse type that are similar to the majority of the commercial fencers in use today. The first circuit, Fig. 6, operates from a 12-volt battery and is a good choice for a remote location that is away from the AC power. Three inverters of a 4049 hex-inverting IC are connected in an

PARTS LIST FOR HIGH VOLTAGE, PULSE-TYPE FENCER CIRCUIT—DC DRIVEN (FIG. 6)

- C1—10- μ F, 25-WVDC, electrolytic capacitor
- C2—470- μ F, 25-WVDC, electrolytic capacitor
- C3—0.1- μ F, 50-WVDC, disc-ceramic capacitor
- D1, D2—1N914 silicon diode
- IC1—4049 hex-inverting buffer IC (equivalent NTE4049)
- Q1—IRF640 high-voltage N-channel MOSFET transistor (equivalent NTE2388)
- R1—220,000-ohm $\frac{1}{4}$ -watt, 5% resistor
- R2—500,000-ohm potentiometer
- S1—SPST power switch
- T1—Auto ignition coil

PARTS LIST FOR HIGH-VOLTAGE, PULSE-TYPE FENCER CIRCUIT—AC DRIVEN (FIG. 7)

- C1—4.7- μ F, 200-WVDC, electrolytic capacitor
- C2—10- μ F, 200-WVDC, electrolytic capacitor
- D1-D4—1N4006 silicon diode, or suitable full-wave bridge module
- D5—47-volt, 1-watt Zener diode, 1N4756A (equivalent NTE5088A)
- F1—1-amp fuse
- Q1—6-amp, 400-volt SCR (RadioShack 276-1020)
- R1, R2—1000-ohm, $\frac{1}{4}$ -watt, 5% resistor
- R3—5000-ohm, 10-watt power resistor
- R4—25,000-ohm potentiometer
- S1—SPST power switch
- T1—117/117-VAC isolation transformer, 20-watt or larger
- T2—Auto ignition coil

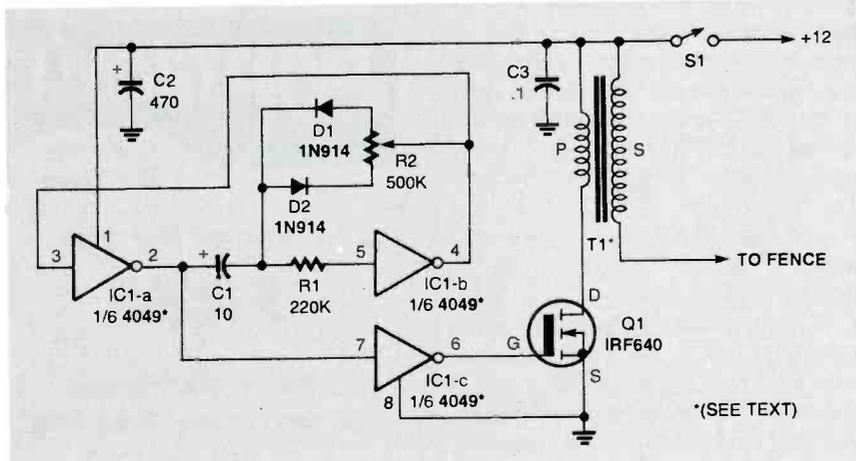


Fig. 6. High-voltage pulse-type circuit used in majority of commercial fencers.

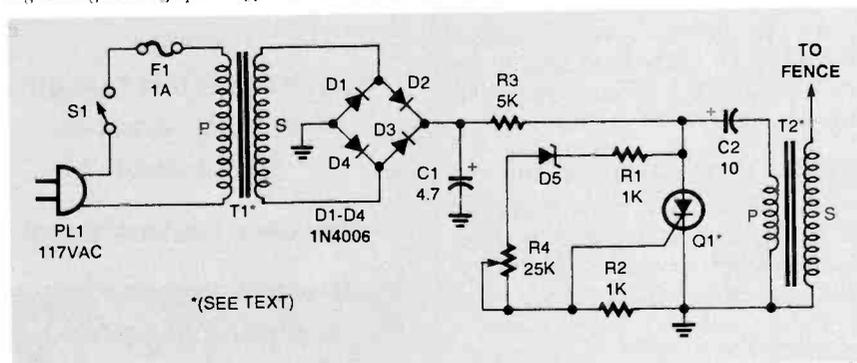


Fig. 7. High-voltage pulse-type commercial fencer circuit powered from the local AC electric source. An isolation transformer is also included for safety.

oscillator buffer circuit that allows the output pulsewidth to be adjusted to fine tune the fencer's output circuitry for efficiency and output voltage. The positive portion of the signal at Q1's gate causes the MOSFET to switch to ground, which in turn ties T1's primary winding across the 12-volt source. When the gate signal goes low, the current through Q1 and the transformer's primary stops, and a high voltage pulse is generated across T1's secondary winding. The simplest way to adjust potentiometer R2 for maximum output and circuit efficiency is to set R2 to its mid-position, connect a DC current meter in series with the fencer circuit and power source, and position T1's output lead about 1/2-inch from ground. Adjust R2 for the best output voltage with a minimum current flow.

Our last fencer circuit, see Fig 7, also is of the high-voltage type that is powered from the local 117-VAC source. Many of the commercial fencers that are powered from the AC work without an isolation transformer. Ours, for safety reasons, uses a 20-watt or larger 117/117-VAC isolation transformer for T1.

The circuit operation is as follows. The DC operating voltage comes from the output of the bridge rectifier made up of diodes D1-D4 and filtered by C1. Capacitor C2 charges through R3 to about 125 volts, which also supplies current through Zener diode D5, R1, and R4 to the gate of the SCR, Q1. When the gate voltage rises high enough to fire the SCR, C2 is discharged through the primary of T2, causing a high voltage pulse at its secondary winding. The pulse rate and output voltage are controlled by the setting of potentiometer R4.

The output transformer used in our last two circuits are auto ignition coils, which will produce a very high output voltage at low currents, and work well for short fence runs. If a long fence run is desired, a better choice of output transformer would be one designed by the commercial fencer companies. Non-operating fencer components can usually be had for the taking, or at maximum of a few bucks each, at a repair station, junk shop, or even at a yard sale.

Time to close again for this visit. Have a high-voltage good time and keep all body parts away from the output terminal. ■

THINK TANK

(continued from page 64)

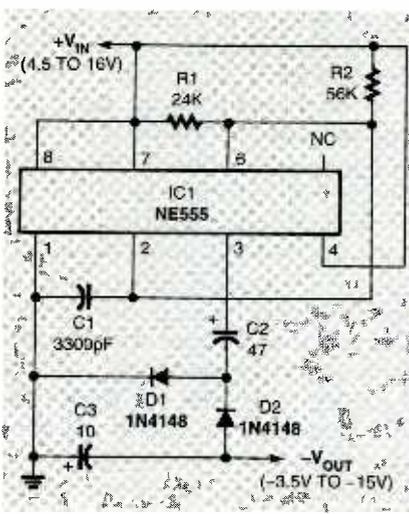


Fig. 9. This simple circuit functions as a power supply inverter. Use it to supply the negative voltage for bipolar op-amp configurations.

above the turn-on voltage. This voltage results in Q1 conducting and I1 lighting. Switch S1 is used to turn off the light. Capacitor C1 serves to keep Q1 turned off when the pulsating DC from D1 is at 0 potential. If you frequently experience brief "dips" in power, and want the light to remain off during those times, increase the value of C1. The component values are not critical. The TIP120 transistor can be replaced with a RadioShack 276-2068. For the battery, B1, I chose the RadioShack NiCd pack (3.60V, 280 mAh) to light I1 (which is rated at 2.25V, 0.25A), although any other combination would be fine. Just make sure D1's PIV is 200 volts or above. One final note, because this circuit is not isolated from the power line, make sure all connections are well insulated. —Alex MeVay, Old Greenwich, CT

I like this circuit, Alex—and your good use of your new knowledge! Placing more batteries in parallel can make the unit last longer, although the charging time would increase.

SUPPLY INVERTER

The simple circuit in Fig. 9 uses an NE555 timer IC to provide a negative-supply voltage for op-amp circuits, etc. The open-circuit output voltage, V_{OUT} , is about 1 volt less than the positive supply ($+V_{IN}$), but with reversed polarity. Add a 3-terminal regulator (such as a 79L05 for -5 volts) if better regulation

is required. External totem pole transistors are not required because they're included in the NE555.

—Fred Nachbaur, Nelson, Canada

Voltage inverters always fascinate me. The idea of using a positive supply to do work that results in a negative voltage seems almost like magic. For the curious, Maxim Integrated Products (120 San Gabriel Drive, Sunnyvale, CA 94086; Tel. 408-737-7600) features some neat inverter chips.

Well, now it's time to close the vault. If you'd like a chance to win a book, send in a schematic with a full description of how it works to *Think Tank*, Popular Electronics, 500 Bi-County Blvd., Farmingdale, NY 11735. Send in enough submissions to fill a column and you'll also receive a Motorola MC1010L chip and an electronics kit. Hope to hear from you soon. ■

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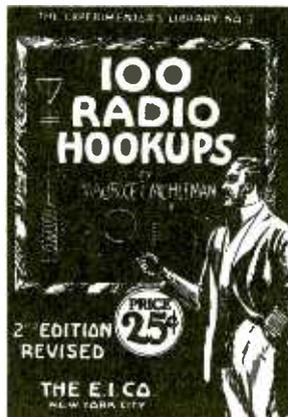
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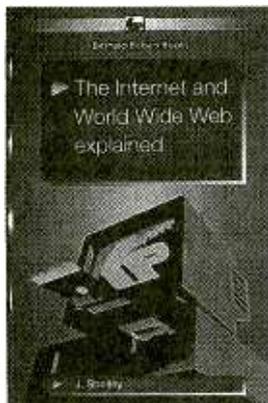
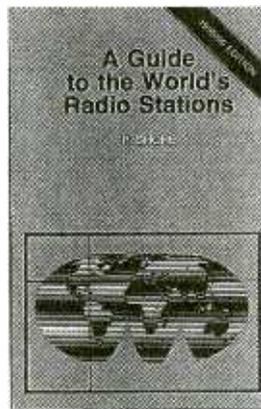
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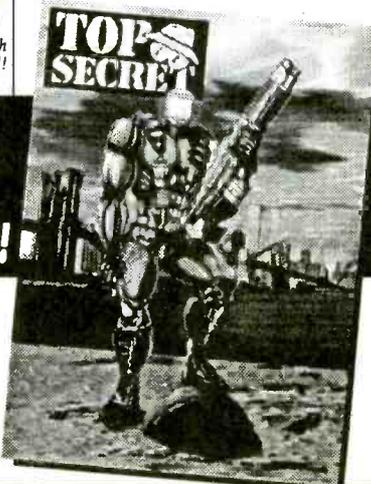
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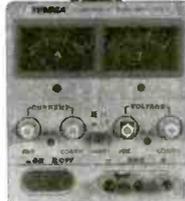
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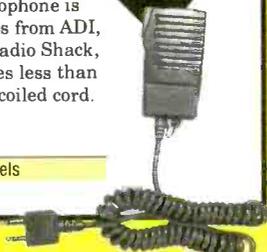
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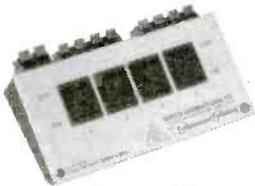
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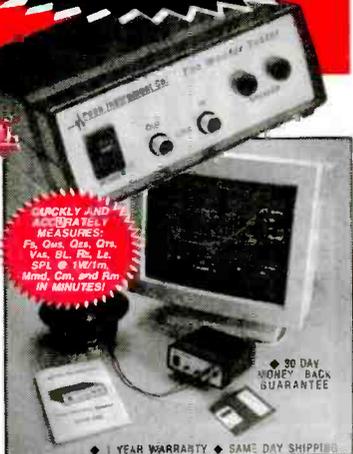
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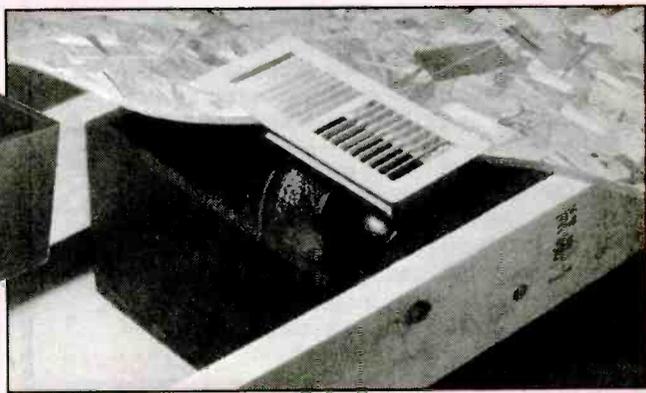
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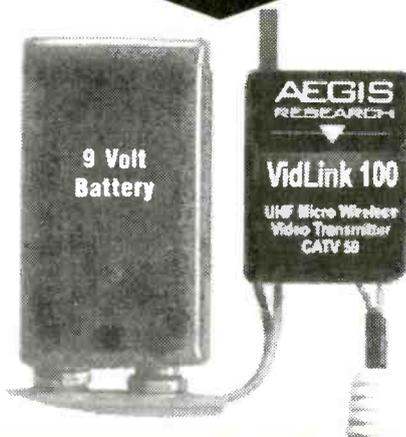
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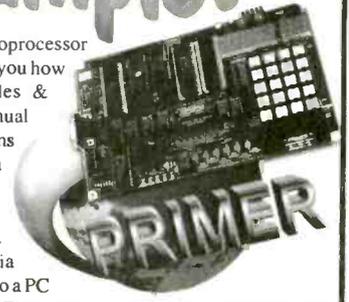
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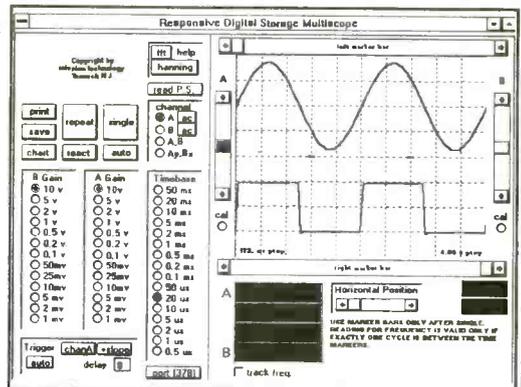
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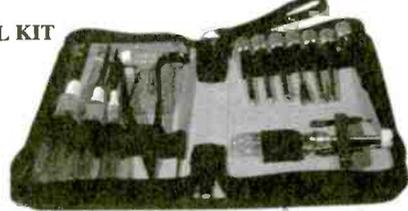


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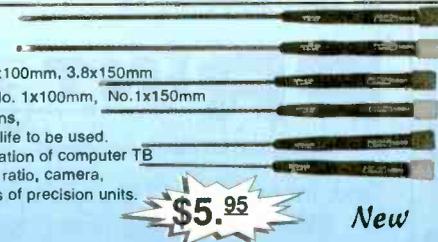
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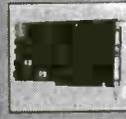
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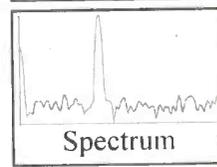
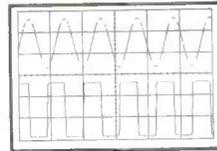
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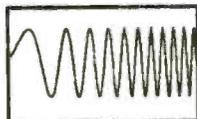
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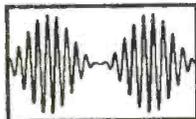
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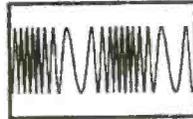
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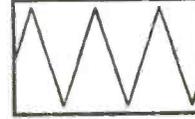
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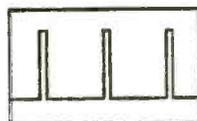
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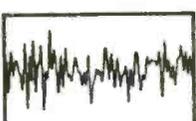
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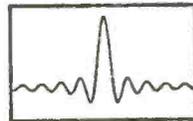
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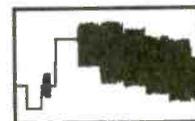
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NET WATCH

(continued from page 11)

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WHOLESALE GIFTS ONLINE

If you're still security conscious when it comes to online ordering, or if you don't have a credit card, you might want to try this site. Wholesale Gifts Online lets you choose from a wide variety of merchandise at wholesale prices, and then mail in a check or money order for payment (the latter is preferred because "personal checks may be held for 30 days to verify funds"). Best of all, the shipping is free.

What exactly does the company mean by "wholesale"? Well, we found many items that should cost \$19.95 selling for \$12.95. Savings increase with price, and some items retailing in the hundreds seem to be about half price!

You can look for gifts under these

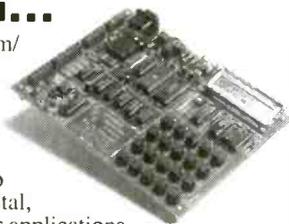
categories: For Cat Lovers, For Bird Lovers, Collectable Angels, Women's Jewelry, Stuffed Animal Friends, Decorative Clocks, Daily Planners and Briefcases, Beautiful Perfume Bottles, Unique Candles and Holders, Products Seen on TV, Stereos, Collectable Cards and Comics, Designer Colognes for Men, Designer Fragrances for Women, Flashlights, Fun and Games, Knives, Products to Make You Safe and Secure, Products for Your Car and Travel, and Rechargeable Batteries and Chargers. As you can see, they have quite a wide selection.

If for some reason you plan on giving several people the same gift, they do have volume discounts. Buying two items saves you 50 cents, but savings go up. Buying six items, for example, saves you \$7.50 off the total. Check the site for more specifics.

Have a happy Holiday Season, and I'll see you all back here next time for a start to the New Year. Feel free to drop me a line at *Net Watch*, **Popular Electronics**, 500 Bi-County Blvd., Farmingdale, NY 11735, or e-mail me at netwatch@comports.com.

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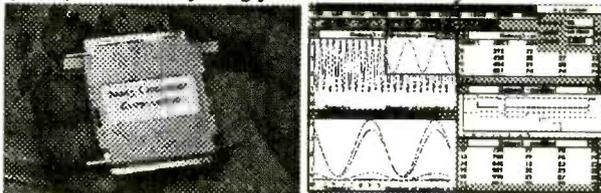
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	<p>DMM</p> <p>DMM-10 (\$19.95): 3 1/2 digit, DC/AC V, Ω, hFE, diode, signal output(+3V, -0.5Vsq., 50% duty)</p> <p>DMM-17B (\$39.95): 3 1/2 digit, DC/ACV, contin., DC/ACA, Ω, Capacitance, hFE, diode, Freq</p> <p>DMM-20 (\$74.95): AC/DC (V, A), Freq, cont., Capac, Induct., Ω, hFE, diode, duty cycle</p> <p>DMM-22 (\$89.95): 4000 counts, bar graph, Freq, AC/DC(V,A), Ω, Capacitance, diode, contin.</p> <p>DMM-23T (\$99.95): 4 1/2 digit, high resol. (10uV, 10nA, 10mΩ), hFE, diode, contin., true rms</p> <p>DMM-89S (\$179.00): true rms, AC/DC (V,A), Ω, bar graph, freq, capac., dBm, logic, diode</p>		<p>LCR METER</p> <p>CAP-15 (\$49.95): 3 1/2 digit, 0.1pF-20mF, 9 Ranges, 0.1pF resolution zero adjustment.</p> <p>LCR-195 (\$89.95): 1uH-200H (induct.), 0.1pF-200uF(Capac.), 0.01Ω-20M (Ωresistance)</p> <p>LCR-814 (\$189.95): 0.1uH-200H, 0.1pF-20mF, 0.1Ω-20MΩ, Q Factor, dissipation, zero adjust</p> <p>LCR-131D (\$229.95): autorange, 0.1uH-10kH, 0.1pF-10mF, 1mΩ-10MΩ, Q Factor, serial/parallel, 120Hz/1kHz testing mode</p>	<p>FREQ. COUNTER</p> <p>FC-1200 (\$129.95): 1.25GHz Handheld, 8 digits display, 10ppm accuracy, sensitivity 5mV (130-350MHz), 30mV (440MHz), 22m (800MHz), batteries or 9V adapter.</p> <p>FC-2500 (\$179.95): 2.5GHz Handheld, 8 digits display, 4ppm accuracy, sensitivity <50mV, batteries or 9V adapter.</p> <p>FC-5270A (\$149.95) 1.2 GHz bench type, 8 digit, 10 ppm, 35mV sensitivity, 10Vp-p max. input, power by 9V adapter.</p> <p>FC-5700 (\$329.95) 1.3GHz bench type, 8 digit, 1 ppm accuracy, 20mV sensitivity, period 0.1us to 100ms. Ideal for test & repair of audio instrument.</p>																		
	<p>DMM-113 (\$24.95): Pocket Size, DC/ACV, Ω, diode, Continuity beeper</p> <p>DMM-120 (\$24.95): economy type, DCV, ACV, DCA, Ω, hFE, diode</p> <p>DMM-122 (\$59.95): DC/AC(V,A), Ω, hFE, diode, capacitance, freq, logic, continuity</p> <p>DMM-123 (\$44.95): DMM + capacitance, DC/AC(V,A), Ω, hFE, diode, continuity</p> <p>DMM-124 (\$69.95): Electrical+Temp, DC/ACV, , capacitance, freq, 3 phase, diode, contin.</p> <p>DMM-125C (\$54.95): Autorange + bar graph, DC/ACV, Cap Ω, diode, continuity beeper</p>		<p>FLUKE DMM</p> <table border="1"> <tr> <th>Handheld</th> <th>Scope Meter</th> </tr> <tr> <td>12 II \$ 84.95</td> <td>92B \$1,399</td> </tr> <tr> <td>70-II \$ 75.95</td> <td>96B \$1,699</td> </tr> <tr> <td>73-II \$ 97.95</td> <td>99B \$1,999</td> </tr> <tr> <td>75-II \$129.00</td> <td>105B \$2,499</td> </tr> <tr> <td>76-II \$175.00</td> <td>863E \$469</td> </tr> <tr> <td>77-II \$155.00</td> <td>847E \$659</td> </tr> <tr> <td>79/29-II \$175.00</td> <td></td> </tr> <tr> <td>87 \$287.00</td> <td></td> </tr> </table>	Handheld	Scope Meter	12 II \$ 84.95	92B \$1,399	70-II \$ 75.95	96B \$1,699	73-II \$ 97.95	99B \$1,999	75-II \$129.00	105B \$2,499	76-II \$175.00	863E \$469	77-II \$155.00	847E \$659	79/29-II \$175.00		87 \$287.00		<p>SPECIALTY</p> <ul style="list-style-type: none"> • Sound meter \$169.95 • EMF Tester \$69.95 • Conductivity \$169.95 • Thermometer \$69.95-\$89.95 • Humid./Temp meter \$169.95 • Press. meter \$299.95 • Electr. scale \$89.95 • Watt Meter \$129.95 • High Voltage Probe \$59.95 • pH Meter \$79.95 • Light Meter \$80-\$90 • Light Adapter \$49.95 • Anemometer \$179.95 • Anemometer adapter (And More) \$89.95
Handheld	Scope Meter																					
12 II \$ 84.95	92B \$1,399																					
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OSCILLOSCOPE

Dual Trace, Component Test, 6" CRT, X-Y Operation, TV Sync, CH2 Output, Graticule Illum, 2 Probes(x1;x10)

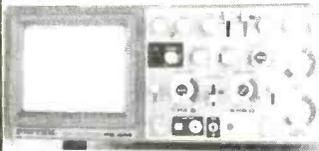
- PS-200 20 MHz Dual Trace \$359.95
- PS-205 20 MHz Dual w/ Delay Sweep \$429.95
- PS-400 40 MHz Dual Trace \$494.95
- PS-405 40 MHz Dual w/ Delay Sweep \$569.95
- PS-605 60 MHz Dual w/ Delay Sweep \$769.95
- PS-1000 100MHz Dual Trace \$999.95

Digital Scope

- DS-303 30MHz Digital, 20 Samples/sec \$849.95
- DS-303P RS-232 interface, 30Mhz \$1,049.95

Scope Probe

- HP-9060 (60MHz) \$15, HP-9150 (150MHz) \$22, HP-9250 (250MHz)\$29, HP-9258 (250MHz, 100:1)\$39



AUDIO/R/F/FUNCT. GENERATOR

RF Generator

- SG-4160 (\$124.95) 100kHz-150MHz sinewaves in 8 ranges, 100mV at 35MHz
- SG-4162 (\$229.95): Generate same signal as SG-4160, but with int. counter (150MHz).

Audio Generator

- AG-2601 (\$124.95) 10Hz-1MHz, 0-8Vpp sine, 0-10Vpp squarewave
- AG-2603 (\$229.95): Same as AG-2601, but with additional counter and digital display.

Function Generator

- FG-2100A (\$169.95) 2Hz-2MHz, 5mV-20Vpp
- FG-2102AD (\$229.95) same as FG-2100A, but with int. counter and TTL, CMOS output.
- FG-2103 (\$329.95) Sweep 0.5Hz-5MHz, linear/log, VCG, GCV, and int. counter



POWER SUPPLIES

Single Output DC Power Supplies

- Short Circuit & overload protected
- Constant current, constant voltage mode
- 0.02%+2mV line regulation, 0.02%+2mV load regulate

Analog Meters Display

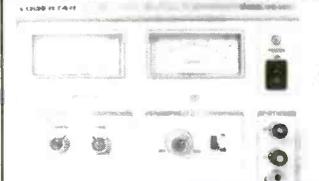
- PS-303 (\$159.00) 30V/3A
- PS-305 (\$219.95) 30V/5A
- PS-8110 (\$289.95) 60V/5A
- PS-8112 (\$399.95) 60V/5A
- PS-1610 (\$289.00) 16V/10A
- PS-8107 (\$399.95) 30V/10A

Digital Voltage, Analog Current

- PS-8200 (\$179.95) 30V/3A
- PS-8201 (\$239.95) 30V/5A

Digital Volt & Current Display

- PS-8300 (\$199.95) 30V/3A
- PS-8301 (\$259.95) 30V/5A



Dual Tracking and Triple Output

- Short Circuit & overload protected
- Constant current & constant mode
- Independent or Tracking

Dual Tracking (Analog V & I Displays)

- PS-303D (\$314.95) 30V/3A/30V/3A
- PS-305D (\$399.95) 30V/5A/30V/5A
- PS-8108 (\$549.95) 60V/3A/60V/3A
- PS-8109 (\$699.95) 60V/5A/60V/5A

One fixed 5VDC, 3 Amp output

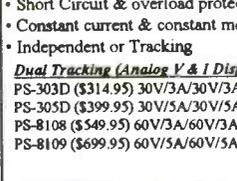
- Parallel to double current output (PS-8102 & PS-8103 only)

Triple Output (Analog displays)

- PS-8102 (\$399.95) 30V/3A/30V/3A
- PS-8103 (\$489.95) 30V/5A/30V/5A

Digital Displays

- PS-8202 (\$499.95) 30V/3A/30V/3A
- PS-8203 (\$549.95) 30V/5A/30V/5A



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<p>OSCILLOSCOPE</p> <p>OS-653 \$699.95 50MHz Triggering</p> <p>OS-622B \$399.95 20 MHz Oscilloscope</p> <ul style="list-style-type: none"> • Dual CH / Delay sweep • ALT trigger, trigger lock • 1mV/div sen., delay line • Z-axis input, CH1 output • TV syn., trigger level lock • Hold off, TV syn. • 2 probes (x1, x10) <p>OS-305 (\$209.95) - 5 MHz One Channel OS-310 (\$324.95) - 10 MHz One channel</p>	<p>DC POWER SUPPLIES</p> <p>Triple Output</p> <ul style="list-style-type: none"> • 2 variable out 0-30V, 0-3A • One fixed 5V, 3A output • Auto track, serial, parallel • Const. volt, current mode • 4 analog or 2 digital display <p>PC-3030 (\$499.95) PC-3030D (\$549.95)</p> <p>Single Output</p> <ul style="list-style-type: none"> • Const voltage, current mod • Voltage regulation <0.01% • Current regulation <0.2% • PS: 2 analog or 1 digital display • PR: 2 analog or 2 digital display <p>Analog Meters Display</p> <p>PS-1830 (\$209.95) 18V/3A PS-1850 (\$219.95) 18V/5A</p> <p>PS-3030 (\$224.95) 30V/3A PS-6010 (\$209.95) 60V/10A</p> <p>PR-3060 (\$314.95) 30V/6A PR-6030 (\$314.95) 60V/3A</p> <p>Digital Meters Display</p> <p>PS-1830D (\$219.95) 18V/3A PS-1850D (\$244.95) 18V/5A PS-3030D (\$254.95) 30V/3A PR-6030D (\$399.95) 60V/3A</p>	<p>FUNCTION GENERATOR</p> <p>Programmable</p> <ul style="list-style-type: none"> • High stability, low drift • One fixed 5V, 3A output • 100point program (PPS ser) • 50point program (PPT ser) • Auto serial/parall (PPT ser) • Auto track (PPT series), IEEE-488.2 and SCPI compatible command set (optional) <p>PPS-1860G (\$1,099.95) PPS-3635G (\$1,099.95)</p> <p>PPS-6020G (\$1,099.95) PPT-1830G (\$1,399.95) PPT-3615G (\$1,399.95)</p> <p>FG-830 (\$1,499.95) 30MHz Synthesized Function Gen.</p> <ul style="list-style-type: none"> • Output sine, tri., square, sync out, arb. waveform 	<p>BENCHTOP DMM</p> <p>FC-8015G (\$189.95) Sweep</p> <ul style="list-style-type: none"> • 0.02Hz-2MHz, no counter • Sine/Sqr/Tri/pulse/Ramp <p>FC-8016G (\$239.95)</p> <ul style="list-style-type: none"> • 0.02Hz-2MHz w/ counter • Pulse, function generator <p>FC-8017G (\$249.95) Sweep</p> <ul style="list-style-type: none"> • Sine/Tri/Sqr/TTL/CMOS • 0.02Hz-2MHz, FM mod <p>FC-8019 (\$399.95) Sweep</p> <ul style="list-style-type: none"> • 0.02Hz-2MHz w/counter • INT/EXT AM/FM mod <p>FC-8019 (\$209.95)</p> <ul style="list-style-type: none"> • 0.02Hz-2MHz w/counter • Arbitrary modulation • RS232, IEEE-488(option) <p>DM-8034 (\$179.95) 3 1/2 digit</p> <ul style="list-style-type: none"> • AC/DV(V,A), Ω, diode • 1000V, 20A, 0.5% accu. <p>DM-8040 (\$339.95) 3 1/2 digit</p> <ul style="list-style-type: none"> • ACV to 50kHz, true rms • 0.006% basic accuracy • 1uV, 1mΩ, InA resolution • dBm, auto, REL, min/max <p>DM-8055G (\$889.95) GPIB</p> <ul style="list-style-type: none"> • Same func as DM-8055 <p>Frequency Counters</p> <p>FC-8131 (\$469.95) 1.3GHz FC-8270 (\$629.95) 2.7GHz UC-2010G (\$294.95)</p>
<p>Programmable Electronic Load (PEL-300) (Patent No. #1013141324)</p> <ul style="list-style-type: none"> • Operating Rating: voltage 3-60V, current 6mA-60A, power 300W, temp 0-40C(operate)/10-70C (store) • Over voltage, over current, over power protection • Operation mode: constant voltage, current, resistance • Transient Gen. Frequency 1Hz-1kHz, duty 10-90% • High Resolution: 20mV, 0.2mA, 0.3mΩ • Self-Test and Software Calibration • Meet UL CSA IEC Safety regulation <p>* NEW * \$1409.95</p> 			

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High Quality Full Sized DMM

\$19.00 any qty

General

Display: 3-1/2 Digit LCD. 21mm Figure Height

with Automatic Polarity

Overrange Indication: 3 Least Significant Digits Blank

Temperature for Guaranteed Accuracy: 23°C±5°C RH<75%

Temperature Ranges:

Operating: 0°C to 40°C (32°F to 104°F)

Storage: -10°C to 50°C (14°F to 122°F)

Power: 9V Alkaline or Carbon-Zinc Battery (NEDA1604)

Low Battery Indication: BAT on Left of LCD Display

Dimensions: 188mm long x 87mm wide x 33mm thick

Net Weight: 400g

DC Voltage (DCV)

Range: Resolution: Accuracy:

200mV 100µV

2000mV 1mV ±(1%rdg+2dgts)

20V 10mV

200V 100mV

1000V 1V

Maximum Allowable Input: 1000V DC or Peak AC.

DC Current (DCA)

Range: Resolution: Accuracy:

200µA 100nA

2000µA 1µA ±(1.2%rdg+2dgts)

20mA 10µA

200mA 100µA

10A 10mA ±(1.2%rdg+2dgts)

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

AC Voltage (ACV)

Range: Resolution: Accuracy:

200V 100mV ±(1.2%rdg+10dgts)

750V 1V

Frequency Range: 45Hz-450Hz

Maximum Allowable Input: 750V rms

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

CAT NO DESCRIPTION PRICE

9300G Rugged High Quality DMM with Rubber Boot \$19.00

Switchable Scope Probe Sets

(Selectable X1/Ref/X10)

These high quality scope probe sets are for oscilloscopes up to 60MHz (model HP 9060) or 50MHz (model HP9150). Both sets include a handy storage pouch and include an IC test-hook adapter for the probe. The BNC connector rotates to avoid cable tangle or kink. Cable length is 1.4 meters.

CAT NO DESCRIPTION PRICE EACH

HP-9060 Scope Probe Set DC~60MHz \$16.49 \$14.49 \$11.58

HP-9150 Scope Probe Set DC~150MHz 24.95 21.95 18.62

Etching Chemicals/Ferric Chloride

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

CAT NO DESCRIPTION PRICE EACH

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



Positive Photo Resist Pre-Sensitized Printed Circuit Boards

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

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

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

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

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

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

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

Removeable Hard Drive Racks

The ideal solution for protecting highly sensitive data. Or, buy one computer and allow individual users to keep their hard drive with their own applications and set-ups. Just turn the system off, lift the handle and the hard drive pops right out. Key lock included to avoid accidental or unauthorized removal. Includes hard drive activity LED's. Rack includes mounting hardware, keylock, front panel LED, convenient pull out handle. Made from high impact ABS plastic. Fits in 5.25" bay.

Features: • Ideal for Hard Drive Portability • Solve Software Data Security Issues • Carry Your Hard Drive Between Home and Office • Each User Can Have His or Her Personal Hard Drive

CAT NO	DESCRIPTION	PRICE
SpecialHDRACK-IDE	For IDE Hard Drive	\$14.95



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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: 4-1/2D 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: 3-1/2D LCD Digital Panel Meter

PM-129: 3-1/2D 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)

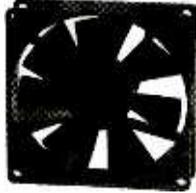
Specifications - PM-128/PM-129	
Maximum Input	: 199.9mV DC
Maximum Display	: 1999 counts (3-1/2 Digits)
	w/Automatic Polarity Indication
Indication Method	: PM-128 - LCD Display
	: PM-129 - LED Display
Measuring Method	: Dual-Slope Integration
	A/D Converter System
Overrange Indication	: '1' Shown in 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

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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



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	1	10	25	100
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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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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



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CAT NO	DESCRIPTION	PRICE EACH	
		1	5
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A34	Power Supply Regulating Kit	\$6.95	----

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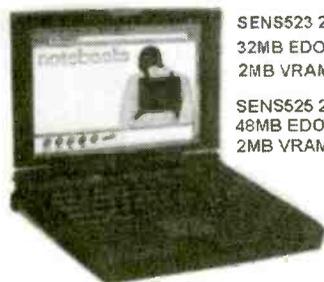
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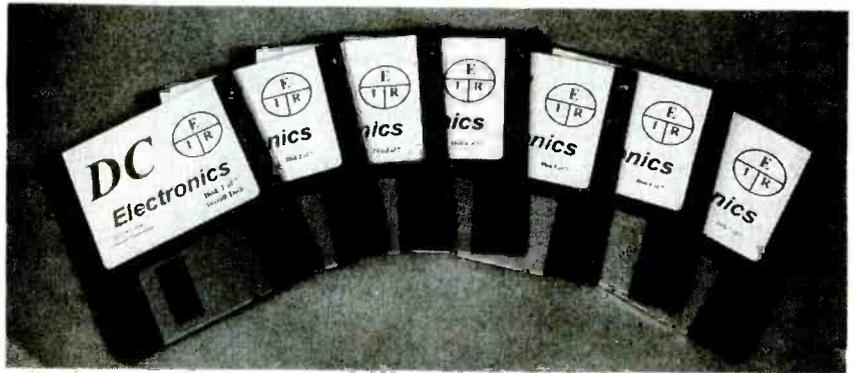
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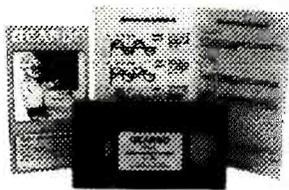
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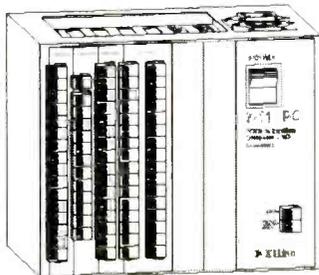
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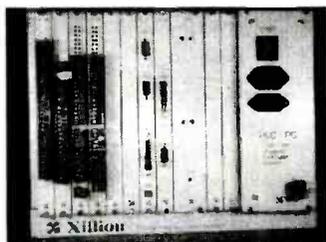
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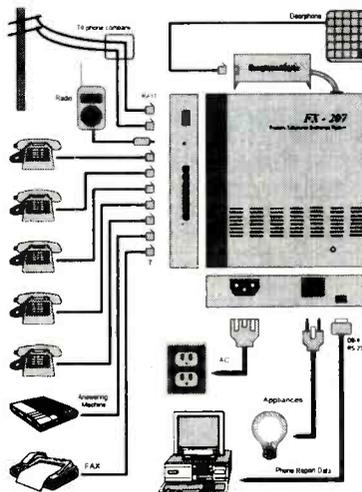


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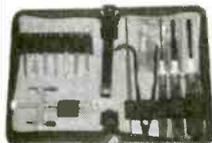
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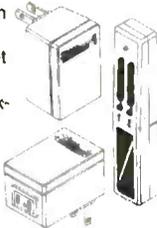
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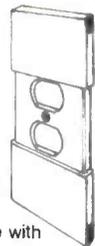
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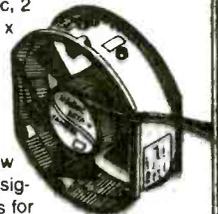
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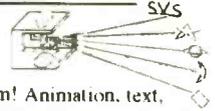
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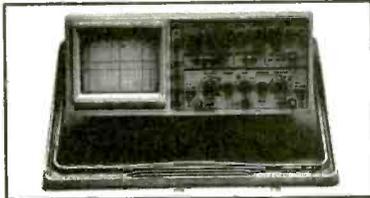
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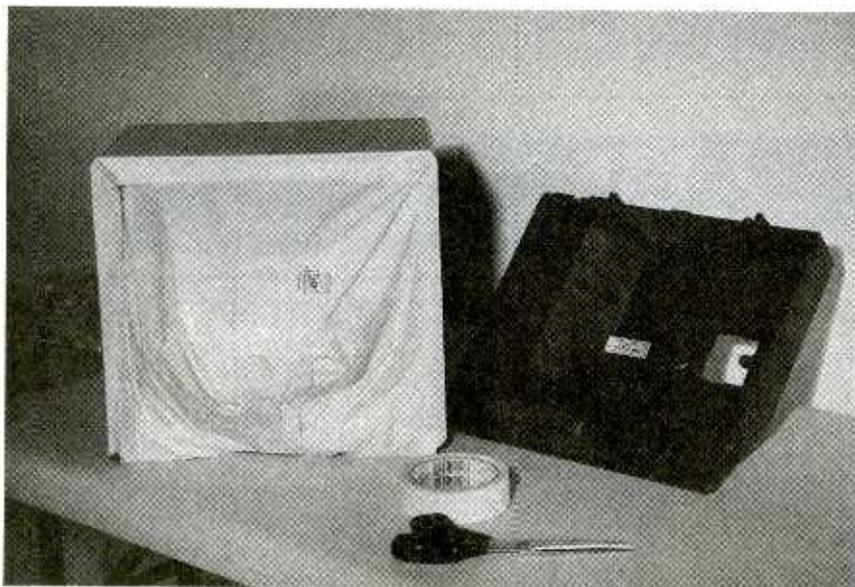
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MONITOR CLEAN UP

(Continued from page 52)



Remove interior dust with a vacuum nozzle and paintbrush. Use gentle strokes with the brush and keep the nozzle at least 3 inches away from electronic components.



The back of the monitor was sealed with a plastic sheet cut from a kitchen garbage bag. The bag pieces are held in place with masking tape.

Although the cathode-ray tube sits snugly against the plastic frame in the front of the cabinet, it is not a water-tight seal. Also, controls coming through the cabinet surface will permit water. Remove the knobs, if possible, and cover the holes with masking tape. It's a good idea to soak the knobs in lukewarm water and soap suds for a few minutes. They should look like new when cleaned.

Use water sparingly. Soap the outside surfaces of the cabinet and re-

move the suds quickly. You can towel-off the suds with a wash cloth or paper toweling. You may want to use a sponge, which is okay provided the sponge has no rough surface that may scratch the cabinet. Work quickly. Redo surfaces that do not clean completely. Use a clean wash cloth free of suds to rinse off the surface. At no time should you see pools of water on the plastic top surface or running down its sides. Use extreme care where the edges of the cabinet meet the screen of the cathode-ray tube. Do not permit water to enter the inside of the cabinet there. Lightly apply suds to the adjoining area and wiped them away quickly. It takes a bit longer to get the job done, but no water seeps inside the cabinet. Now towel the monitor case dry.

Remove the plastic sheeting and inspect the inside of the monitor. You should find that there is no water. If some seeped in, blot it up. Now set the

monitor aside in an out-of-way place and allow it to dry at room temperature for an hour or two.

You should have no trouble putting the cover back in place on the monitor's cabinet. Seat all the screws and you are ready to power up! Reconnect the power cord and signal cable, and turn on your computer. If anyone asks you, "Did you get a new monitor?," answer by saying, "The old one was filthy so I chucked it out!" Try not to laugh! ■

MOBILE PHONE

(continued from page 50)

mounting the potentiometer; two other holes, $\frac{1}{4}$ -inch in diameter, were drilled in the other end of the enclosure to provide for mounting the phone jack (not shown in Fig. 1) and the LED. The phone jack is used to connect the circuit board to the 5-watt speaker. It was necessary to trim a portion of the perfboard on the potentiometer side of the enclosure so that the board can be properly seated in the enclosure. Small holes were drilled in the potentiometer end of the enclosure through which to feed the power leads and those that allow the inline fuse holder's leads to be fed into the enclosure. The fuse holder leads connect to the relay.

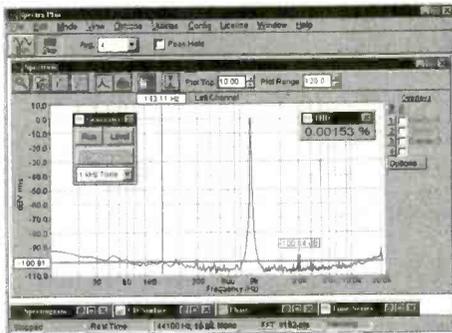
A DC cable assembly with fuse holder, designated F1 in Fig. 1, (available from RadioShack) was used to allow for easy transfer of the circuit from one vehicle to another. The red lead of the DC cable assembly is connected to one side of the relay coil and its normally open contact, while the black lead is connected to the negative side of the board. Sixteen-gauge wire leads were connected to an inline fuse holder (for F2) and the leads run through another set of holes drilled in the case. One end of the leads from the F2 fuse holder is connected to the free relay-coil terminal. The other F2 lead is used to tie the circuit to the mobile telephone. The purpose of F2 is to protect the mobile telephone. The proper fuse size can be determined from the phone's owner's manual.

The external speaker (SPKR1) can be mounted in the engine compartment of the vehicle. Solder a phone plug onto one end of the speaker cord, making sure the positive and negative wires do not touch when the phone plug is assembled. An ohmmeter can be used to check for continuity between the assembled phone plug's two terminals. Insert the phone plug into the phone jack mounted to the Mobile Phone Annunciator, and connect the wire to the speaker in a careful manner, taking care to keep the wire away from moving parts. ■

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THE POINT: Standard surge suppressors allow too much current to hit the computer. Standard surge suppressors divert surge current to the ground wire and disrupt data transfer. Standard surge suppressors eventually fail without warning. Modern computers have logic voltage levels (the signals that transmit the data) and power supply voltages that are dramatically lower than that of their recent predecessors. Modern computers use integrated circuits with transistors of ever decreasing physical geometries. Modern computers are virtually always interconnected to other computers or peripheral equipment. The bottom line; **modern computers are much more sensitive and susceptible to powerline anomalies.**

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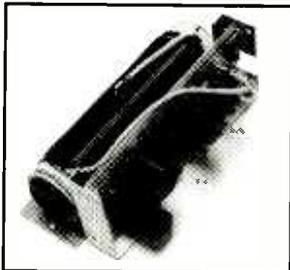
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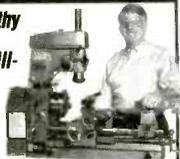


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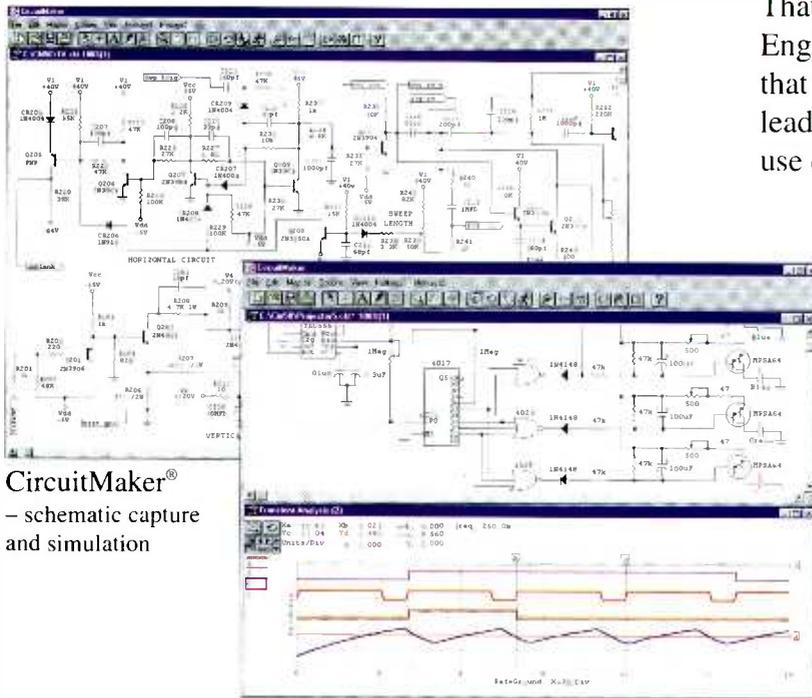
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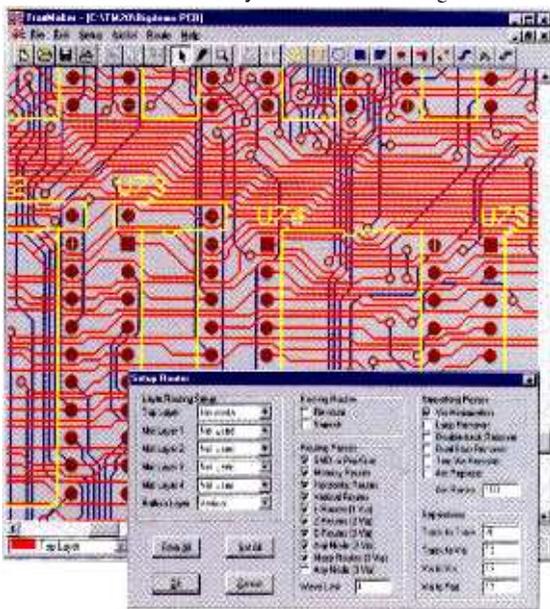
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