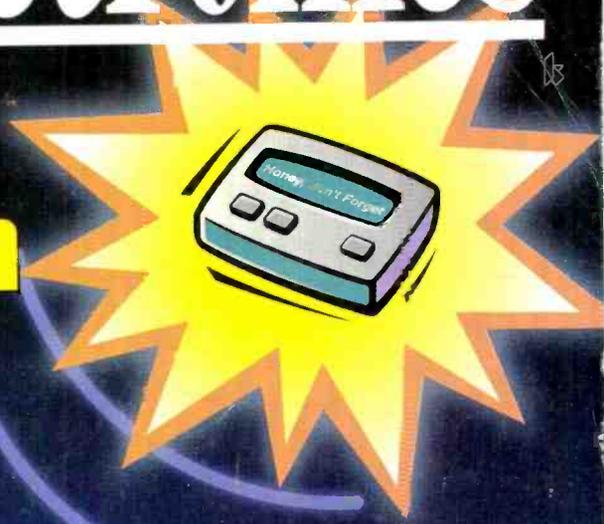


TINY MACHINES THAT THINK FOR THEMSELVES

March 1997

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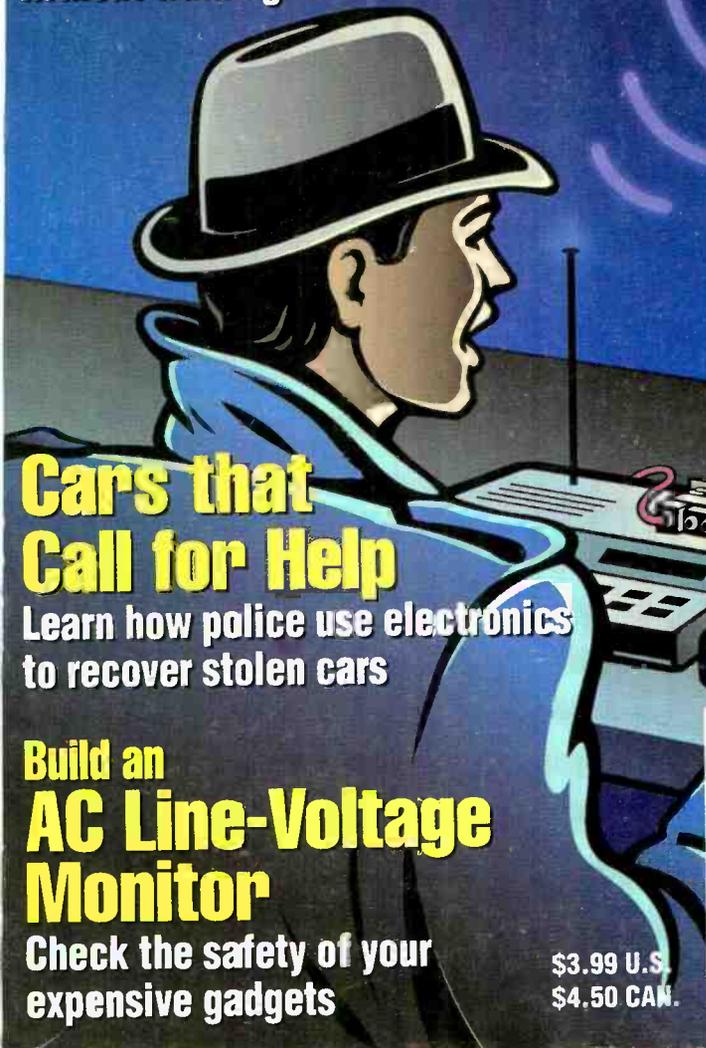
Build a Pager Decoder



Build an Electronic Parrot

It repeats everything you say,
without training

Receive beeper
messages and phone
numbers with a scanner,
and read them on a PC



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Learn how police use electronics
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Build an AC Line-Voltage Monitor

Check the safety of your
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Vol. 14, No. 3



A GERNSBACK
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COVER STORY

39 Build an Alphanumeric Pager Decoder

This innovative device lets you view digital pager messages right off the airwaves. Just connect the circuit to a scanner radio and your computer, load up some special software, and you can be certain your beeper is grabbing all the messages that it should—*Alan D. Jones*

CONSTRUCTION

45 Build an Electronic Parrot

Having a parrot repeat what you say can be a lot of fun, but teaching one to talk can also take a lot of time. With this easy-to-build circuit you can have all the fun of an accurate mimic, in about an evening. Best of all, there's no cage to clean!—*David Williams*

52 Build an AC Line-Voltage Monitor

Just how safe are your expensive electronic devices? Find out if the AC outlets in your home or workshop are producing "clean" electricity with this inexpensive circuit—*Marc Spiwak*

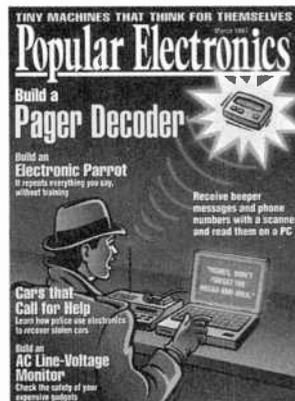
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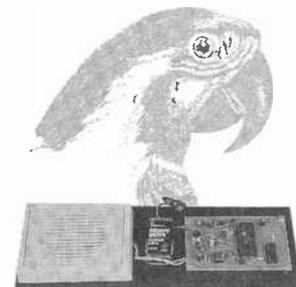
Learn how electronics can help roadside assistance get to you, even if you're lost. Also, find out what new technology makes it easy for police to get your stolen vehicle back—*Bill Siuru*

58 Intelligent Micromachines

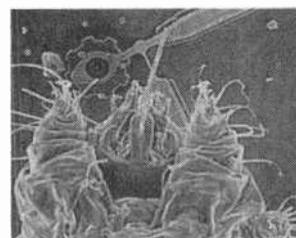
Microscopic motors and machines have been around for a few years; however, now they can think for themselves. Join us for a look at the marriage of microminiature processors and motors that could result in some amazing applications—*Douglas Page*



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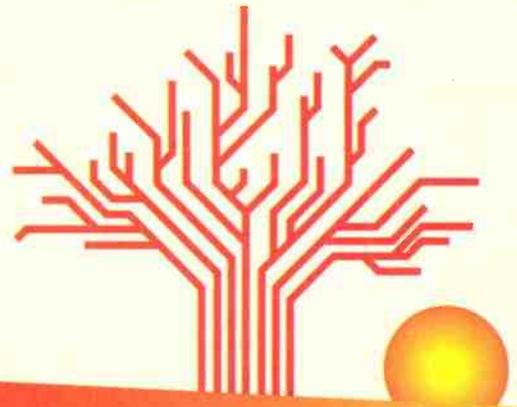
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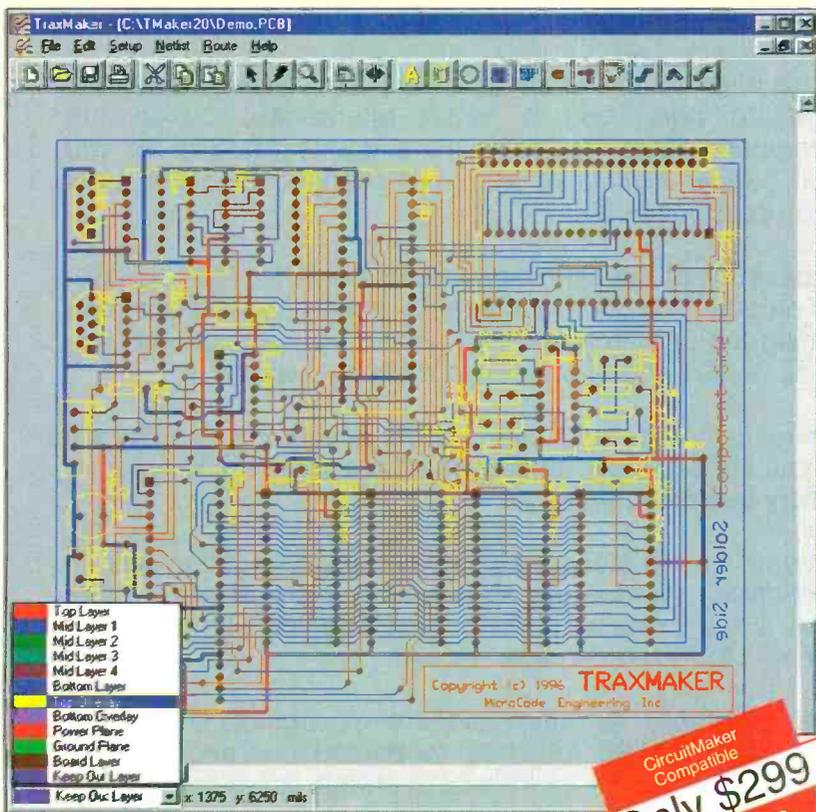
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EDITORIAL

Getting Your Beeps

Digital pagers—it seems like everyone's using them. But unlike telephones, which can be easily interchanged if you suspect there's a problem, beepers can't be easily tested. If you don't get a message, did it really ever get transmitted, or did your beeper fail to receive it? Do you need a new service or a new device?

A worse problem is possible if you use an alphanumeric pager—one that lets you receive text messages. With these devices, you could receive part of a long transmission, and not know that it's incomplete because of the bizarre wording and punctuation often used by those who want to fit a lot of information into as few words as possible.

Because pagers can't be swapped without a lot of difficulty, we decided to bring you a better alternative. Called the *Alphanumeric Pager Decoder*, it's a device that will let you receive beeper messages with your scanner radio and view them on your computer.

Also, because of the seemingly endless data-storage capabilities of modern PCs, the Decoder also makes it possible to keep a running log of all the text and phone numbers you receive. After all, pagers can only store so many messages.

But no matter what your concern is, we're sure the Decoder will have you pulling pager messages off the airwaves in no time. The story begins on page 39.

This month's cover story is just another example of the latest in technological coverage that **Popular Electronics** has to offer. And, as always, we take pride in providing you with that information in a form you can actually use.

With a constantly evolving field like electronics, things are always changing. So feel free to peruse our pages often. Because with technology, the best is always yet to come.

Dan Karagiannis

Dan Karagiannis
Editor

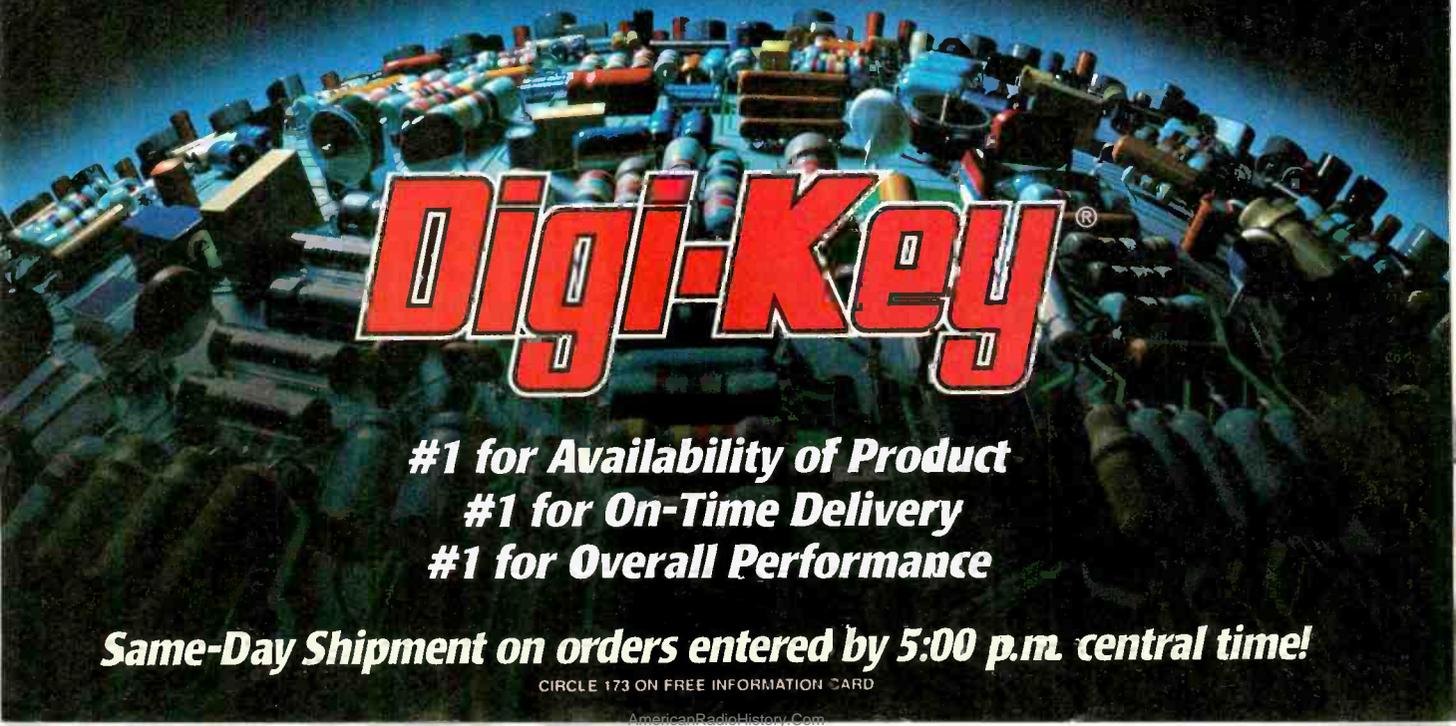
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LETTERS

Radar-Detector Problems

THE COBRA STRIKES

I read the review of the Cobra RDL/712SW radar detector in the January 1997 *Gizmo*. The features sound great, and for that reason I had bought one, a few months before it appeared in your magazine.

I found a problem with the detector that was not mentioned in *Gizmo*: The unit's display cannot take heat. This is an automotive gadget that says in its instructions not to allow it to remain in a closed car! On a typical day last summer, with the unit concealed between the seats, the display overheated and I now have no display at all. Of course the display can be replaced, but for nearly the price of a brand new detector!

I still find it surprising that an automotive unit would require the user to take it out of the car every time you park.

H.P.

S. Hackensack, NJ

AN INTERNAUT SPEAKS

Thanks for bringing monthly Internet coverage to **Popular Electronics** in *Net Watch*, and for continuing to publish articles that deal with its resources. I'm new to the Net, and appreciate having information on it within the pages of my favorite magazine.

I was surprised to learn at first just how much was available online of interest to electronics hobbyists, and indeed, of interest to just about everyone. It's great that the magazine that brought us the first computer information in the 70s is keeping up with the times with the Internet.

Keep up the good work and thanks for a great magazine.

M.B.

New Orleans, LA

THANK YOU!

Popular Electronics readers are the greatest! Your response to my plea for a 185 chip has been heart warming. You have boosted me from the depths of apprehension to a restored peace of mind.

Many thanks for your kind generosity. I really appreciate your help. And thanks to **Popular Electronics** for making it possible!

R.J.S.

Harper Woods, MI

HAVES & NEEDS

I have been singularly unsuccessful in finding a manual for a Sweet-P plotter (Model SP-100) that was manufactured by Enter Computer Inc. circa 1982. If anyone could help me out with the manual or point me toward a source, I would really appreciate it.

NORMAN LEET

840 Hunter Road, Apt. L

Enon, OH 45323-1815

e-mail: ah255@dayton.wright.edu

I have an EMC Model 208 tube tester, manufactured by Electronic Measurements Corporation (New York, NY). The unit is housed in a small black-plastic case that measures about $7 \times 5\frac{1}{2} \times 2\frac{1}{2}$ inches. It checks the following types of tubes: 7-pin miniature, 9-pin miniature, octal, and loktal. No meter movement is provided; instead, a large neon lamp is used as the indicating device.

I need the instruction manual/tube setup chart for this tester; a schematic diagram also would be helpful. I will be happy to reimburse copying and postage costs.

Thanks.

DOUGLAS D. FOX

603 S. 12th Avenue

St. Charles, IL 60174-3238

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<http://www.gernsback.com>

I need the instructions and/or programming procedures for a Curtis Mathis H.Q. VHS VCR, Model DV-725 (S/N V9100406936), as this model is too old for on-screen instructions.

I will be happy to pay for any costs.

Thanks.

A. DRUMMOND

4471 SE Inwood Lane

Port Orchard, WA 98367-9017

I need a schematic for a Sears dual-cassette stereo, model number 28171 (chassis number 132-10102). I especially need a diagram of the cassette circuit showing the power source, and a TD6301AP IC.

Any help is appreciated.

Feel free to call me at 815-589-3576, or to write.

ED TIESMAN

1231 12th Avenue

Fulton, IL 61252

Hello, fellow readers. I am seeking a simple synch-lock (time-base correction) circuit to lock together two consumer camcorders (one VHS and the other Hi-8).

The reason I'm asking is because I inherited a professional JVC KM-1200U video mixer (and color special-effects generator). But it is built for cameras costing thousands of dollars that come with a synching system called "Gen-Lock."

I realize I'm asking for quite a difficult-to-find circuit, but I have used two camcorders with a Videonics MX-1 mixer, and a Panasonic MX-12 mixer. Because both worked beautifully, I believe such a circuit does exist for the JVC I now have.

In summary, can anyone help me use my cameras without the "Gen-Lock" system? I can't find that gear anywhere.

I'd really appreciate any help or hints. Thanks in advance for any assistance you could provide.

BOB MEUSE

600 Rainbow Drive

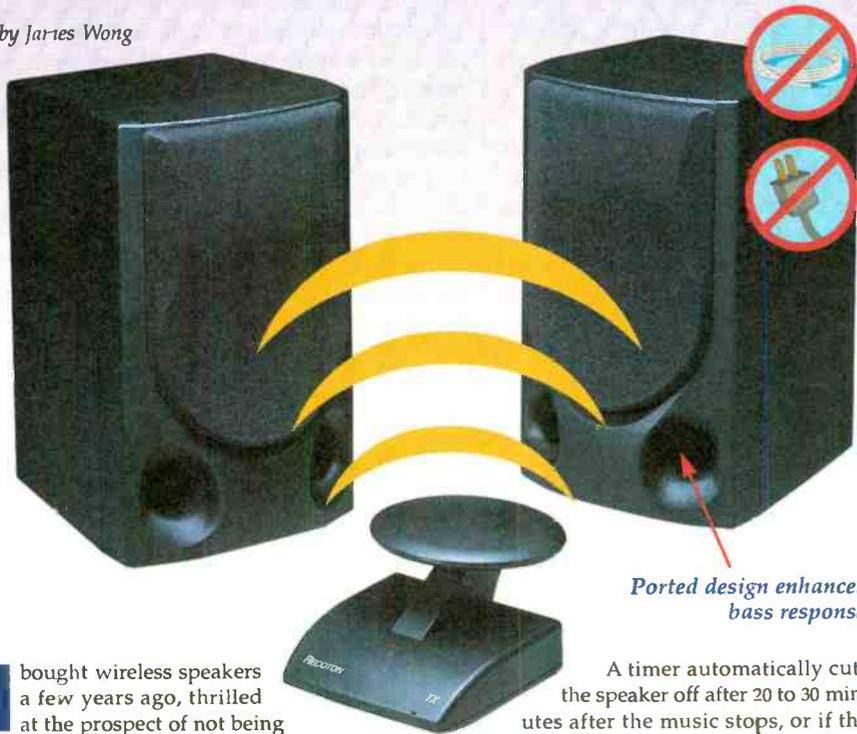
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Mountain View, CA 94041

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With variable bass response, improved acoustics and technology designed to prolong battery life, Recoton's newest wireless speakers are the best yet...and they're also cordless!

by James Wong



Ported design enhances bass response

I bought wireless speakers a few years ago, thrilled at the prospect of not being restricted by speaker wires. While that was convenient, I soon realized that I was still limited by where the existing outlets were in my home. I could enjoy my music wirelessly within my home, but as for outdoors, I was stuck with the same old problem.

Ultimate portability: freedom to listen to music anywhere. The W445s are the ultimate in wireless speakers, because they are also cordless. They are powered by eight "D" batteries, an optional rechargeable lead acid battery or AC power. Put these cordless speakers anywhere you want within the 150-foot range of the transmitter, indoors or out.

A timer automatically cuts the speaker off after 20 to 30 minutes after the music stops, or if the battery voltage drops too low. Plus, these portable speakers have a built-in handle!

Great sound quality. The speaker, mounted in a bookshelf-sized acoustically constructed cabinet, provides a two-way bass reflex design for individual bass boost control. Full dynamic range is achieved by the use of a 2" tweeter and 4" woofer. Plus, automatic digital lock-in tuning guarantees optimum reception and eliminates drift. The new technology provides static-free sound in virtually any environment. The speakers are also self-amplified; they can't be blown out no matter what your stereo's wattage. Plus, the speakers will mute when the music stops playing so no noisy hiss is heard.

One transmitter, any number of receivers. The powerful transmitter plugs into an audio-out, tape-out or headphone jack on your stereo or TV component, transmitting wirelessly to speakers

or headphones. The transmitter plugs into a standard outlet.

One transmitter will broadcast to any number of stereo speakers and headphones. Since each speaker contains its own built-in receiver/amplifier, there are no wires running from the stereo.

150-foot range. Just imagine listening to your stereo, TV, VCR or CD player in any room of your home—without running speaker wire. Plus, you'll never have to worry about range because the new 900 MHz technology allows stereo signals to travel distances of up to 150 feet through walls, ceilings and floors without losing sound quality.

Stereo or hi-fi, you decide. These speakers have the option of either stereo or hi-fi sound. Two speakers, one set on right channel and the other on left, will give full stereo separation. Or, if you just want to add an extra speaker to a room, set it on mono and listen to both channels on one speaker for hi-fidelity sound.

Save \$30 on additional speakers. Our factory-direct pricing allows us to sell more wireless speakers than anyone! For this reason, if you purchase two or more Recoton speakers, they'll cost just \$99 each.

Add headphones, save \$100. For a limited time, when you order two speakers and a transmitter, you can add wireless headphones for only \$49. (That's a savings of \$100 off the system.)



Enjoy your music anywhere, risk-free. Experience for yourself the true freedom of these speakers. They come with Comtrad's risk-free home trial. If you don't love both their sound quality and portability, return them within 90 days for a full refund, "No Questions Asked." All Recoton products are backed by a 90-day manufacturer's warranty.

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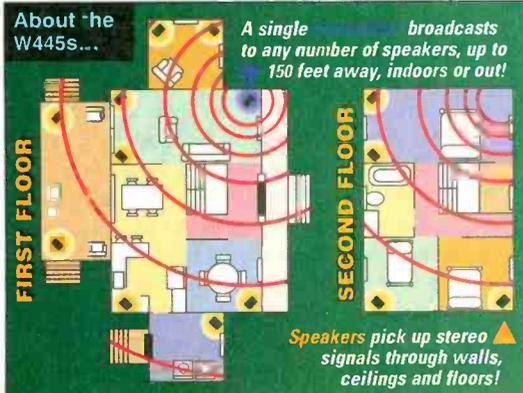


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New Products

GRAPHICAL MULTIMETER

The *Model 867B Graphical MultiMeter (GMM)* is Fluke's most accurate handheld multimeter to date. The instrument provides engineering and industrial users with exceptional graphical and reporting capabilities presented on the largest and most technically advanced display screen available in today's market, allowing information to be viewed quickly as trends, waveforms, component V-I curves, or logic symbols.



Several innovative technologies were used in the Model 867B's display, including blue LEDs from Nichia of Japan. The color is a broadband, sky blue that is converted to white backlight by means of an amber filter. Coupled with Hitachi's transmissive LCDs, the backlight technology provides higher contrast and a significantly brighter image than other display modes—while using less than half the power of backlights of similar intensity.

The Model 876B offers 0.025% basic DC accuracy, which allows the detection of very small DC signal variations, especially in low-level transducers and analog electronics. And, because the backlight runs off of 5 volts, there is no AC-DC converter in the multimeter, which produces very "quiet" readings.

The graphical multimeter also can

measure small currents with 10-nA resolution. That is useful for finding signal variations in general electronics and industrial transducers.

The Model 876B's computer interface can be used with an optional software kit to log readings to a PC for later review. In addition, continuous monitoring is possible through a Trend Graph feature that graphically represents a signal's performance over time.

The 867B Graphical MultiMeter costs \$695. For more information, contact Fluke Corporation, P. O. Box 9090, Everett, WA 98206; Tel. 800-44-FLUKE; Fax: 800-FLUKE-FAX; e-mail: fluke-info@tcfluke.com; Web: <http://www.fluke.com>.

CIRCLE 80 ON FREE INFORMATION CARD

PORTABLE POWER SUPPLY

Cutting Edge Enterprises' Powerport 149 portable power supply provides 12 volts DC and 140 watts AC power with 9 amp hours of storage capacity. The compact unit measures 4×4.5×6 inches and weighs just nine pounds.

The rechargeable power supply is built around a sturdy 12-volt/9-amp-hour gel cell battery. A fully automatic wall charger is included. The charger allows you to leave your battery plugged in year round, keeping it in prime condition and ready to go at a moment's notice. The Powerport 149 can also be charged in your car through the cigarette lighter plug.



The Powerport, which is also available in a 50-watt model, is particularly useful in the field where conventional power sources are limited or not available. Powerport can be used to run and charge handheld radios, cell phones, laptop computers, fax machines, test equipment, soldering irons, electric hand tools, video cameras, and emergency lighting. It can even be used for boosting low car batteries through the lighter plug.

The Powerport 149 costs \$159.95 plus shipping; the 50-watt *Powerport 50* costs \$114.95 plus shipping. For further information, contact Cutting Edge Enterprises, 1803 Mission Street, Suite 546, Santa Cruz, CA 95060; Tel. 800-206-0115.

CIRCLE 81 ON FREE INFORMATION CARD

VIDEO EDITING START-UP KIT

The *Home Video Producer* from *Videonics* is an easy-to-follow video editing start-up kit for camcorder enthusiasts of all skill levels. The kit provides all the basic tools needed to create exciting, professional-style videos at home. It includes the *Thumbs Up 2000* video editor, the *Sound Effects Mixer 2000*, an instructional videotape, a handbook of tips and tricks, a microphone, and a set of all-purpose speakers.



The Thumbs Up 2000 video editor allows you to instantly cut or move scenes anywhere you want in your video production using just two main controls. The large button marked with a thumbs up symbol is used to mark the scenes you want to keep; the thumbs-down button marks those you want to delete. The video editor then assembles all the scenes you want to keep and records them on a blank

continued on page 16

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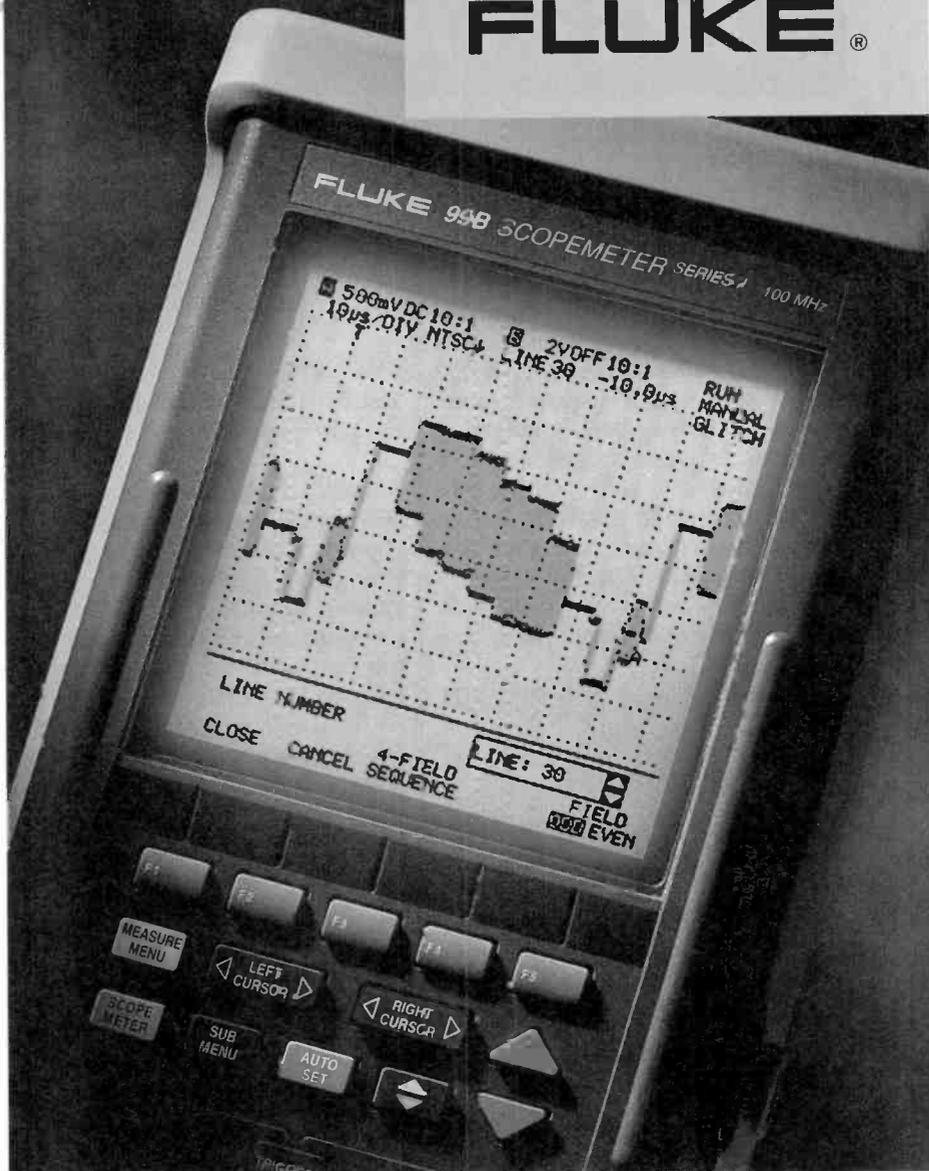
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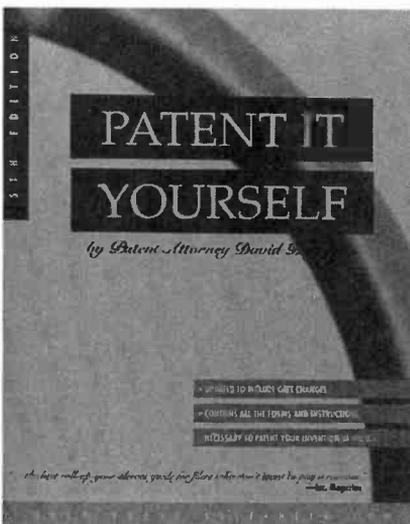
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PATENT IT YOURSELF: 5th Edition

by David Pressman

The newly revised fifth edition of this guidebook for inventors has been updated with new information about software and other computer-related inventions, software claims, design patents for computer icons, and more. The book discusses the changes in patent law brought about by the GATT trade agreement, such as the Provisional Patent Application—a new program that provides preliminary protection for an invention and gives the inventor a year to refine his or her ideas before filing a regular patent application.



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Patent It Yourself: 5th Edition costs \$49.95 and is published by Nolo Press, 950 Parker Street, Berkeley, CA 94710; Tel. 800-992-6656; Fax: 510-548-5902.

**CIRCLE 90 ON FREE
INFORMATION CARD**

THE INTERNET TELEPHONE TOOLKIT

by Jeff Pulver

Save a fortune on your phone bills every month by turning your PC into a phone and making your calls via the Internet. All it takes to get started in Internet telephony is the information contained in this book and software like that which is presented on the included CD-ROM.

The book reveals things that the phone companies would prefer to keep under wraps. It explains just what you can do with Internet telephony, and how to avoid some of the trouble spots of current Internet telephones. It predicts what the future holds for this fast-growing industry, and discusses how other emerging technologies like video on the World-Wide Web will fit in with Internet telephony.



The CD-ROM lets you test drive all of the leading Internet telephone and broadcasting software. It presents demo software including VocalTel's Internet Phone 3.2 and 4.0 Demo Versions, and Internet Wave; Voxware's

TeleVox ToolVox; NetSpeak's WebPhone; FreeTel Communications' FreeTel; White Pine Software's Enhanced CU-SeeMe for Windows and Macintosh; VDONet's VCOLive Video Player; Telescape's TS Intercom; IDT's Net2Phone; IRIS Systems' IRIS Phone; the beta version of IBM Internet Connection Phone; and more.

The Internet Telephone Toolkit costs \$29.95 and is published by John Wiley & Sons, Inc., 605 Third Avenue, New York, NY 10158-0012; Tel. 800-225-5945; Web site: <http://www.wiley.com/compbooks>.

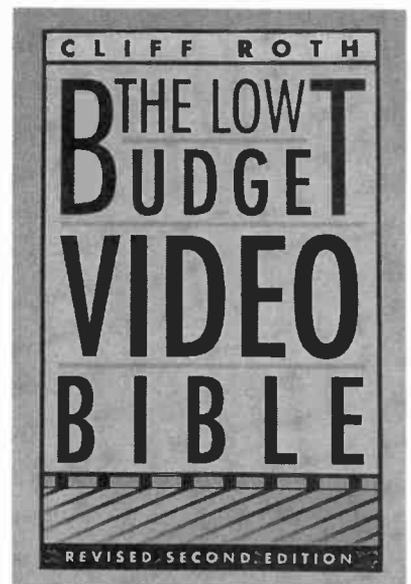
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THE LOW BUDGET VIDEO BIBLE:

Revised Second Edition

by Cliff Roth

Close to a third of American families own a camcorder. All too often, however, that camcorder spends most of its time gathering dust in a closet because its owner became frustrated trying to create good videos. This book tackles the "closet camcorder" head on. It teaches beginners how to avoid some of the most common problems with home-video footage, including-



continued on page 75

The efficiency of ceramic warmth combines with oscillation to create the perfect heater...

This compact heater uses a genuine ceramic heating element and an oscillating fan to eliminate cold spots and provide intense warmth throughout an entire room!

by Irma J. Westburg

If you could build the perfect heater, what features would it have? A safe, yet effective, heating element? A thermostat that would let you select a desired comfort level? An effective way to disperse the heat throughout an entire room? Safety features like automatic tip-over and overheat protection?

If you're like me, you're thinking "Sure, that sounds like the perfect heater, but there's nothing like that available." Guess again. Royal Sovereign recently unveiled a remarkable new heater that combines a ceramic heating element with a solid-state thermostat and an oscillating fan—its called the RST-1200 Oscillating heater.

The ceramic advantage. Many space heaters use a nickel coil which burns oxygen—a process which can produce odors and even cause headaches. Plus, the heaters often get hot to the touch, creating a possible fire hazard. And because they don't have a thermostat, you must constantly turn them on and off to stay comfortable.

The RST-1200, on the other hand, utilizes a genuine ceramic heating element. Ceramic elements are known to be a very efficient and effective heating method. Ceramic heaters do not burn air—therefore, they do not cause any odors or produce any unwanted side effects. Even more important is the fact that the RST-1200 does not get hot to the touch—that means it is not a fire hazard.

Control your climate. The RST-1200 has an electronic thermostat that lets you choose your own comfort level. Simply set the dial to the appropriate temperature, and the RST-1200 will automatically maintain that comfort level. It provides even, uniform heat—without irritating hot/cold cycles.

Spread warmth throughout a room. One of the best features about this amazing new heater is its oscillation—the RST-1200 oscillates over a range of 70°. A high-velocity fan disperses the intense warmth produced by the ceramic heating element, resulting in even distribution of the heat. The RST-1200 will eliminate cold spots, even in those rooms with poor ventilation!

Safety features. The RST-1200 may be the safest space heater you can buy. Its cool-touch cabinet prevents the RST-1200 from being a fire hazard, even when in close proximity to drapery, quilts and paper tissue! The RST-1200 also

has built-in, automatic overheat and tip-over protection. The unit will shut off if tipped over, airflow is blocked or anything is spilled on it. A red safety light indicates that the unit has shut itself off for some reason. The RST-1200 is so safe you can let it run 24 hours a day, worry-free!

Designed to fit in any environment. The RST-1200 is very compact, measuring a mere 13" tall and weighing just under two-and-a-half pounds! With a diameter of 8.3", you can put the RST-1200 virtually anywhere in your home! In addition, its sleek design makes it a welcome addition to any decor—most people won't even know it's a heater!

Try it risk-free. The RST-1200 Oscillating heater is backed by Comtrad's exclusive risk-free home trial. Try it, and if you are not completely satisfied, simply return it within 90 days for a full "No Questions Asked" refund. It also comes with a one-year manufacturer's limited warranty.

RST-1200 oscillating heater \$99 \$9 S&H
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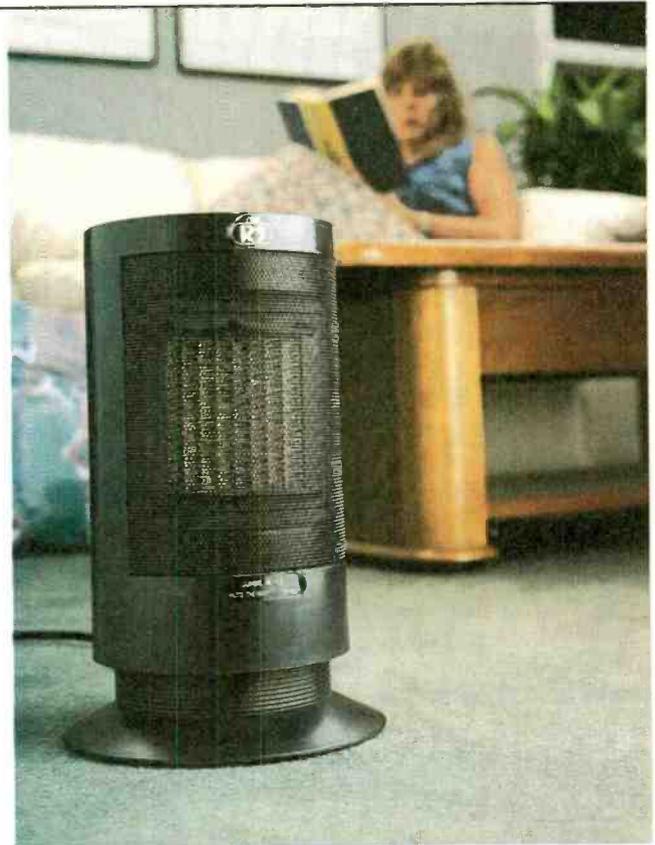
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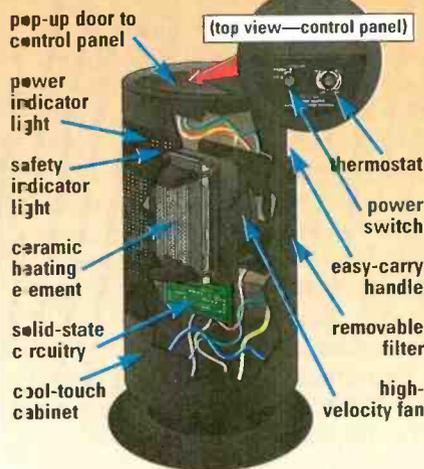
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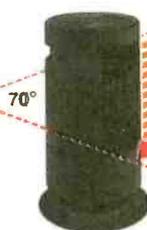


EXTENSIVE FEATURES



The RST-1200 is the only heater that combines the intense warmth of a ceramic heating element with a solid-state thermostat and an oscillating fan. The result? An energy-efficient space heater that will consistently heat an entire room to your desired temperature.

The RST-1200 oscillates 70°, distributing warmth throughout an entire room.



The oscillating difference. The RST-1200 is unlike ordinary space heaters. Because it oscillates

over a range of 70°, the RST-1200 spreads the warmth created by its genuine ceramic heating element evenly throughout your room, eliminating cold spots. And with its solid-state thermostat, you can set a specific temperature, and the RST-1200 will maintain it effectively and efficiently.

Multimedia Watch

The Best PC Speakers in the World?

BY MARC SPIWAK
TECHNICAL EDITOR
WINDOWS MAGAZINE

I recently had the pleasure of testing—or listening to—what I think are the best PC speakers in the world. Of course they're magnetically shielded, but they're also small and sound great. But just saying that alone does not do this speaker system any justice at all, because you really have to see the system, and then hear it, to understand what I'm saying. I'm talking about the Bose Acoustimass Multimedia Speaker System.

no power adapter—it's built into the bass module.

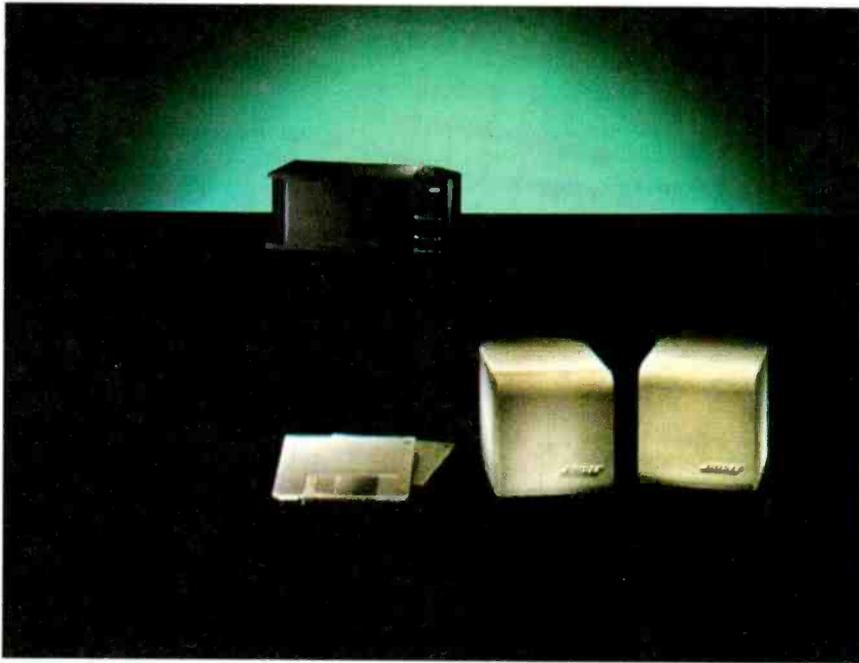
Each platinum-colored driver contains a specially designed 2-1/2-inch wide-range transducer. The little cube drivers measure only 3 × 3 × 5 inches and weigh 1.1 pounds each. They're so small that they can actually get lost in desktop paperwork, as opposed to other speakers I've tested that can dwarf a 20-inch monitor. The bass module measures 7-1/2 × 18-1/2 × 8-1/2

Lotta Love." This speaker system can really crank, and with no noticeable distortion at very high volumes. A crowd quickly formed outside my office to see what was going on. The next day I tested it with a digitally mastered classical CD (Mozart's *Eine Kleine Nachtmusik* performed by The Academy of Ancient Music with Christopher Hogwood) and was equally impressed by the sound. Awesome! And nobody believes how small yet powerful the drivers are, even while they listen to them.

The system boasts a total power output of 90 watts. That's 50 watts for the bass module and 20 watts for each driver.

The Acoustimass features active equalization, a separately amplified bass channel, automatic protection circuitry, and automatic turn on/shut off. Dual inputs let you connect both your PC and another source.

As I said before, this is the best multimedia speaker system I've ever heard. But what I haven't mentioned is that it costs \$699 to have one of your own. Oh well, the very best always costs a premium. You can look at it as an investment in the future, though. While today's hot PC becomes run-of-the-mill in a matter of months, the Bose Acoustimass Multimedia Speaker System will be considered state-of-the-art for a long, long time.



The Bose Acoustimass Multimedia Speaker System is the best-sounding multimedia speaker system I've ever heard.

When I unpacked the system from its carton, I thought the left and right drivers were missing. Filling the majority of the box was the bass module. Then I pulled out a small cardboard box that I thought contained a power adapter. But then I found another identical small cardboard box and wondered why there would be two power adapters. Upon opening one of the boxes I found one driver and then another in the other. They were much smaller than I expected. And there is

inches and weighs 19 pounds. It contains a single 5-1/4-inch woofer. It looks great with its black-matte finish and bass ports on the left corner. Volume, bass, and treble controls are located on the front right. Normally you would tuck a subwoofer out of the way somewhere, like below your desk, but the Bose bass module looks so good you'll want to display it right on top of your desk proudly.

I set up the system in my office and first tested it with Led Zeppelin's "Whole

NEW STUFF

Steven Spielberg's Director's Chair, from Knowledge Adventure, puts you in Steven's seat, and shows you how hard it can be making millions of dollars.

Seriously, though, this unique game requires that you make the right decisions so that you end up on Hollywood's "A-List." Different modes take you deeper and deeper into the world of movie making. You're challenged with creating multiple story lines, coordinating stunts, special effects, and lots more.

The main goal, of course, is to not

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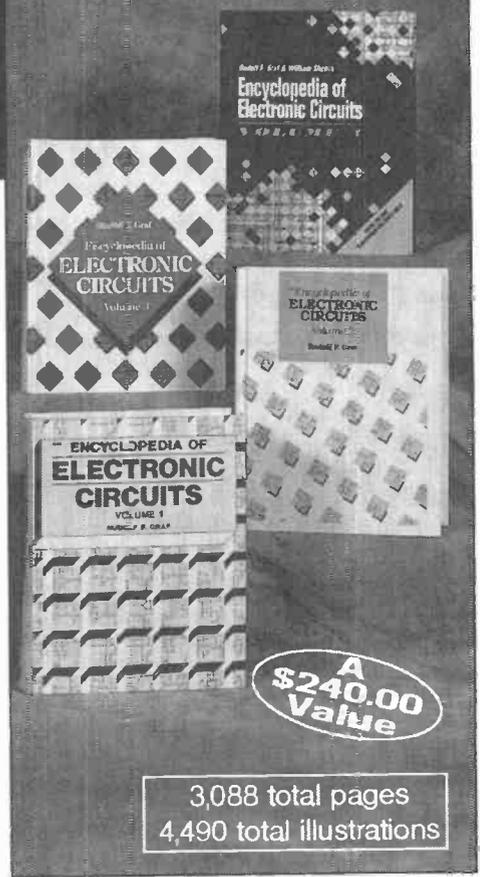
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One of the many projects in Broderbund's Kid Pix software series.

go over budget. That can quite quickly ruin your budding career as a director in Hollywood.

I recently received the latest golfing software from Access Software, *Links L.S.* This update to the well-known series of golf games and add-on courses now has unlimited screen resolutions and you can run in true color if you like, too. There's a new terrain-rendering engine and a ball-flight mode as well. Plus new game modes, modem and network play, stereo sound, 54 championship holes, and even a virtual tour of Arnold Palmer's trophy room. All of this adds up to incredible realism. It's almost as realistic as the actual game, except that you'll never get rained out!

How many of you are familiar with DEVO? They were one of the first new-wave bands, if you want to call them new wave. I actually used to like them, although I haven't listened to them in years. But I know there are still plenty of die-hard DEVO fans out there who won't be able to resist playing Inscap's *DEVO Presents Adventures of the Smart Patrol*, a multimedia game created by the founders of DEVO. It's a battle between good and evil where you must help the Smart Patrol save Spudland from the dreaded disease with a bizarre name: Osso Bucco Myelitis.

I'm seeing more and more software intended for children, and I have a bunch of it this month. I figure it must be because our kids are now better at

using the computer than we are, so there's a high demand for suitable material. Heck, my son is under two and already knows how to put disks in my computer—not that I want him to just yet.

How many of you still remember *Highlights for Children* magazine? I still do, sort of, but it's been a long time for me. It's a magazine devoted to teaching children in entertaining ways. Anyway, Creative Multimedia has a new CD-ROM out, called *Highlights Interactive*, that coincides with the magazine's 50th anniversary. It's intended for kids ages 5 and up. The disc teaches words, cooperative learning, writing, creativity, and a lot more, all with the animated characters that lots of kids know and love. Any kid that likes the magazine will enjoy this disc, and you only have to pay \$39.95 to bring it home.

New from Activision is *Muppet Treasure Island*, an interactive game based on the movie. Children can join characters from the movie and many other popular Muppets in this swash-buckling multimedia adventure. There are plenty of places to visit, many things to learn, and plenty of laughs. Puzzles, activities, and games round out the entertaining disc. *Muppet Treasure Island* has a suggested retail price of around \$49.

Where in the World is Carmen Sandiego is one of the oldest multimedia titles for children that I know of. It's been around since the beginning of

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multimedia. But that doesn't mean it's outdated, because Broderbund has recently released the latest generation of the software, intended for ages 9 and up. The traveling detective game now features 360-degree views from 50 countries and an extensive database of world information that helps kids with the game. Newly available is *Where in the USA is Carmen Sandiego*, which keeps the traveling within our own country's borders. Both titles will sell for around \$40.

For children a bit younger, ages 3 to 12, Broderbund has an ImagiMaker Series of creativity software titles. *Kid Pix* lets kids paint and draw and work on all sorts of art projects—even add sound effects. *Kid Pix Studio* goes a few steps further and also lets kids animate their creations. *The Amazing Writing Machine* quite effectively lures kids ages from 6 to 12 into the world of creative writing, illustrating, and story planning.

Fifteen years of micro-electronic research makes conventional antennas a thing of the past!

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

Technology corner

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

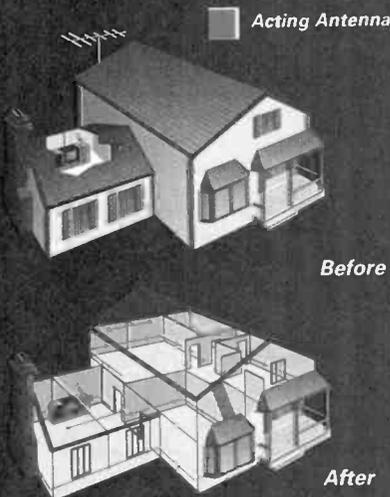
Bandwidth of TV Signal
1 2 3 4 5 6



- When TV signals are tuned at the TV channel's center frequency, optimum tuning has been achieved.
- Other antennas can't offer center frequency tuning like the Spectrum Antenna can. They only offer such tuning up to the edge of the center frequency. As a result, your TV picture remains snowy.

How does Spectrum use a home's electrical wiring as an antenna?

Believe it or not, the Spectrum Antenna simply "activates" the giant antenna that already exists in your home. Essentially, it uses all of the wiring throughout your home's walls and ceilings to make an antenna as large as your house for unbelievably clear reception of local broadcasting.



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

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

Advanced technology. Just imagine watching TV and seeing a picture so clear that you'd almost swear you were there live. Just plug the Spectrum Antenna into a standard AC outlet and plug your TV into the Spectrum. You can remove the unsightly clutter of traditional TV-top devices gathering more dust than television signals. Get ready for great reception. Your TV will display a sharp, focused picture thanks to Spectrum's advanced "Signal Search" and "Fine Tuner" controls.

Uses your home's electrical wiring. The Spectrum Antenna is a highly sophisticated electronic device that connects into a standard wall outlet. The outlet interfaces the Spectrum Antenna with the huge antenna that is your home wiring network. It takes the electrical wiring in your house or apartment and turns it into a multi-tunable, giant TV reception station which will improve your TV's overall tuning capability. The results are incredible. Just think how much power runs through your home's AC wiring system—all that power will be used to receive your local broadcasting signals.

How it works. Broadcast TV signals are sent out from the local broadcast station (ABC, CBS, NBC, etc.). They interface with your home's AC power line system, a huge aerial antenna network of wiring as large as your home itself. When the Spectrum Antenna interfaces with the AC line, the signal is sent to its signal processing circuit. It then processes and separates the signal into 12 of the best antenna configurations. These specially-processed signals route themselves into 12 separate circuits. The Spectrum Antenna includes a 12-position rotary tapping switch, the "Signal Switch" control, which gathers 12 of the best antenna configurations.

Parallel 75 ohm resistance
For minimum loss of signal

Signal search control
For selecting multiple antenna configurations

Resonant fine tuner control
For dialing in crisp, clear TV/stereo reception, eliminates ghosting

Dual outlets with surge protection

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

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

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

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

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NEW PRODUCTS

(continued from page 8)

tape. It can remember the location of more than 200 scenes and can fade to black between scenes.

The Sound Effects Mixer 2000 is a push-button device that offers a collection of 59 sampled audio effects, including footsteps, door slams, rim shots, laughing, crying, birds, gun shots, tire squeals, phone ringing, and hoof beats. There are also 18 built-in electronic tunes and arcade sounds. The device offers a built-in audio mixer that lets you combine sound and music from different sources such as a VCR, CD player, cassette deck, and microphone. The included speakers let you listen as you go.

The Home Video Producer kit has a suggested list price of \$329. For more information, contact Videonics, 1370 Dell Avenue, Campbell, CA 95008-6604; Tel. 408-866-8300; Fax: 408-866-4859; e-mail: info@videonics.com; Web: <http://www.videonics.com/>.

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CELL PHONE WITH VIBRATION ALERT



RadioShack's CT-500 is a handheld, flip-style cellular phone that can be set to vibrate instead of ring when a call is received. It can also be placed in "silent mode," where a message on the LCD will signal an incoming call. The compact phone measures 5.6x2.4x1.1 inches and weighs only 8.6 ounces

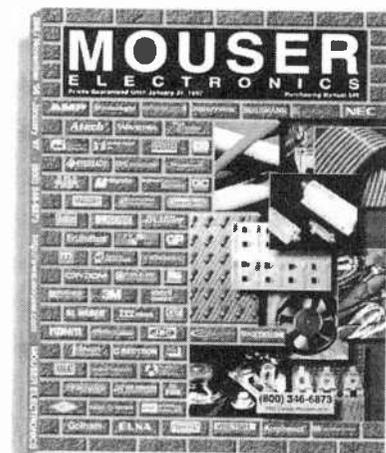
with a standard slim-line battery installed. The battery provides 60 minutes of talk-time and 10 hours of standby time.

The CT-500 offers several convenience features, including automatic redial of any of the last ten numbers and nine programmable one-touch memory storage locations for priority numbers. The phone's flip cover remains closed to protect the keypad when not in use. Its LCD can be read in almost any lighting condition. In automatic answer mode, calls are answered after two rings. Dual-number capability saves on roaming charges. An electronic lock can be used to prevent outgoing calls, except emergency 911 calls.

The CT-500 cellular phone sells for \$69.99 with activation. (In California, the price is \$169.99 due to state legal requirements.) Prices require a new activation and minimum service requirement with a RadioShack authorized cellular-service carrier. For further information, contact RadioShack, 700 One Tandy Center, Fort Worth, TX 76102; Tel. 800-THE-SHACK; Web: <http://www.tandy.com/rs>.

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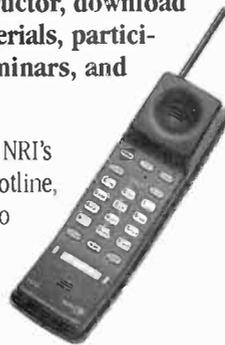
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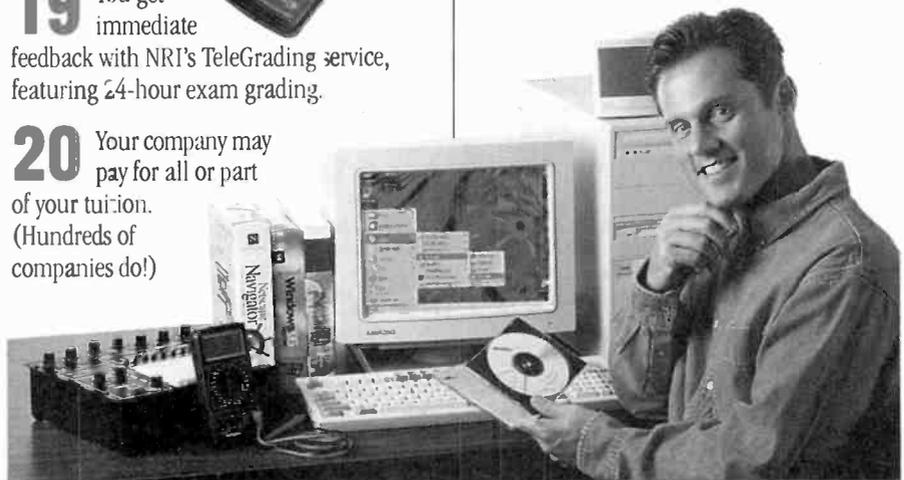


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NET WATCH

EXTRA! EXTRA!

BY DAN KARAGIANNIS

Unless you're really young, and haven't seen any old movies, the title of this month's column should evoke an image. Most likely that of a newspaper boy standing on the corner and waving the latest edition to come off the press.

long been this famous paper's motto. Apparently, the pioneer publisher has decided that all that news is fit to put on a server as well. Best of all, it's all available for free, for the near future. The only catch is that you have to take a minute to register as a user. You then

Internet should check out CyberTimes and Web Specials. Politics, Business, Editorials/Letters, Op-Ed, are pretty self-explanatory sections, as are Arts & Leisure, Travel, and Real Estate. Again, clicking on any of these sections gives you the information from the current edition.

What if you want to find old stories? That's possible too (I sense the demise of library microfilm coming). You can search the *Times* site by filling out an online form. For starters, enter up to three search terms and decide whether to search for articles that contain all the terms you entered or at least one of them.

Next you can choose how many results come back to you. Select from 4-50 returns, or click on for the site to give you *all* the resulting articles. It's also possible to sort them by most recent, closest matched, longest, oldest, or shortest first, or just alphabetically.

You may also find articles you are looking for by browsing through the following indexes: Quick Read of Today's Front Page, CyberTimes Index, Business Digest, Travel Index, or Arts & Leisure Index.

You might have noticed so far that I didn't mention a weather section of the online paper. That's because there isn't a static *Times* weather section. Instead, the site links to another site for weather. This was a great idea because, the link is very impressive and constantly updated. There's a news-ticker-type banner that gives current conditions and warnings, as well as a color map. Also, you'll find graphical forecast boxes like you're used to seeing on the news (you know the type I mean, a box with a name of a day and a picture of a cloud with rain, or a sun, etc.).

USA TODAY

While the *New York Times* has great national and international coverage, it has to devote some space to the first two words in its title: "New York." Of course, that's fine in my case, considering that's where I live. However, most of you reading this are not from here, and



The *New York Times* website makes it easy to find any piece of information in current as well as many past editions of this famous paper.

Of course, in recent years, that hasn't been the method of choice for distributing written news. Newsstands and home delivery pretty much did away with those young lads in caps. And now, it looks like they've met their match, too. News off the Web is becoming a hot trend, and soon it might do away with not only those selling newspapers, but with the paper they're printed on as well!

THE NY TIMES

I would feel almost guilty if I didn't cover this newspaper's site first. That's for two reasons: First, the *New York Times* is considered by many (myself included) to be one of the finest papers in the world. Second, they have one of the finest sites on the Web.

"All the news that's fit to print" has

pick a password, enter the verification code they'll e-mail to you, and access the *Times*.

When you first log on, you see a computerized version of the cover of the *New York Times*. To the left of the headlines, there are several selectable categories that you can click on.

Front Page, like the name implies, has headlines from the front page of that day's edition. News by Category gives you a simulated ability to turn to a particular news section.

Job Market and Classifieds are particularly powerful sections to enter. Forget about scanning pages looking for a particular item. In true advanced-web-site fashion, you can simply enter a few keywords and look for a particular career or item for sale, for example.

Those particularly interested in the

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Executives, students, professional people, men and women in all walks of life from 15 to 70 have benefitted from this program. *Speed Learning* is a fully accredited course...costing only 1/4 the price of less effective speed reading classroom courses. Now you can examine the same easy, practical and proven methods at home...in your spare time...without risking a penny.

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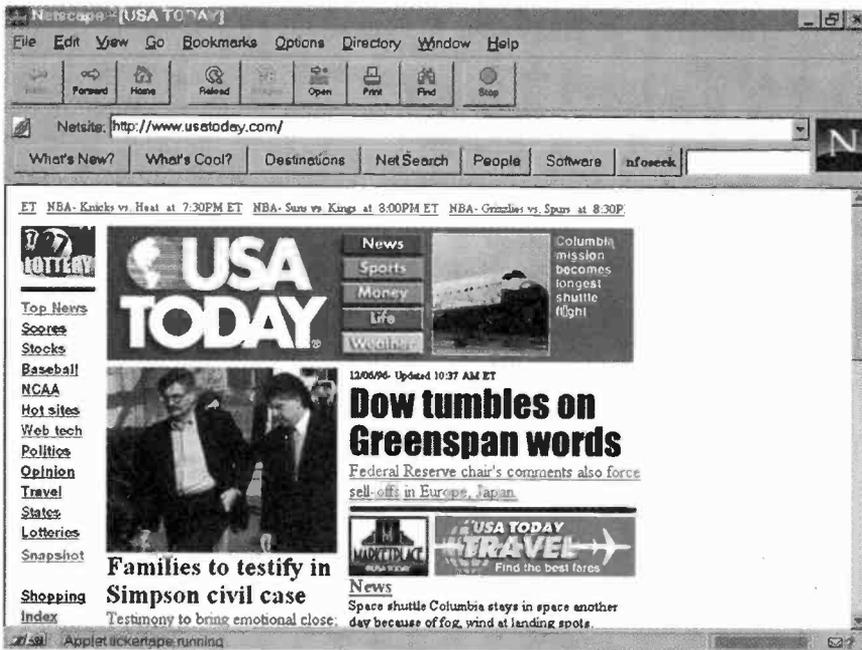
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March 1997, Popular Electronics



Those looking for news from across the nation will love the USA Today site. Note the ticker running sports scores at the top of the page.

might not want to deal with "local" coverage that's not from your locality. If that's the case, you should point your browser to the online version of another well-known newspaper: *USA Today*.

The free site is instantly accessible; there's no registration of any kind required. Once you load up the site you're met by a full-color, attractive page. Actually, "attractive" is a key word when describing the online version of this paper. *USA Today* is famous for its good-looking graphics, and online

they're all present. Those who appreciate charts, graphs, and illustrations will love navigating through this very colorful site.

Using colored buttons to the right of the paper's logo the page lets you choose from: News, Sports, Money, Life, or Weather. None of which need any explanation. You can also pick from specific sections of each, such as Top News, Scores, Stocks, Travel, and Lotteries.

On the front page of the online

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USA Today
<http://www.usatoday.com>

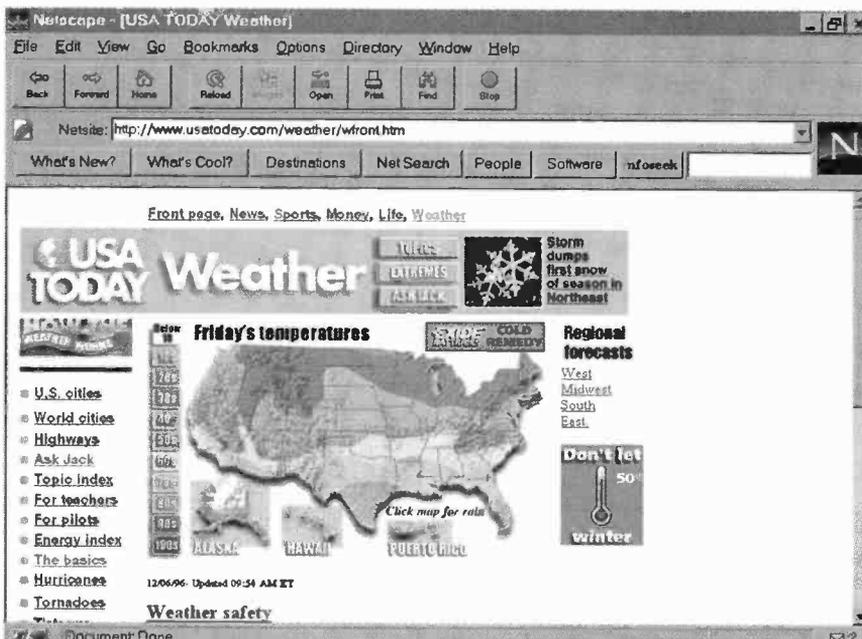
paper, you will find headline stories, along with headings that indicate which section the story is found in (News, Sports, etc.). Just click on a title and you'll get a summary. Then you can choose to read the whole article if you like.

Another way to find a story you like is to use this site's search engine; it's quite different from that found in the *Times* site. At *USA Today* you first choose from one or more databases: News, Reviews, Hotsites, Olympics, Election, and Sports. Then you describe what you are looking for in a few words.

Sports fans will particularly like the front page of this paper. At the top of the screen, a ticker-tape application runs off the latest sports scores. Apparently, these ticker apps are the latest craze in online news providing.

Finally, because we touched on the *Times'* outside weather sites, it's important to note that *USA Today* has several weather-reporting options available. First, you can view the paper's national map, indicating the forecast for the day. Or you can click on one of the several outside weather sites that are linked in this section.

Well, it's about that time again. Until next month, I hope these sources save you some time (and currently, some money). Feel free to get in touch with me by e-mail at peeditor@gernsback.com or by sending snail-mail to *Net Watch*, **Popular Electronics**, 500 Bi-County Blvd., Farmingdale, NY 11735.



March 1997, Popular Electronics

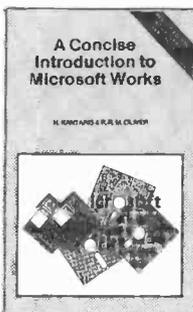
22 A good example of USA Today's graphics can be found in the Weather section of the paper's site.



"You must have skipped a step."

Buyers' Budget Books Better Buys

BP294—A Concise Introduction to Microsoft Works \$6.95. In the shortest and most effective way, you can use the word processor to advantage to type, edit, print and save documents. It goes on to explain how Works can be used to build up simple spreadsheet examples, edit them, save them, print them and retrieve them. It informs you how to create simple macros, and enables you to simplify long repetitive tasks and to customize the program to your own needs.



BP349—Practical Opto-Electronic Projects \$5.95. If you shun opto-electronic projects for lack of knowledge, this is the book for you. A bit of introductory theory comes first and then a number of practical projects which utilize a range of opto devices, from a filament bulb to modern infrared sensors and emitters.

BP350—Electronic Board Games \$6.00. Twenty novel electronic board games that you can build from the plans in this book. Whether you are interested in motor racing, searching for buried treasure on a barren island or for gold in Fort Knox, spinning the wheel of fortune, or doing a musical quiz—there is something for you to build and enjoy!

BP351—WordPerfect 6 Explained \$6.95. This is a practical, hands-on, book and the routines described will help you get the most out of WordPerfect 6. The book explains the hardware requirements for the package and steps you through a standard installation. It guides you through the WordPerfect program environment to enter, edit and enhance text and shows how to get the best from the three different operating modes, depending on the type of PC you are using. The formatting codes, button bars, ribbon, tabs, graphic manipulation and styles will no longer be a mystery.

BP388—Why Not Personalize Your PC? \$6.95. Find out how to: Set up and organize groups of programs and data files, and change the opening logo; use the Control Panel to personalize your working environment; use screen savers and wallpaper files; manage the DOS prompt; and transfer your customization files to a new Windows installation. In DOS, you discover how to: Write batch files and create specialist programs using the debug program, design professional looking menus, and more.

BP367—Electronic Projects for the Garden \$6.95. Electronics enters the Garden! New exciting book points out how gardeners can build simple gadgets to promote success where the elements work against you. Some of the projects are: over/under temperature monitoring, dusk/dawn switching, automatic plant watering, warming cables, etc.

BP368—Practical Electronics Musical Effect Units \$5.95. There is a constant hullabaloo for musical effects projects by the hobbyist community. This book provides practical circuits for several projects that range in complexity and are sure to work. All the circuits are easy to build and use readily-available parts.

BP363—Practical Electronic Music Projects \$5.95. The text contains a goodly number of practical music projects most often requested by musicians. All the projects are relatively low-in-cost to build, and all use standard, readily-available components. The project categories are guitar, general music and MIDI.

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BP385—Easy PC Interfacing \$6.95. The built-in ports in your PC provide an easy and hassle-free way of interfacing your circuits. This book provides useful PC add-on circuits including the following: Digital input/output ports; analog-to-digital and digital-to-analog converters; voltage and current measurement circuits; resistance and capacitance meters, temperature measurement interface, biofeedback monitor, and many other useful interfaces.

BP393—Practical Concise Introduction to UNIX \$5.95. If you are using or intend to use the UNIX multi-user operating system and want to get the most out of your computer system in terms of efficiency and productivity, then you must learn its operating system. The book explains how the UNIX operating system is structured so that you understand what happens when you first approach your computer.

BP396—Electronic Hobbyists Data Book \$5.95. This book provides a wide range of data. If, for example, you require details of a modern five-band resistor code or an old color code for a ceramic capacitor, the formula for parallel resistance, or basic data on an NE5534AN operational amplifier, it is contained within these pages. The subjects covered are numerous and widespread to cover all hobbyist interests.

BP343—A Concise Introduction to Microsoft Works for Windows \$7.95. The book explains and details: How the Works for Windows package fits into the general Microsoft Windows environment; how to use the word processor to advantage; how to use Microsoft Draw to create and edit graphics and place them in your documents; how to build up simple spreadsheet examples; and how single, and multiple charts, or graphs, of different types can be generated. And there's much more!

BP282—Understanding PC Specifications \$7.25. This book explains PC specifications in detail, and the subjects covered include the following: Differences between types of PC (XT, AT, 80386, 80486, Pentium etc.); math co-processors; input devices (keyboards, mice, and digitizers); memory, including both expanded (EMS) and extended RAM; RAM disks and disk caches; floppy disk drive formats and compatibility; hard disk drives; and display adapters (CGA, Hercules, super VGA, etc.).

BP298—Concise Intro to the Macintosh System and Finder \$6.25. Although the Mac's WIMP user interface is designed to be easy to use, much of it only becomes clear when it is explained in simple terms. The book explains: The System and Finder, what they are and what they do; how to use the System and Finder to manipulate disks, files and folders; configuring and printing files from the Finder; getting the most from the system utility programs; and running MultiFinder.

BP301—ANTENNAS FOR VHF AND UHF \$6.00. From installing a TV or FM antenna to setting up a multi-antenna array for shortwave listening or amateur radio, this book explains the essential basics of VHF and VHF antenna operation and installation. In easy-to-understand terms it helps you understand how antennas work, the advantages of different antenna types, and how to get the best performance out of an antenna.

BP316—Practical Electric Design Data \$7.95. A builder's bargain book—a comprehensive ready-reference manual for electronic enthusiasts with over 150 practical circuits. It covers the main kinds of components (from pig-tail leads to surface mount), pin-outs, specs and type selection. Basic units are defined and most used formulae explained. Five additional sections are devoted to circuit design, covering analog, digital, display, radio and power supply circuits.

BP319—Making MS-DOS Work For You \$6.50. This book could help you improve your system set-up and provide you with a simple-to-use, but professional looking, menu system. The routines described will help you understand more of the workings of MS-DOS and help you get the most out of your computer in terms of efficiency, productivity and enjoyment.

BP341—MS-DOS 6 Explained \$7.95. The book covers: How the DOS operating system of your computer is structured so that you can understand what happens when you first switch on your computer; How directories and subdirectories can be employed to structure your hard disk for maximum efficiency; how to use the DOS Shell program, and much, much more.

BP345—Getting Started In Practical Electronics \$5.95. If you are looking into launching an exciting hobby activity, this text provides basic essentials for the builder and 30 easy-to-build fun projects with which every experimenter should toy. Printed-circuit designs are included to give your project the professional touch.

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GIZMO®

(Will You Still Love Me) When I'm 64

NINTENDO 64 64-BIT VIDEOGAME CONSOLE. Manufactured by Nintendo of America Inc., 4820 150th Avenue N.E., Redmond, WA 98052; Tel. 206-882-2040. Suggested retail price: \$199.95.

The much hyped, long-anticipated moment has arrived: *Nintendo 64*, the first 64-bit home video-game console, is finally being sold on our fair shores. Was it worth the wait? Was it ever!

Its introduction has been a long time coming. Nintendo, once the uncontested leader in the fickle field of video games, intentionally sat on the back burner as its arch rival, Sega, and relative newcomer, Sony, battled it out in the 32-bit arena. As the Sega Saturn and Sony PlayStation (reviewed later in this issue of *Gizmo*) stirred up the somewhat sluggish videogame market, Nintendo was busy cooking up its next-generation 64-bit machine.

That's not to say that Nintendo has been completely out of the public eye. For the past few years, the company has continued to sell its 16-bit games for the SNES console—including a vastly improved Donkey Kong Country—and has introduced some new portable games. Nintendo has also been manipulating the 32-bit wars from the sidelines with strategically timed product announcements. Last winter, promises of an early springtime release of Nintendo 64, at a lower suggested retail price than either Sega or PlayStation, slowed critical Christmas sales of both 32-bit systems. (Despite the introduction of the two 32-bit systems, video-game system sales rose only slightly last year, from 10.5-million units in 1994 to 14.3-million in 1995—sorry figures, indeed, when compared to the 27-million machines sold in 1992.)

All those potential buyers who decided to wait for the more powerful system had their patience sorely tested. Nintendo 64's



CIRCLE 55 ON FREE INFORMATION CARD

U.S. debut date was pushed back until autumn—surprise!—just in time for the 1996 holiday season. It remains to be seen if sales figures rise dramatically in response.

That will be determined in part by the amount of available software. After all, it's always been the quality of the games that sell any given platform. As we go to press, a mere 35 shopping days until Christmas, only three N64 games are available. What good is a 64-bit machine if you don't have much to play on it?

Actually, in the case of Nintendo 64, the answer is quite good. Our unit arrived with just two games—Japanese versions at that—Nintendo's own "Super Mario 64" and "PilotWings 64," developed in conjunction with Paradigm Simulation. Between the two, we could have kept playing, and playing ... if we didn't have to stop to eat, sleep, and write this. More to the point, the games showcase the new platform's power and capabilities, and leave users panting for more.

As for the hardware, Nintendo 64's specs are quite impressive. A 64-bit RISC CPU with a clock speed of 93.75 MHz provides Pentium-like power. A separate 64-bit processor is included just to handle the graphics. N64's 36 megabits of DRAM with a maximum transmission

speed of 4500 Mb per second can be upgraded with the addition of a plug-in 64-Megabyte, 3¼-inch magnetic disk drive, which will be sold separately.

Nintendo teamed up with Silicon Graphics Inc. (SGI) to create a specialized coprocessor to handle the graphics. SGI had already come up with a \$100,000 device, known as the Reality Engine, that had proven itself fully capable of tackling any graphics job—most notably, it was used for some of the special effects that made the film "Jurassic Park" such a megahit. The challenge facing Nintendo and SGI was to take that \$100,000 device and somehow make it fit in a home videogame console with a \$250 maximum price tag.

The resultant coprocessor has 90% of the features of the original Reality Engine. In fact, it consists of two separate processors. A signal processor does the geometric calculations (N64 games are based on 3D polygons, with characters and backgrounds created out of geometric shapes). A display processor, which actually generates the screen images, also takes care of such features as texture mapping and Z-buffering. Advanced texture mapping allows developers to add reality enhancers, such as shadows that follow a character, and mood enhancers, such as smoke and



Additional Nintendo 64 game controllers are available in a variety of colors.

fog to obscure objects but not fully hide them. Z-buffering makes it possible for the system itself, rather than the games, to determine which parts of the image are hidden behind others in each 3D scene.

Together, the two processors produce lifelike three-dimensional images and 360-degree movements. The Reality Coprocessor also handles anti-aliasing, which smoothes images by reducing the jagged-edge effects often seen in bitmap images, and MIP mapping, which improves the appearance of a textured surface by changing the image depending on the viewer's distance from it. MIP-mapping keeps an object clear when you zoom in on it, or view it from afar.

Memory-saving features like Z-mapping are particularly important because Nintendo decided to forego the memory-dense CD-ROMs used in Sega Saturn and Sony's PlayStation in favor of silicon-based ROM cartridges. The decision was not made out of misplaced loyalty to an old-fashioned format. What cartridges lack in memory they more than make up for in speed; access time is much faster than any CD-based system. There's virtually no down time spent waiting for a new scene or character to appear, which can take as much as half a minute with a CD-ROM game. That might not sound like much on paper, but when you're sit-

ting in front of the TV waiting, and waiting, it can seem like forever.

You're much less likely to notice the cartridge's lack of available memory—unless you're a game developer who has to be very frugal with it—than the CD-ROM's lack of instant access. But game developers won't feel the memory pinch too severely. According to Nintendo, compression technology allows the cartridges to store plenty of game data, and the console's coprocessor takes over several of the memory-intensive tasks that are done in the software on CD-based systems.

For consumers looking for more memory, an add-on option called the *64DD* is soon to become available. The high-speed, mass-volume disk drive attaches to the bottom of the console. High-density, 3 $\frac{3}{4}$ -inch magnetic disks, which are front-loaded into the unit, each hold about 64 MB of data. It will allow players to write data to game software, to save characters and games, for instance.

Still more add-on memory is available for the Nintendo 64 controller. A memory pack, which plugs into the bottom of the controller, can be used to save a player's individual game-play and controller preferences. The memory pack can be removed and interchanged with any other N64 controller, providing portable customization.

The controller has been designed to take full advantage of three-dimensional Nintendo 64 games. Its shape is evocative of some alien space ship, with three wing-like handles extending out from its front. At the base of the center handle is an analog 3D control stick—a thumb-oper-

ated joystick—that is used to manipulate characters in their full 360-degree range of motion. Exerting different amounts of pressure subtly changes the character's gait—a soft touch makes him creep slowly, full throttle has him running all out. The 3D joystick also provides realistic acceleration and turning in auto-racing and flight simulation games. A set of four yellow buttons, located to the right of the joystick, is used to switch the perspective, revealing objects or characters who become hidden behind other objects in the three-dimensional game. In sports games, the perspective buttons are used to position the players on the field.

Near the yellow buttons are two others—one blue, one green—that are used to make the character jump, spin, throw punches, and make other moves. Behind the right handle (at the back of the controller) is a button whose purpose varies with the game. In "PilotWings 64," for instance, it is used for snapping "photographs." A trigger button, found on the bottom of the center handle, is most often used for firing weapons. Above the left-side handle is found a traditional cross-shaped game controller.

Having three handles might seem like overkill, considering that game-players have only two hands. But the separate grips allow different hand positions for various game types. For 3D action, racing, and fighting games, you would hold the center and right handles. That position allows you to get the most out of the 3D stick. You'd grasp the left and center grips to be able to control both the 3D stick and the Z-Trigger button for explosive action games. The Super NES position—holding the two outside grips—is used for playing side-scrolling action games, action puzzle games, and role-playing games.

The Nintendo 64 console offers four front-mounted controller ports. Additional controllers are available (at a suggested retail price of \$29.95 each) in five different colors—yellow, green, blue, red, gray, and black. That allows a family of game players to readily distinguish between their own customized controllers.

We found the controller comfortable to hold, and the controls to be accurate and responsive as we moved about the three-dimensional worlds of "Super Mario 64" and "PilotWings 64." A third N64 game—"Mortal Kombat Trilogy"—went on sale as we were finishing up this article.

If you're concerned about the paucity of software, keep in mind that more than 50 games currently are being created by Nintendo and third-party developers. By the end of 1996, Nintendo itself expects to release at least a dozen 3D games, including "WaveRace 64" (futuristic boat racing), "TetrisPhear" (puzzle), and "Super Mario Kart R" (go-cart racing). ■

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Plumbing The Depths

SUPER MARIO 64. Manufactured by Nintendo of America Inc., 4820 150th Avenue N.E., Redmond, WA 98052; Tel. 206-882-2040. Suggested retail price: \$59.95.

As the latest incarnation of Super Mario roams the castle in search of a princess who needs rescuing, he encounters large paintings hanging in various rooms. Nudge the 3D stick forward, press the blue JUMP button, and Mario vaults *into* the picture—like Alice through the looking glass. And that's a bit what you feel like too, as you leave this world behind and fall into *Super Mario 64*.

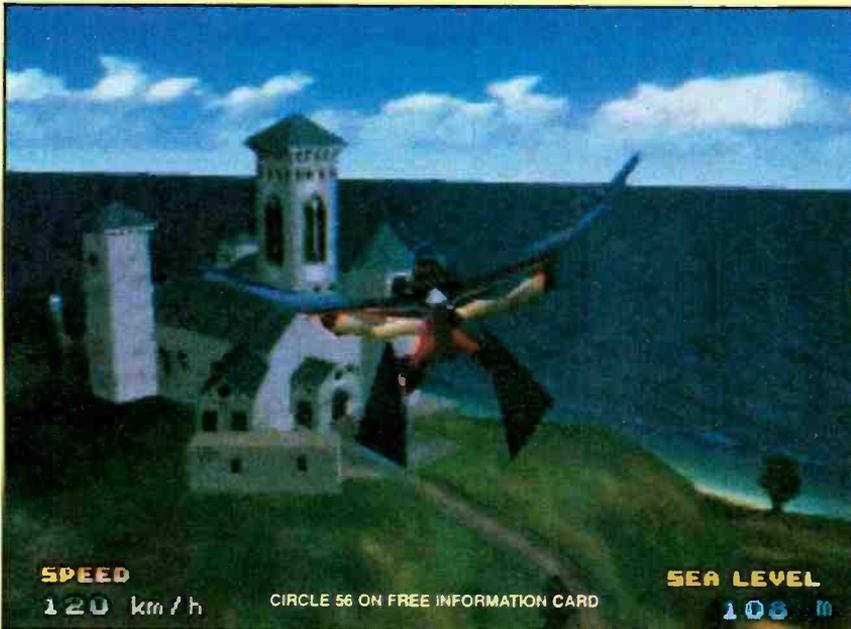
The one-player game features elements familiar to fans of earlier versions of Super Mario—coins, stars, power-ups, puzzles and mazes, hidden treasures, and his old nemesis, Bowser. But the new Mario is a fully three-dimensional figure, created from hundreds of texture-mapped polygons. (At the closest camera zoom, Mario consists of 1500 polygons.) And Mario's world is a beautifully rendered, intricate land with exciting 3D elements. For instance, when Mario climbs inside a cannon, the view switches to a first-person perspective as Mario is blasted through the air (to a safe landing, if you've aimed well).

The game's objective is to rescue the princess and defeat Bowser. To do so, you must explore 25 different areas, including a desert, an undersea landscape, a haunted mansion, and snow-covered mountains. As you travel through each of those environments, it's easy to lose sight of the objective. There's so much to see and do along the way; the ultimate goal doesn't seem so important.

Truly goal-oriented individuals can ascertain Mario's position at any given time, and make strategic game playing decisions, by checking a map. As the game goes on, Mario can gain the strength of up to eight plumbers.



Mario swims with the fishes in one watery landscape.



Flight Simulator Revisited

PILOTWINGS 64. From Nintendo of America, Inc., 4820 150th Ave. N.E. Redmond, WA 98052; Tel. 206-882-2040. Price: \$59.99.

If flying through a three-dimensional world is your idea of fun, then you'll have a ball with *PilotWings 64*, the first flight-simulator for the Nintendo 64. Don't even try to compare it to those rather boring simulation games where your main worries revolve around the mechanical aspects of flying. This flight simulator is built for fun.

We were at a slight disadvantage with this game—our pre-release copy of the game was entirely in Japanese, so we couldn't read the instruction manual or the on-screen displays. Nevertheless, we were able to figure out most of the game play, and even get respectable scores.

Like *PilotWings* for the Super NES, the game requires players to progress through a variety of assignments and stunts to earn points for their pilot-license certification.

There are three basic games. The first requires you to pilot a hang glider; the second, a gyrocopter; and the third is a rocket pack. After you complete all three at one level, you can proceed on to the next. Each one gets progressively more difficult—or even impossible for some people—as the controls get touchier, and the fuel supply runs down with great speed.

When in the hang glider, the game starts

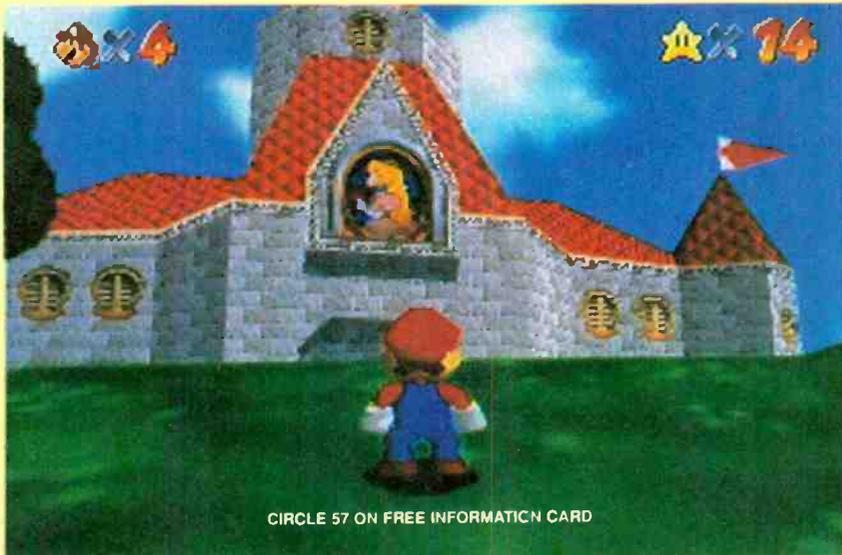


Meters and gauges don't get in the way of the flying fun in this game.

out with you in the air. The object is to land safely at the target. Along the way, however, you try to fly through aerial targets, collecting points. If you need a little extra height, you can fly through some of the updrafts produced by factory chimneys, or through thermals over open fields. With both the gyrocopter and rocket pack, you start out on the ground. You must successfully take off, hit the targets, and land again safely.

The three-dimensional worlds are rendered quite nicely, and fun effects, such as shadows and reflections, are thrown in. You can choose your on-screen character from among six, watch replays of your landings, or even take aerial snapshots. Fly your rocket pack to the top of Seattle's Space Needle and rest a bit, if you like.

Interestingly, the game was designed with the help of a team of programmers from Paradigm Simulation, which has a reputation for producing some of the best military and commercial 3D flight simulators. *PilotWings 64* should earn them a similar reputation in the gaming world. ■



CIRCLE 57 ON FREE INFORMATION CARD

At each level of play, Mario can lose power when he is attacked by various enemies. His remaining strength is denoted by a circular power meter; power can be replenished by finding power-ups.

Mario runs, jumps, somersaults, vaults,

climbs hills or even trees, slides down slopes. He swims in fountains, pools, or the ocean; creeps crab-like along walls; hangs by his fingertips over ledges and then pulls himself up. In one snow-covered landscape, he slips and slides down icy

slopes, bringing the player closer to the sensation of skiing than any ski-simulation games we've tried.

You can precisely control Mario's motions and his speed. As he moves, his shadow follows him. You can also see the shadows of such perils as bouncing balls, and try to get Mario out of their way before they strike him. As he moves in 360-degree turns, his world changes to reflect the changing perspective. Objects are hidden behind walls, or revealed, as he travels around.

The result is incredibly realistic—and incredibly addictive—game play. Everyone who saw "Super Mario 64" was immediately impressed by what a big step forward it was from the old, two-dimensional version, and quickly drawn into play.

There might not be many games yet available for Nintendo 64, but as far as we're concerned, in "Super Mario 64" Nintendo has found a killer app. Judging by preliminary retailer reports, holiday shoppers agree—N64, and its three available games, are the big sellers so far this season. ■

Power Play

PLAYSTATION GAME CONSOLE. Manufactured by Sony Computer Entertainment America, 919 East Hillside Blvd., 2nd Floor, Foster City, CA 94404; Tel: 415-655-8000, 800-222-SONY; Fax: 415-655-8001; Web: <http://www.sony.com>. Suggested retail price: \$199.

When Sony decided to test the waters of the videogame market, it didn't just stick its toes in. It jumped right in with its 32-bit PlayStation—and made quite a splash. Within a year of its introduction, Sony Computer Entertainment America (SCEA) shipped close to two million units, and SCEA and its third-party publishers shipped about 9-million game CDs.

According to Sigeo Maruyama, SCEA chairman and CEO, "The PlayStation game console is one of the most successful new products that the Sony Corporation has introduced during the company's entire 50-year history." Maruyama attributes the platform's success to several factors, including its "technological superiority," a diverse selection of software titles, and the power of the Sony name.

We can't argue with the name-recognition factor. Let's take a look at the other two claims.

The PlayStation is a 32-bit, CD-ROM-based system that packs the power of a computer workstation into a gray plastic



set-top box. At its heart is a 33-MHz, 32-bit RISC CPU that offers a 4-KB instruction cache and a 1-KB data cache. The CPU is backed up by a graphics processor (GPU) that provides a maximum of 16,770,000 colors and 640- × 480-dot resolution. The CPU also handles the texture mapping used in creating 3D games. In terms of audio, the PlayStation delivers CD-quality sound—and can be used to play audio CDs as well as games. The

sound processor can also add built-in digital effects, such as reverb and envelop.

What that all comes down to in real life is that the PlayStation provides developers with enough power to create exciting three-dimensional worlds, and to populate them with characters that do more than move up and down and right and left. Like the Nintendo 64, the graphics for PlayStation games are created from geometric shapes, or polygons. The PlayStation's

graphics processor can handle 360,000 flat, shaded polygons per second or 180,000 texture-mapped polygons per second. From those polygons, developers are able to produce 3D settings and objects. Texture mapping further enhances the realism.

As a CD-based system, PlayStation has a huge storage capacity. Each CD has 600 megabytes of space available, of which game action rarely takes more than 5%. Developers can use the remaining space as they see fit, giving them much more freedom than when designing cartridge-based games. They can even add bits of memory-intensive full-motion video and CD-quality digital sound to their games.

The main drawback to CD-based games is that they don't provide instant access. There's always that lag in play as you reach a new level and wait for it to be loaded. When you're caught up in the game action, even a few second's delay can be annoying.

The PlayStation console features a top-loading disc holder at its center, with the large round POWER button to its left and an identical OPEN button to its right. Just behind the POWER is found the RESET button. On the front of the unit are two ports for plugging in the game controller that comes with the game, and an additional one you can buy for about \$30.

The controller offers two separate sets of buttons. On the right side are four individual buttons, marked with an "X," a circle, a triangle, and a square. Each is used for specific moves in various games. On the left side of the controller is a set of four directional buttons that allow you to move on-screen characters up, down, right, left, and diagonally. Between the two groupings are the SELECT and START buttons. At the back of the controller are four "action" buttons, arranged two behind each grip for easy access by the index finger of each hand.

Just above each of the controller plug-in ports is a slot for a memory card. Available optionally, the memory cards let a player save his or her place in a game, store a high score, or save character or team attributes. You can bring your memory card to a friend's house, plug it into his or her PlayStation, and prove that you weren't exaggerating your scores!

The PlayStation doubles as a CD player, which is especially nice if you have it connected to a home-theater setup with a good audio system—or the GXTV, described later in this issue. CD operations are controlled on-screen, using the game controller to select specific tracks, play mode (shuffle, program, continuous), or "press" play, pause, fast forward, reverse, or stop.

In its primary role as a game console, the PlayStation is a joy to use. Sound and
(Continued on page 33)



Adventure Down Under

CRASH BANDICOOT. Manufactured by Sony Computer Entertainment America, 919 East Hillside Blvd., 2nd Floor, Foster City, CA 94404; Tel: 415-655-8000, 800-222-SONY; Fax: 415-655-8001; Web: <http://www.sony.com>. Suggested retail price: \$59.95.

Move over Mario and Sonic—meet *Crash Bandicoot*. (A bandicoot, by the way, is a marsupial native to Australia.) Sony is banking on Crash to weasel his way into game-players' hearts everywhere.

Remember *The Island of Dr. Moreau*? Well, this game could have been called "The Island of Dr. Neo Cortex." He's the arch-villain who's trying to turn ordinary animals into armored beasts with which to



Crash Bandicoot faces a series of Indiana Jones-style dilemmas, such as being chased down a narrow lane by a huge boulder.

conquer the world. With the help of his assistant, Dr. N. Brio, he invents two machines—one to give the animals superior brain power, and the other to make them totally loyal to him. Unfortunately, they don't work as planned; instead of devoted geniuses, he keeps creating raving lunatics.

Crash Bandicoot was a reject from this diabolical program, booted out for his overdeveloped conscience, and cast adrift. As game play begins, Crash has washed up on the sandy shores of N. Sanity Beach, two islands away. He's determined to find his way back to Dr. Cortex's island, where the love of his life, Tawna, is being held captive. Along the way, he faces deadly pitfalls, collects valuable objects, and encounters increasingly dangerous enemies and obstacles.

Okay, we've established the genre. He's collecting tropical fruits and gems instead of coins or stars, rescuing a female marsupial instead of a princess, navigating through island jungles instead of a castle—but Crash Bandicoot is an awful lot like Super Mario. They have two other things in common: Both characters are endearing, and both games are addictive.

Crash Bandicoot is one of Sony's "3D" games for the PlayStation. Crash moves forward (deeper into the picture) and back (toward the player), as well as left and right and up and down, which gives you the sense of moving into the game. And after Crash jumps over a wall, you'll want to turn him (facing you) to see if there's any treasure hidden behind it.

(Continued on page 34)

PLAYSTATION GAMES

Aquanaut's Holiday

This is our kind of video game—non-violent, educational, and, most important, fun. *Aquanaut's Holiday* takes kids of all ages into a world few people have experienced in real life. On your 3D undersea journey, you can swim along a school of rainbow-colored fish as you explore a marine canyon, and invent your own language to communicate with the denizens of the deep. You'll meet more than 120 varieties of sea creatures as you walk along the ocean floor, build coral reefs, and explore the sunken ships and other ancient ruins hidden throughout the exotic watery landscape. You can play for hours without retracing your steps. This is a pressure-free gaming experience, with no deadline or clear objectives past the joy of discovery. The New Age soundtrack enhances the relaxed mood.

Beyond the Beyond

Sony Computer Entertainment America's (SCEA) first role-playing game for the PlayStation is *Beyond the Beyond*, an adventure saga that leads players through a labyrinth of a storyline, full of cunning knights, dragons, evil monsters, fierce battles, and magic spells. In the Land of Quamdar, an age-old truce between good and evil ends, and dark forces begin to rise from the depths of the planet. A knight-in-training named Finn gets on-the-job experience as he and his trusty dragon Steiner lead a band of assorted good guys in the fight to banish evil from Quamdar. It's up to you to develop their powers as you unravel the nonlinear storyline. The 3D strategy adventure is intensified by the use of two rich perspectives: a continuously evolving, top-down, isometric view; and a revolving, 360-degree three-dimensional view.

Bogey: Dead 6

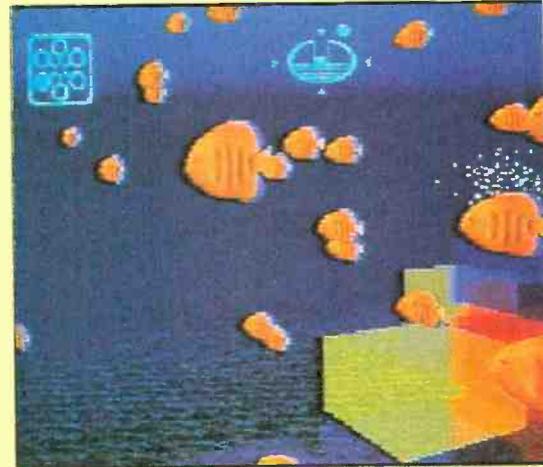
If you liked watching "Top Gun," you'll love playing *Bogey: Dead 6*. This 3D flight-simulation game features 360-degree movement, tight controls, grueling combat action, and terrific special effects. There is also a plot: An international crime organization, with the aid of several countries, has built a powerful military force. You assume the role of a Naval fighter pilot, a team member of an elite air squadron, who is assigned to respond to classified international missions. You can select from various types of fighter planes as you go off to save the world from destruction. There's no need to fly off unprepared, however. A "training" mode allows you to build the skills needed to tackle the "scenario" mode, where you'll find air-to-air, air-to-sea, and air-to-ground assaults.

Epidemic

And you thought your real life was bad? In *Epidemic* (the sequel to "Kileak: The DNA Imperative"), a deadly virus has forced what's left of the human race to live underground. A life-support system controlled by a computer keeps living conditions comfortable. But the population is tyrannized by a dictator who uses the guise of population control measures to obtain superior DNA samples with which to create a master race. As a member of the only group to stand up to the tyrant, you must save your captured leader, find a cure for the virus—which has infected your girlfriend—and destroy the dictator's regime. Along the way, you encounter a variety of enemies, each equipped with an arsenal of weapons, movement patterns, and other combat characteristics. Strategy and action are combined in a real-time shooting game, complete with new sound effects, advanced 3-D rendered graphics, and faster character movement.

Jumping Flash! 2

SCEA's *Jumping Flash! 2* opens with Robbit, the robotic jumping rabbit from the award-winning original "Jumping Flash!," trying to save the Muu Muus (poor, pathetic creatures) from total destruction. There are six different worlds, each filled with traps, hidden areas, suspended platforms, and underwater areas to explore. You must collect four Muu Muus before advancing to the next level—not an easy task, with Robbit surrounded by a horde of enemies that he must squish or shoot. They include cockroaches, hermit crabs, paragliding Kiwis, jumbo frogs, slime, and origami cranes. Robbit has unlimited shooting capability and new weapons. For Robbit to succeed, you must sharpen your jumping skills. The game is enhanced with 3D environments, movie segments, and hidden bonus levels.



Aquanaut's Holiday



Bogey: Dead 6



Jumping Flash! 2

King of Fighters '95

Developed by SNK and aimed at males in their teens and early 20s, *King of Fighters '95* is an adaptation of a popular arcade game. With 24 top fighters—including those from “Fatal Fury” and “The Art of Fighting 2”—available to form three-player teams, the game provides 2000 game-playing team combinations. Each combatant is armed with at least five special moves, plus an extra “last resort” move that radically alters the game odds in the last seconds of play. Game play is two-dimensional, arcade-style fighting for one or two players. (Parents worried about the senseless violence can try to soothe their consciences with the knowledge that their sons’ fighters are trying to save the world from the sinister Omega Rugal.)

MLB Pennant Race

With licenses from Major League Baseball (MLB) and the Major League Baseball Players’ Association (MLBPA), *MLB Pennant Race* features the more than 700 players that make up all 28 real-life teams in both leagues. Each team’s home stadium is fully texture-mapped in three-dimensional detail. The players—dressed in home or away uniforms—are animated using motion-capture technology for head-first slides, diving, jumping, and spectacular catches. In-depth statistics include tracking full-season stats for each player and team, and ranking league leaders in more than a dozen different categories. You can put yourself in the game by creating a player with your personal attributes, or create an all-star team using the trade-player feature. The game offers three levels of difficulty, in either simulation or arcade style, and allows you to play “Home Run Derby,” “Exhibition,” “Season,” “Playoffs,” or “World Series” games.

NHL Face Off '97

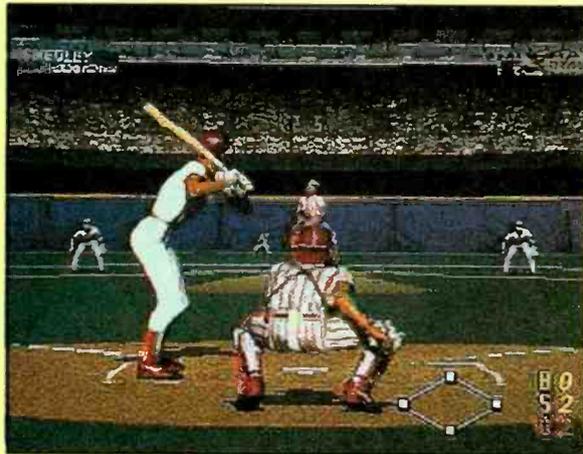
NHL Face Off '97 features realistic 3D hockey action with a twist—a revolutionary new passing system. “Icon Passing” lets you bring up symbols, which correspond to the geometric icons on the controller buttons—under the hockey players. Press one button to pass the puck to that player. Use a combination of those buttons to pass it between players with lightning speed. Press the SHOOT buttons immediately after passing the puck, and the receiving player will shoot on goal. The game also offers a host of team strategies that allow you to change your team’s offensive and defensive style, and even focus play around a specific hockey player. Real statistics and player attributes are included for each of the 650 National Hockey League players on all 26 teams, and you can invent a player to represent yourself in the game. Get ready to practice your drop passes, fake shots, give and go’s, backward skating, and flips; try to avoid painful injuries; and get ready for the winning teams’ exuberant celebrations.

Project: Horned Owl

Metallica, a terrorist force of “cyber-mechs,” is attacking an urban city resembling Los Angeles in *Project: Horned Owl*, a futuristic action-shooter game. As the city is buckling, street by street, you become a member of an elite armed squad—a.k.a. Horned Owl—whose goal is to seek out and destroy the Metallica force and its evil leader. Armed with an arsenal of weapons including bombs, missiles, and automatic machine guns, you progress through increasingly difficult and dangerous levels of non-stop combat action. Fully interactive backgrounds allow you to shoot anything in your path—from blasting out windows to blowing up cars. The game offers one- and two-player modes and three levels of difficulty.

Twisted Metal 2

Co-developed by Sony Interactive Studios America and SingleTrac Entertainment Technologies, Inc., *Twisted Metal 2* is a high-action, car-to-car combat game that puts you in control of heavily armed vehicles as you search out your opponents through “live” 3D environments. There are no pre-set paths; you can cut through parks, drive on the sidewalk, and take any action needed to defeat the competition. The game begins where its predecessor, “Twisted Metal,” left off—in the wake of the destruction of Los Angeles.



MLB Pennant Race



NHL Face Off '97



Twisted Metal 2

Game, Set, Watch!

GXTV MODEL GXE1395 PERSONAL VIDEOGAME TV. Manufactured by Samsung Electronics, 105 Challenger Road, Ridgefield Park, NJ 07660; Tel. 800-SAMSUNG. Suggested retail price: \$349.

The family dinner, as always, was a noisy affair. Clean-up, a chaotic effort involving parents and teens, is done. At last, you can retire to the den, settle in your recliner, and relax in front of the TV, watching—Crash and Burn? MTV?

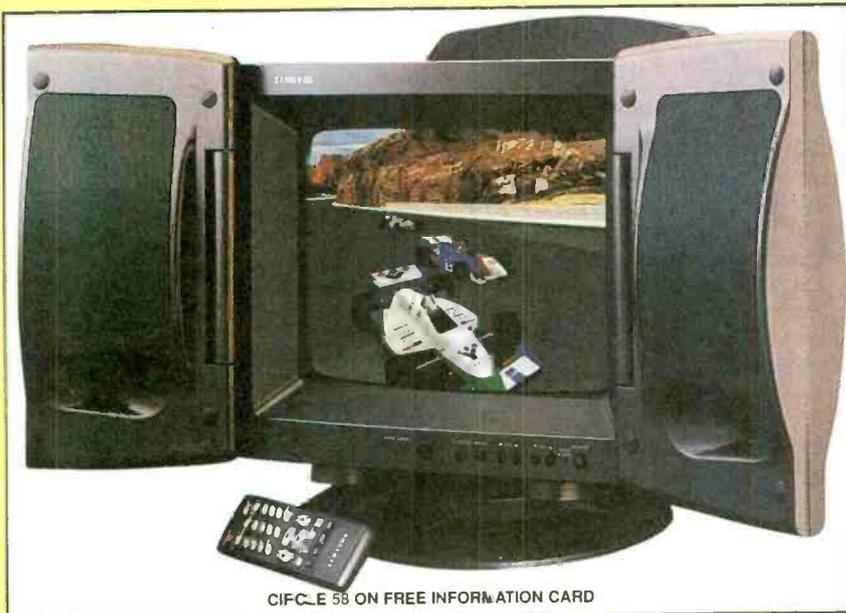
Gone are the days when the whole family would gather around the black-and-white console to watch *Bonanza* or *The Ed Sullivan Show*. With the wealth of broadcast programming and other video options available today, it's hard enough for members of the same generation or gender to reach a viewing consensus—forget about finding one show to suit the disparate tastes of four or five people who just happen to be related by blood or marriage.

Before someone ends up in the *ER* or you're driven to *Homicide*, why not consider buying the kids their own TV, so that they can play their videogames and enjoy their music videos without disturbing your peace? And so they won't feel bad about surrendering the big-screen set in the family room to their folks, why not buy them a TV that's specifically designed for videogame playing?

According to Samsung, its *GXTV Model GXE1395* is "the world's first personal game monitor ..." designed to "completely immerse the player in today's hottest video games." To that end, the 13-inch set features two wing-like speakers that open out for game play and close up when not in use, protecting the screen (from the fallout of a teenager's room, we suppose), and a built-in 15-watt subwoofer to boost the bass. Preset audio modes such as "warzone" and "roadrace" are intended specifically to optimize the sound of games that fall into those popular categories. There are also preset video modes for game-playing and watching TV.

The *GXTV* more closely resembles a computer monitor than a traditional TV. Like a PC monitor, it sits upon a swivel base. The tilt/swivel stand can be moved 45° to the left or right of center, and up 10° or down 5° from level. As we've become accustomed to in the age of multimedia PCs, there are speakers mounted to either side of the screen.

Those speakers, however, are much bigger than those that come standard with today's PCs. Set into hinged doors, the bass-reflex speakers can be positioned anywhere within a 175° range, allowing the user to pinpoint the "sweet spot" ac-



ording to the number of players and their positions relative to the TV. The built-in set-top subwoofer enhances the bass sounds of games and music videos alike.

The *GXTV* is compatible with all videogame systems. In fact, if you have more than one system, you can keep two of them hooked up at all times, thanks to the two audio/video inputs found on the rear.

When you're not playing games, the *GXTV* won't sit around gathering dust. The second A/V input could also be used to connect a portable CD or cassette player to take advantage of the set's speakers, or perhaps a VCR instead. (Of course, if your game console is CD-based, like the Sega Saturn or Sony PlayStation, you won't need a separate CD player; both games machines also play audio CDs.) Two RF inputs allow dual connection of the TV antenna/cable; no separate switcher box is needed to select sources. A headphone jack is found on the front panel.

The set's swinging-door speaker design precludes front-panel A/V inputs—the doors couldn't close with anything plugged in. Front-panel placement of those inputs—and perhaps a few more of them—would facilitate switching input sources. We imagine that with the *GXTV* at the heart of their room-entertainment centers, today's electronics-laden kids would tend to be plugging and unplugging devices frequently as they switched from CD to radio to videogame to videotape. The swivel base, however, makes it fairly easy to reach the rear panel.

The front-panel indicators and controls are found below the screen. They include LEDs that light when the subwoofer and surround preset functions are in use, the remote-control sensor, and a sensibly thorough assortment of controls. Besides POWER, VOLUME, and CHANNEL buttons,

Samsung wisely included a MENU button. It can be used to call up the set's on-screen menus—without resorting to the remote control. When in menu mode, the volume and channel controls are used to move through the menus and select features and functions. Finally, there's a button labeled GX MODE, which, when pushed, automatically turns the set on and puts it into videogame mode.

A second GX MODE button can be found on the remote control. The backlit remote offers the usual (numeric keypad, power, volume up and down, channel up and down, mute, input select, menu, channel scan, and previous channel) buttons, as well as a couple of controls that aren't standard fare. The P.STD and S.STD buttons are used to adjust the picture and sound, respectively, by selecting one of the factory preset modes or your own custom settings. And the SKIP TIMER button (a.k.a. "Remote Surf") lets you flip through other channels during a commercial break and return to the original channel just in time to see your show return, thanks to an on-screen countdown timer that you can set in 30 second intervals up to 5 minutes. At the end of the specified time, the TV automatically returns to the show you were watching.

Once you've got your game console plugged in and the speakers and screen angle positioned properly, using the *GXTV* is a piece of cake. The GX MODE button, found on both the front panel and the remote control, automatically powers up the set and switches its input to Video 1. Turn on your game, and you're ready to play.

In game-playing mode, the *GXTV* offers you a choice of three different video settings—game, custom, and standard—

(Continued on page 34)

Listening to the World

ICF-SW1000T SHORTWAVE RECEIVER. Manufactured by Sony Corporation of America, One Sony Drive, Park Ridge, NJ, 07656; Tel. 800-222-SONY; Web: <http://www.sony.com>. Price: \$699.

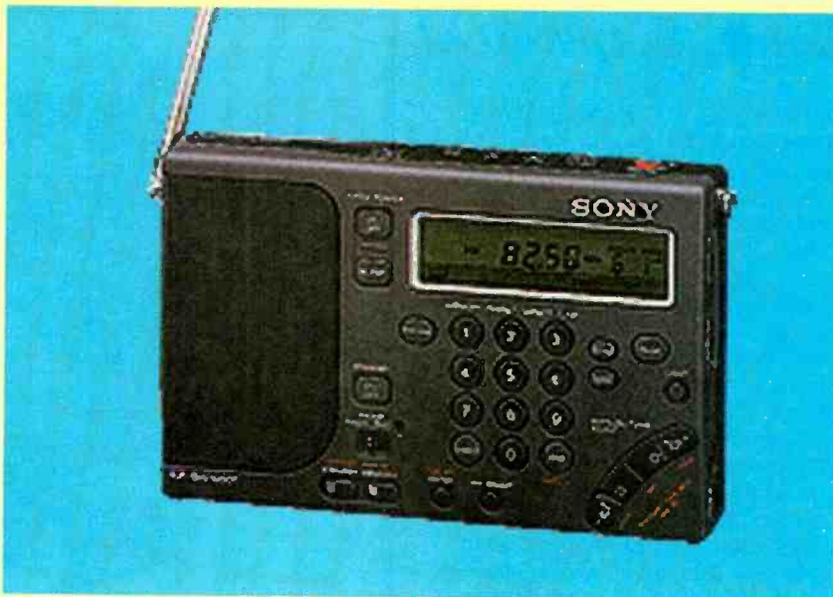
We doubt that anyone will ever make a perfect radio receiver. We doubt, in fact, whether such a thing actually exists—a perfect radio receiver, or anything else that's truly perfect. There's a reason that those old adages, "You can't please all of the people all of the time" and "You can't be all things to all people," have been passed down through the generations.

Sony's *ICF-SW1000T*, however, comes close. It will surely please a lot of people most of the time. And it has something for just about everyone.

Ham-radio operators will like it—though they probably won't use it when making contacts, or QSOs. Shortwave listeners will love it—even though they might have a dedicated, desktop receiver that they prefer for catching the toughest DX stations. Travelers will want to take it along—even though they might have more miniaturized receivers available to them. Rush Limbaugh listeners will love it, as will listeners to NPR's "All Things Considered." Even casual listeners will come to appreciate the *ICF-SW1000T*, which can open up a whole new world of radio for them.

Why should the *ICF-SW1000T* be a favorite of so many people? It's not only a general-coverage receiver—although its coverage does start at 150 kHz (below the AM broadcast band) and extend up to 30 MHz. It also covers the FM band; in fact, its FM coverage starts at 76 MHz, the bottom of Japan's FM band. It's portable, measuring just $7 \times 4\frac{1}{2} \times 1\frac{3}{8}$ inches. And it is also a cassette recorder; it just happens to be the smallest combination shortwave receiver and recorder on the market.

The recorder is a great feature for shortwave listeners, who can use it to verify reception or to study recordings to try to pick up things they missed the first time around. But it's an even better feature for any average everyday radio lover. Not only does the *ICF-SW1000T* let you record radio reception in real-time, but it can also time-shift programs. So for example, if you can't stay up late enough to catch a favorite late-night radio show, just tell the *ICF-SW1000T* to record it. TV watchers have become accustomed to such convenience, but radio listeners have had to forego it as consumer-electronics manufacturers took clocks out of receivers, and timer settings out of cassette decks.



The *ICF-SW1000T* has two timer settings, so that you can record two different shows. The tape deck is auto-reversing, so you should be able to record up to 90 minutes of programming unattended.

As you'd expect on a receiver with such wide coverage, there are several ways to tune the *ICF-SW1000T*. One way is to enter the desired frequency directly on the keyboard. For example, to tune to 9,630 kHz, you could press **DIRECT-9-6-3-0-EXE**. Alternatively, you could use the tuning buttons.

The receiver has a diagonal row of four tuning buttons on the right side of the keyboard. They work differently in each of the receiver's several operating modes. In shortwave mode, the outer two buttons allow the frequency to be increased or decreased in relatively coarse 5-kHz increments, while the inner two buttons allow tuning in 1-kHz increments. On the AM band, the outer buttons provide 10-kHz tuning steps, and the inner ones tune in 1-kHz increments. (Because the spacing of AM stations in much of the world is 9 kHz, it is also possible to configure the *ICF-SW1000T* in 9-kHz increments.) Finally, in the SSB receiving mode, the outer buttons are used to tune in 1-kHz and the inner buttons provide 0.1-kHz increments. However, the display cannot show the 0.1-kHz steps.

The tuning buttons can also be used to switch the *ICF-SW1000T* between shortwave bands. When the **AM BAND** button is held down, the outer tuning buttons become band-changing controls. So, to tune to the same 9,630-kHz frequency of our previous example, you would first tune to the 31-meter band and then use the outer tuning buttons to reach the frequency.

Unfortunately, when tuning from one band to another, the display doesn't give any indication of what band you are tuned

to. So, for example, when you tune to the 31-meter band, you see the frequency of the lower band edge, but there's no indication on the display that you're in the 31-meter international broadcast band. That shouldn't be a problem for experienced listeners, but it might be frustrating for newcomers.

The receiver enters its scan mode when either of the outer tuning buttons is held down for about two seconds. The receiver will scan in either direction until a station is detected. Then it will stop for about three seconds. Scanning will continue unless one of the tuning buttons is pressed. When the top of a band is reached, the scanning will resume at the bottom of the band.

One of the high-tech features that makes the *ICF-SW1000T* special is a synchronous detector. Signal fading is a big problem in shortwave reception. Synchronous detection reduces the problem by replacing the carrier of the received signal with a perfectly synchronized, stable carrier generated by the receiver itself.

Another problem that plagues shortwave reception is interference from adjacent stations. However, the synchronous detector circuit locks onto only the upper or lower sideband (USB or LSB) of the station. So if the frequency of an interfering adjacent station is higher in frequency, you would want to lock on to the lower sideband. Conversely, if the interfering station was lower in frequency, you would want to lock on to the higher sideband.

The receiver's USB and LSB/CW modes allow single sideband and continuous-wave (Morse code) signals to be received. Single sideband and CW transmissions are commonly used by amateur radio operators (hams).

The *ICF-SW1000T*'s tiny front-panel

(Continued on page 34)

Organizer Fit for a King

ROYAL FLASHLINK 95 (FL95) PC ORGANIZER. Manufactured by Olivetti Office USA, Royal Consumer Business Products, 765 U.S. Highway 202N, Bridgewater, NJ 08807-0945; Tel. 908-526-8200. Suggested retail price: \$44.95.

New Year's Day has come and gone—how are your resolutions holding up? Have you knocked off a few pounds yet? Still walking a few miles each morning? Putting 10% of your take-home pay into savings? Called your parents at least once a week (without asking for money)? Finished cleaning the basement or garage or attic?

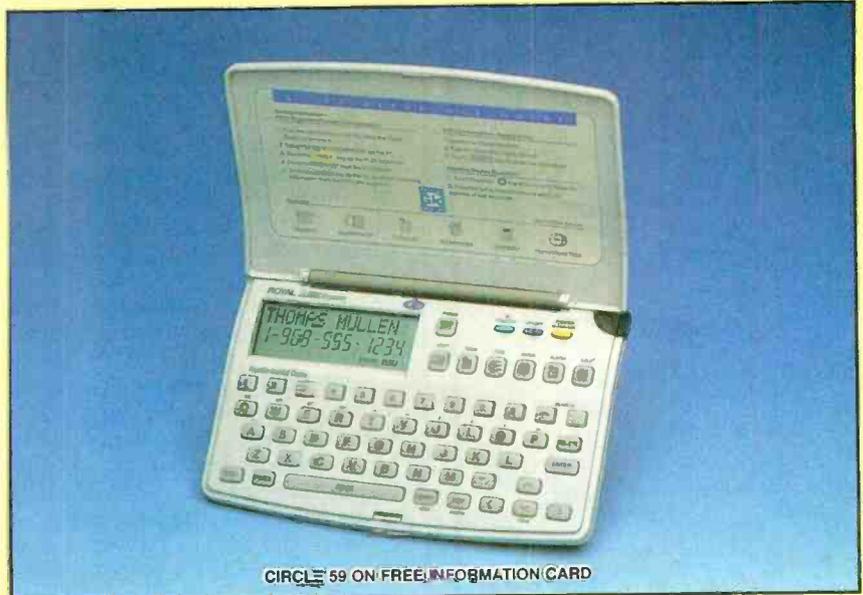
And—this one's a perennial favorite—are you organized yet? Have you cleaned out your Rolodex? Updated your address book using the return addresses on all the Christmas cards you received a couple of months ago? Come up with a way to remember your appointments, birthdays, and your anniversary?

If you're anything like us, your intentions were good, but somehow your business-card collection is still jumbled in a desk drawer, and you never even got around to sending out Christmas cards, let alone save all the envelopes from the ones you received. There are three whole pages in our address book devoted to a family member who refuses to stay put—in either a home or a job. But we can chronicle his last dozen or so addresses, jobs, home, business, and fax numbers, and even the names of some of his (also usually transitory) girl friends, just by glancing at the entries crossed out in our book. It's an interesting, but highly inefficient system.

We've sought out electronic help by purchasing pocket organizers. In the spirit of keeping resolutions, we began transferring the names and addresses and phone numbers from our business-card collections and address books into the organizer, typing on a tiny, cramped keypad. We've never made it past "C."

This time, however, we have high hopes. We also have the *Royal FL95 PC Organizer*. The pocket-sized device has one of those midget keypads—but we don't have to use it. That's because the FL95 also has the Timex Data Link, which lets us enter data on our standard PC keyboard, and then download it to the organizer.

The Timex Data Link system was developed for the Timex Data Link Watch, a wrist watch that doubles as a personal information manager (PIM). The technology transmits data from a computer to another device by flashing lines on the monitor.



Timex Data Link software is included with the organizer. It works with Windows 3.1 or Windows 95, and provides basic functions for keeping track of names, addresses, phone numbers, appointments, anniversaries, and miscellaneous lists. When you are ready to send the data to the FL95, you simply click on the on-screen "Send to Device" button, and point the organizer at the screen.

The Data Link software is adequate for getting the information into the organizer, but the last thing we would want to do is give up using our current PIM. Fortunately, we don't have to, because our current PIM of choice is Microsoft's Schedule +.

Schedule + supports the Timex Data Link system. In fact, if you're a Schedule + user and you're curious to see what the flashing on-screen bars look like when data is being transferred, just click on the Data Link button on the Schedule + tool bar.

The FL95 has an 8K memory, which is enough to store over 400 entries. The display is a two-line by 12-character LCD, which has a pleasant blue "RoyalGlo" backlight. Its keyboard is small, and not quite touch-typeable, but it is adequate for inputting occasional entries when you're away from your PC.

In addition to the organizer functions, the FL95 acts as a 10-digit calculator, and includes metric conversion functions. Password protection is also provided to keep any confidential entries secure.

We have never been big fans of personal organizers—they always proved to be too hard to keep up to date, and transferring data from our PC always seemed to be a big headache. Royal's FL95, however, has proven its worth to us. Thanks to the Timex Data Link system, and its compatibility

with Microsoft's Schedule +, we have been able to integrate the product into our routine without having to treat it like it's a chore.

Will the FL95 finally make us organized? After losing the organizer under a pile of books and papers for a couple of days—we found it only after an appointment alarm started beeping—we've sadly come to the conclusion that no amount of electronics can help with that. But—assuming that we can find it when we're packing—we now have a single, highly portable place to keep our travel itinerary, appointment schedule, and important phone numbers when we go to conferences or trade shows. ■

POWER PLAY

(Continued from page 28)

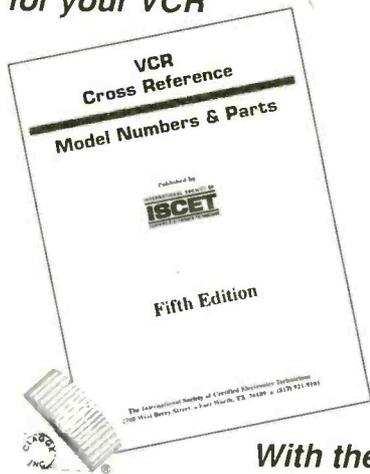
graphics are excellent, the controls are easy to handle, movements are quick and accurate.

The PlayStation's "three-dimensionality" was not quite up to Nintendo 64 standards, however. While a marked improvement over "flat" 16-bit games, you didn't get the same sense of falling into another world that was afforded by Super Mario 64. On the plus side, however, with at least 150 titles to be available for the 1996 holiday season, you won't get bored anywhere in the near future.

Read on for an in-depth look at the game we spent much more time playing than we should have—Crash Bandicoot—and some capsule reviews of several more new titles for the Sony PlayStation. All of the games reviewed are available from Sony Computer Entertainment America at suggested retail prices ranging from about \$50–\$60. ■

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ADVENTURE DOWN UNDER

(Continued from page 28)

The PlayStation's standard controller, however, doesn't provide the same range of movement as Nintendo 64's, with its analog joystick. The only way to regulate Crash's speed is to tap the forward button, as opposed to holding it down. (The optional PlayStation joystick, which does provide 360° movement, will set you back about \$60.)

While Crash can move to either side of the screen, the primary action is straight down the middle. The game play remains linear, despite some 3D effects. At times he can circle around objects or adversaries, but Crash's perspective never changes. And you don't get the 360-degree views that make "Super Mario 64" so super.

You do, however, get a challenging game requiring ever increasing levels of skill on your part. We found ourselves playing for hours on end, and didn't come near completing the more than 30 levels of game play on the disc. And Tawna (who, by the way, looks much more like a Barbie Doll than a bandicoot) is still waiting for Crash to come save her. Oh well, maybe one of these days.

Has Sony found its Sonic? It just might have! ■

GAME SET WATCH

(Continued from page 31)

and two audio settings—game and custom. The video settings change the intensity, brightness, and light levels of the image. The audio settings change equalization. The on-screen menu system can be used to create custom audio and video settings to suit your tastes.

In TV mode, there are even more audio and video settings to choose from. Preset audio modes include standard, music, movies, speech, and custom (set your own bass, treble, and balance). Preset video modes are standard, sports, movies, mild, and custom, which lets you adjust contrast, brightness, sharpness, color, and tint.

We set the GXTV up in our home office—which, sad to say, resembles a teenager's room. It's filled with books and boxes, tapes and CDs, joysticks, computer gear, magazines—everything but empty pizza boxes and soda cans (we had to draw the line somewhere). With not a single empty desktop, we ended up placing the GXTV on top of a computer monitor box on the floor. Then we sat ourselves down cross-legged in front of it—if you have

teenagers in the family, you know the position—and proceeded to play Super Mario 64 for a few hours.

We were glad to learn that the GXTV features a low-emissions CRT; its X-radiation of 0.01 mR/H is significantly lower than most 13-inch TVs, making close-up viewing safer. We were also happy to hear that the CRT resists image burn-in, which can be caused by leaving a game in the pause mode for an extended period of time.

The tilt stand allowed us to slant the TV down for a comfortable angle of view. It was easy to swing the speakers to the proper angle for our listening position. We could easily picture our teenaged selves parked on the floor, talking on the phone, thumbing through magazines, watching music videos. And we could easily have stayed there, making Mario run, jump, climb, and swim, for the whole night—if only our not-quite-middle-aged selves didn't get so stiff after a couple of hours on the floor! ■

LISTENING TO THE WORLD

(Continued from page 32)

speaker is surprisingly adequate for much listening. FM stereo broadcasts are received in stereo through the headphone jack. The audio quality is pleasant enough for casual listening. It is, however, lacking in bass output. No tone controls are available for FM broadcasts, but a NEWS/MUSIC tone control is provided for the radio's AM reception.

The built-in telescopic whip antenna performs well for casual listening, as does the built-in loopstick antenna for AM-band and long-wave reception. For better results on the shortwave bands, a clip-on antenna is provided with the receiver, so you can string it across the room and greatly increase the power of the receiver. When you're finished listening, the antenna winds up into a compact case. An external antenna jack is also provided. However, the jack is primarily intended to be used with a compatible active antenna—3 volts for powering the active antenna is always present on the jack.

Power for the receiver portion is provided by two AA batteries. A separate AA battery provides power for the cassette deck. An optional wall-mount adapter is available as well.

The ICF-SW-1000T is a very good shortwave receiver and a very good cassette recorder, crammed into a rather small package. Its main problem is that it's somewhat expensive. Otherwise, it has something for everyone—and a lot for anyone who really loves radio. ■

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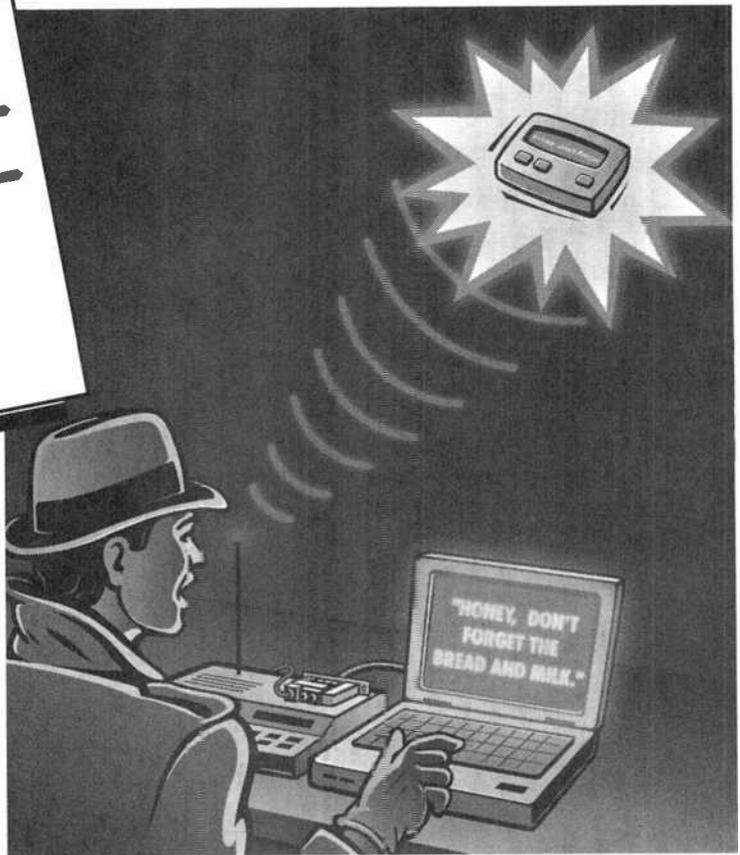
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BUILD AN ALPHANUMERIC PAGER DECODER

Catch beeper messages from the airwaves with this device and view them on your computer screen.

BY ALAN D. JONES



Digital pagers, or beepers as they're commonly called, have become exceedingly popular in the past decade. Pagers of all kinds are clipped to the belts of millions of people today, and it's quite likely that one of those people is you.

A signal intended for a digital pager consists, among other things, of an individual pager address followed by the message to be displayed on the pager. Note that the word "digital" here refers to any pager that receives binary data, including both numeric (digits only) and alphanumeric (full text) pagers. The majority of messages in a broadcast will be simple telephone numbers or digit codes, but people with alphanumeric pagers are increasingly making use of detailed text messages, often of considerable length.

But how do you know if the messages being transmitted are being received correctly? There's no backup message generated by paging services, and you therefore have no way of determining if you're getting the whole message. What's needed is a way of getting a second look at a message.

The *Alphanumeric Pager Decoder*

described in this article, together with a scanner radio and a PC, will permit you to decode the messages that are transmitted to about 80 or 90 percent of beepers that are commercially available, and view them on your computer screen. You could, for example, keep a log on disk of all messages transmitted to your own pager and verify that all were received by the beeper. Also, corporations could keep time-stamped logs of all messages sent to their in-house pagers.

Units like the Decoder are quite effective, and for this reason are even used by law-enforcement agencies. With such high-tech help, the good guys in blue can keep tabs on the dealings of known nefarious characters.

How Pages are Transmitted.

Paging channels can be found scattered around the VHF (152 MHz) and UHF (454 MHz) bands. In most metropolitan areas, a large number of paging channels can be found within the dedicated paging band from 929 to 932 MHz. To discover the frequency used by a specific paging service, just look at one of their pagers. There will almost always be a sticker indicating

the reception frequency.

Pager signals of the type we are interested in here are modulated by the "direct FSK" method. This means that the RF carrier is switched between center frequency +4.5 kHz and center frequency -4.5 kHz, to represent binary "1" and "0," respectively. Bit rates currently range from 300 to 2400 bits per second.

The most commonly used data format is POCSAG (Post Office Code Standard Advisory Group). This coding standard was devised in a series of meetings of industry representatives hosted by British Telecom in 1978 and 1980. POCSAG is a 32-bits-per-word synchronous error-correcting code using a 17-word frame. It is broadcast at 512, 1200, and 2400 bits per second. On most paging channels you will hear the signal switching rapidly between different bit rates as various pagers are addressed. To learn to recognize POCSAG by its distinctive sound, just use the search mode on your scanner in the 929- to 932-MHz range. About 90 percent of the signals you hear will be POCSAG at one of the three standard bit rates (see the "POCSAG Messages" box for more information).

providing the desired output. Because of the audio filtering, you can normally decode 1200-bps and lower transmissions, but it's pretty hopeless to extract useful data at 2400 bps without a direct discriminator output.

Just because you have an accurately reconstructed binary data stream doesn't mean that the problem of interpreting pager signals is solved. We could try level-translating the signal to RS-232 voltages and feeding it into a serial port, but the following must be considered: (1) bit rates may change unexpectedly, and (2) POCSAG is a 32-bit synchronous format that is incompatible with the data input mechanism of the type of UART that is normally used in PCs.

There is some temptation to solve both of these difficulties by feeding the signal to a "handshake" line of the serial port (instead of the normal data line) and using highly timing-intensive software to measure individual bit transitions in order to determine the current bit rate and extract the correctly synchronized data words. In fact, there exist products on the market that do exactly this, and the ingenuity that must have been required to write such software is something to be admired. The disadvantage of this approach is that the software running on the PC must perform timing tasks at the sub-millisecond level in a way that essentially prohibits operation under multitasking operating systems such as Microsoft Windows. Such programs tend to run under MS-DOS only and must "own" all the CPU time in order to function correctly.

The Decoder overcomes this disadvantage by adding one more processing step between the reconstructed data stream and the PC serial port. A Microchip PIC16C54 microprocessor is used to reformat the data into a form that is acceptable to a standard PC UART. In order to retain the versatility and general applicability of this device for future applications in decoding other digital data stream formats, the embedded software for the PIC CPU operates simply as a constant-rate sampler, continuously taking samples of the state of the data stream at approximately 9600 samples per second. Each time a group of eight samples has been accumulated, the group is transmitted to the PC serial port as a conven-

tional asynchronous byte, including start and stop bits, at 19,200 bps. This amounts to four samples per bit at a 2400-bps incoming data rate (more for lower rates), which is adequate for purposes of software-based bit synchronization.

The work of determining the data rate and subsequently converting the data to a usable one-bit-per-data-bit stored format is still handled by the PC itself. The advantage of this method is that, since data is received by the PC serial port in the standard way, the usual operating-system-supplied serial port device drivers can be used to receive and initially buffer the data. This buffer can be occasionally read and analyzed by an application program that, because of the buffering in the device driver, can easily run in a multitasking environment.

The writing of PC software to bit-

sync, word-sync, error-correct, decode, and display the data stream from this device would be a project of greater magnitude than the physical construction itself. However, a program that performs these functions under either Microsoft Windows 3.1 or Microsoft Windows 95 is available at no charge via the Internet at <http://www.cylexinc.com/download.htm> or from <ftp.gernsback.com>. This program decodes POCSAG at all three standard rates; if you need to decode another coding format, you will need to write your own software for now. Note that any program accepting data from this device must be capable of accommodating a never-ending stream of 19200-baud data and performing a fair amount of computation on that data at real-time speeds. It is necessary to use a reasonably fast PC to run such a pro-

PARTS LIST FOR THE ALPHANUMERIC PAGER DECODER

SEMICONDUCTORS

IC1—PIC16C54 preprogrammed microcontroller, integrated circuit
IC2—LF444CN quad low-power op-amp, integrated circuit
IC3—LP2950CZ low drop-out 5-volt regulator, integrated circuit
Q1—2N3906 general-purpose PNP silicon transistor
Q2, Q3—2N3904 general-purpose NPN silicon transistor
D1—D6—1N4148 general-purpose silicon diode
LED1—Light-emitting diode, 3-mm diameter, red

RESISTORS

(All resistors are 1/8-watt, 5% units.)
R1, R2, R5, R7, R8—47,000-ohm
R3, R11, R12, R18—10,000-ohm
R4, R15—200,000-ohm
R6, R17—2200-ohm
R9, R13—470,000-ohm
R10—4700-ohm
R14—68,000-ohm
R16, R20—100,000-ohm
R19—100-ohm

CAPACITORS

C1, C2—15-pF, ceramic-disc
C3—0.022- μ F, Mylar
C4, C6, C8—1- μ F, 16-WVDC, tantalum
C5, C10—0.001- μ F, ceramic-disc
C7—47-pF, ceramic-disc
C9—1- μ F, nonpolarized Mylar (see text)

ADDITIONAL PARTS AND MATERIALS

XTAL1—4-MHz crystal in HC-49/US package
J1, J2—3.5-mm mono phono jack
SO1—DB-25 female connector with solder-cup terminals
H1, H2—Two-pin header (right-angle break-off pin strip, 0.1-inch spacing)
Printed-circuit materials, DB-25 connector hood designed to accommodate a DB-25 at both ends, jumper shunts (0.1-inch spacing) to fit H1 and H2, cable with a 3.5-mm plug on each end, wire, solder, hardware, etc.

Note: The following items are available from Cylex Inc. (2501 Afton Court, League City, TX 77573-3438; Tel. 800-356-7047; Fax: 713-332-4730): double-sided etched and drilled PC board with matching plastic case—\$25.00; kit of parts including pre-programmed PIC16C54 (no board or case)—\$35.00; pre-programmed PIC16C54 only—\$11.00. When ordering by mail add \$5.00 shipping and handling to all orders. Texas residents please add an additional 7.25% sales tax. Visa, MasterCard, American Express, and Discover cards will be accepted. A floppy disk containing the AccuPage Radio Monitor program will be included free of charge with all orders.

gram; we recommend a 33 MHz 486 as a minimum.

Circuit Description. The schematic for the Decoder is shown in Fig. 1. Basically, the circuit consists of four blocks: the power supply, input-signal processing, Schmitt trigger, and digital sampler/UART. All necessary power is drawn from the handshake lines of the serial port itself. The request-to-send line (pin 4 of SO1) provides negative voltage and the data-terminal-ready line (pin 20 of SO1) provides positive voltage (software must set these outputs appropriately). Regulator IC3 creates a 5-volt logic supply for microcontroller IC1. The RTS line (negative supply) doubles as a reset control for IC1 when it is set momentarily positive, while the data-output line from the PC serves as a separate negative supply to produce the necessary voltage swing to drive the PC's data input at RS-232 levels.

Resistor R19 is a simulated speaker load for the scanner if needed. Components R18 and C10 form a lowpass filter to remove the 455-kHz IF components (and harmonics) that are often present at discriminator outputs. Both

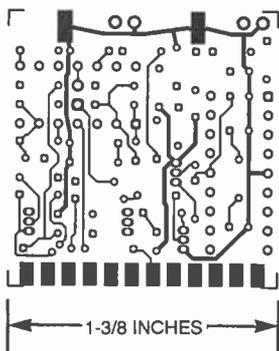


Fig. 2. This is the solder side of the Decoder circuit board.

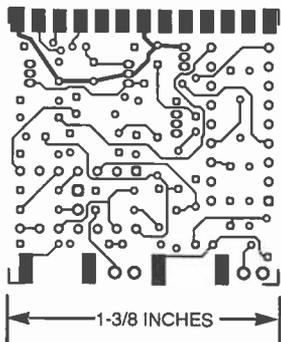
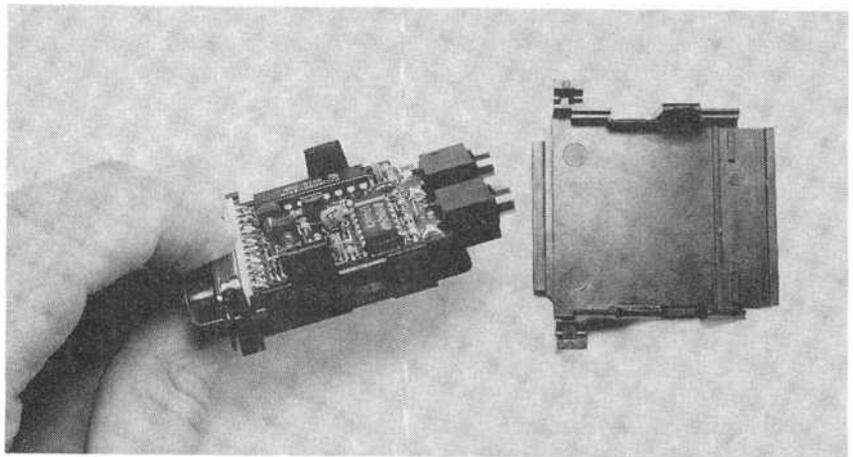


Fig. 3. Here's the component side of the board.



A properly assembled Decoder PC board will fit inside a DB-25 connector hood.

C9 and R20 eliminate any undesired DC components that may exist in the scanner signal. One section of an LF444CN, IC2-a, is simply a buffer and gain block with two jumper-selectable gain settings; IC2-c buffers the signal to the auxiliary speaker output.

Section IC2-d and its associated feedback components form a Schmitt trigger with thresholds of approximately +0.1 and -0.1 volts. Capacitor C5, section IC2-b, and their associated resistors are set up to cause LED1 to flash on each negative transition of the Schmitt trigger output as an aid in setting the scanner output-level control. Transistor Q2 converts the rail-to-rail swing from IC2-d to logic levels for input to microcontroller IC1, a PIC16C54.

The PIC contains on-chip PROM that must be programmed with the small program whose source code and compiled hex file can be downloaded from the Cylex Internet site mentioned earlier, or the Gernsback FTR. Pre-programmed chips are also available from a source mentioned in the Parts List. This program is clock-rate sensitive and will not work unless a 4-MHz crystal is used.

Construction. Layout of the circuit is non-critical. For that reason, any reasonable breadboard assembly technique can be used to build the Decoder. The only precautions you'd have to follow are: (1) Be sure that crystal XTAL1 and its shunt capacitors C1 and C2 are close to microcontroller IC1 with short lead lengths, and (2) Keep C8 close to IC3, and C3 close to IC1. However, when it comes to size, building the circuit on a bread-

board is not desirable.

For the most compact assembly, you might want to build the circuit in the fashion the prototype was assembled—on a double-sided printed-circuit board. That way, the entire circuit will fit inside a plastic DB-25 connector shell. If you'd like to etch your own double-sided PC board, you can use the solder- and component-side foil patterns shown in Figs. 2 and 3, respectively. Or, you can order a drilled and etched board from the source mentioned in the Parts List.

If you build the Decoder on the circuit board, use the parts-placement diagram shown in Fig. 4 as a guide. Be careful about the sequence in which you install the parts. Note that some of the discrete components in Fig. 4 are shown made up of dashed lines. Those mount on the solder side of the board directly under ICs. Solder those parts in place and clip their leads before you install ICs. Do not use sockets under the ICs if you plan to enclose the circuit in the plastic shell; there is simply not enough room.

It is also important to solder all TO-92 parts (Q1, Q2, Q3, and IC3) with their plastic cases all the way down to the board, again because of the shortage of room. Jacks J1 and J2 and SO1 go against the edge of the board and some of their pins solder to each side. Be sure that SO1 is perfectly straight against the board edge or the connector shell will not fit. The LED should protrude through a hole in the connector shell drilled or punched to accommodate it. Also, make sure that C9 is small enough to fit in the space allowed on the board.

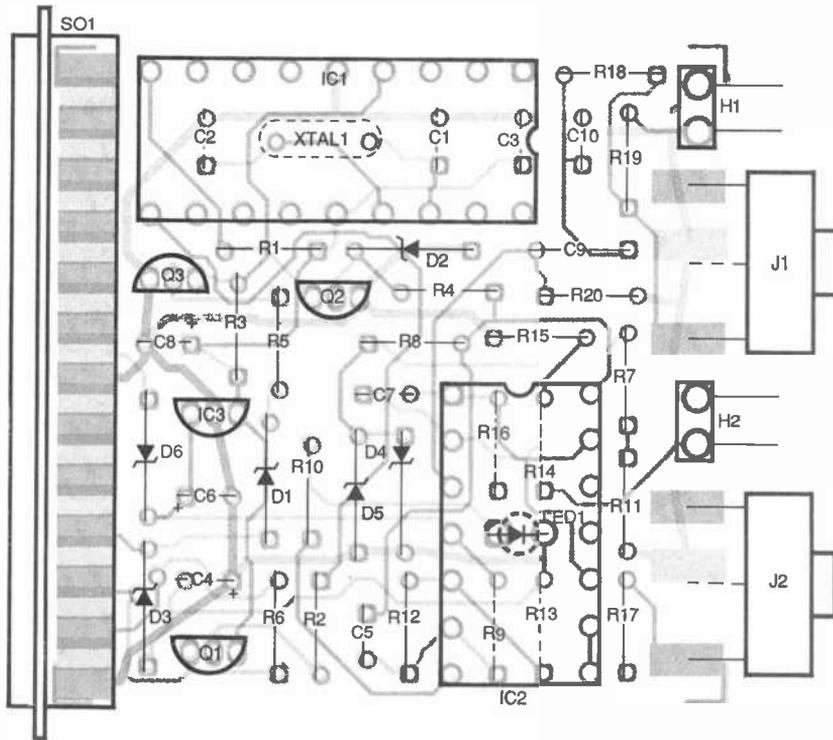


Fig. 4. Use this parts-placement diagram as a guide when assembling the Decoder on a PC board. Note that the parts drawn with dashed lines are mounted on the component side of the board.

Keeping all those assembly tips in mind, this is the recommended sequence to optimize putting together the circuit board: Solder the two 3.5-mm phono jacks to the board, centering them against the edge. The ground lug on each will need to be bent about 45 degrees in order to touch the pads on the board. Next mount the DB-25 connector to the board using only pins 1 and 13. Temporarily place the board into one side of the plastic shell. If things do not line up properly, reheat the solder joints and adjust the position of the connector. Then solder the remaining pins of the DB-25.

Using the plastic shell half containing the LED hole as a guide, install the LED on the solder side of the board. Be sure to get the polarity correct. We stress this because the installation of IC2 later will make desoldering of the LED difficult. Install C1, C2, C3, X1, R9, R13, R14, and R16 on the solder side of the board as well. Leave about 1 mm of extra lead length on C1-C3 and bend these parts down flat against the board in the direction away from the crystal.

Install all remaining parts on the component side of the board. Be sure that all parts, especially Q1-Q3, and

IC3, are flush against the board. Test the circuit before installing the plastic shell; the shell is difficult to take apart.

Checkout and Adjustment. To power up and test the circuit, it is necessary to have either the AccuPage Radio Monitor program for the PC (mentioned earlier) or a test program that sets the COM port as follows: RTS = 0, DTR = 0 for at least 0.1 sec, followed by RTS = 1, DTR = 0 indefinitely. This resets IC1, then configures the lines to provide power. Start with the device connected to the COM port but nothing connected to J1 or J2. Measure the voltage (relative to circuit ground) at IC1 pin 14 and IC2 pin 11; these should be +5 volts and -6 to -11 volts respectively. The LED should not be lit.

Next, tune your scanner to an active paging frequency. Use an appropriate cable to connect the output of the scanner to J1. If you are using the speaker/earphone output of the scanner, install a connecting pin to header H1; remove it if you are using a discriminator output (more on that later). Leave the pin on header H2 off; it is needed only in a small percentage of cases with discriminator outputs and almost never with speaker

outputs. If you are using a discriminator output, then the following paragraph referencing volume-control settings does not apply; you should be able to just plug and go. If the LED does not come on during transmissions, then install the pin on H2.

Set the volume control to its minimum position. Connect a small speaker or earphone to J2. Be sure that the COM port is set correctly and that you check the "Enable" checkbox near the top of the AccuPage Radio Monitor screen. Gradually increase the volume setting until the LED begins to glow continuously during transmissions; stop at this point. Do not change the volume between transmissions; you will just be turning the control with no reference. During a paging transmission, the apparent intensity of the LED should appear to waver in sync with the sound you hear, but it should not go out except between transmissions. (If you have an oscilloscope, connect one channel to pin 1 of IC2 and the other to pin 9 of IC1 to see how the circuit is interpreting the analog waveform.)

It is worth pausing here for a moment to emphasize the importance of clean reception on the scanner. Move or re-orient the antenna as necessary! The sound you hear should be as free as possible from hiss or crackling noises. The sensitivity and selectivity of a wideband receiver is often not as good as that of a single-frequency pager receiver, and getting good reception is subsequently more difficult.

Watch the "Signal" indicators near the top of the AccuPage Radio Monitor screen. The green to red ratio corresponds to the correct to errors ratio. The left indicator is the one to watch initially; the right indicator always starts at "100% bad" and represents a cumulative weighted average over the last several seconds of valid data. We are looking for the left indicator to show mostly green. White indicates no valid data at all. If the indicator remains white, and the LED glows as described, try toggling the "Inverted Data" checkbox. Every scanner is different and the output polarity of yours may be backwards from the program's convention.

If you just can't seem to get any indication on the signal indicator, try increasing the volume setting by tiny

incremental amounts, being sure to try both settings of "Inverted Data" at each position. Once the indicator shows some green, then keep adjusting the volume for best results (minimum red). If you are getting readings but are unable to reduce the "bad" (red) percentage to a small value, then approach from the other direction. Set the Inverted Data checkbox to its opposite setting (to trigger on the overshoot as described earlier) and increase the volume to a much higher setting. Then decrease the volume incrementally, searching for an optimum setting based on the Signal indicators.

The AccuPage Radio Monitor program by default logs and displays all messages that it decodes. If you would like to see only text messages, or to filter the messages so that only those for particular pagers are logged, select "File/Search List" from the menu bar. A typical paging service might easily transmit 100,000 pages per day, and the message log file generated by logging all of them will rapidly grow to a size of many megabytes.

Troubleshooting. The following are some of the most likely reasons why the device might not work properly:

- (1) Connector problems at the scanner output.
- (2) Wrong COM port set up in software.
- (3) "Inverted Data" setting is incorrect.
- (4) Computer is too slow (use a 486/33 or faster).
- (5) Weak or noisy radio reception.
- (6) Wrong settings for pins in H1 and H2.
- (7) The received signal is not direct FSK.
- (8) Wrong scanner demodulation mode (should be narrow FM).
- (9) The received signal is not POCSAG (there are other paging formats).
- (10) Soldering problems, wiring errors, damaged components, etc.

Obtaining Unfiltered Scanner Audio.

Every scanner is different, and it would be difficult to provide specific instructions for tapping into the unfiltered demodulator output for every type of scanner on the market (though we will give tips for one later on). Here are some general suggestions:

First of all, get a schematic of the scanner! Without this, you still might have success, but it's going to take an oscilloscope and a lot of patience.

Look for the audio amplifier circuit. This will usually consist of two or three stages of amplification, probably with a second-order lowpass filter and a second-order highpass filter somewhere in the chain. Try to obtain a take-off point at the beginning of the amplifier chain. The signal here will probably be only a few tenths of a volt, should look like square waves, and is likely to have a lot of 910 kHz superimposed on it (twice the lowest IF).

As an alternative (particularly if you

don't have a schematic), look for the FM demodulator. In many scanners, this is the popular Motorola MC3361 chip. If you find one of these in your scanner, then pin 9 is the unfiltered demodulator output. Depending on the external circuitry, it is possible that pin 11 is also a good place to get a signal. Use an oscilloscope if possible to select the "squarest-looking" signal.

In addition to the signal take-off point, you must of course also bring out the scanner's circuit ground.

Warning: In some handheld scanners we have examined, the "case" side of the external speaker jack is not grounded. Look on the circuit boards

(Continued on page 60)

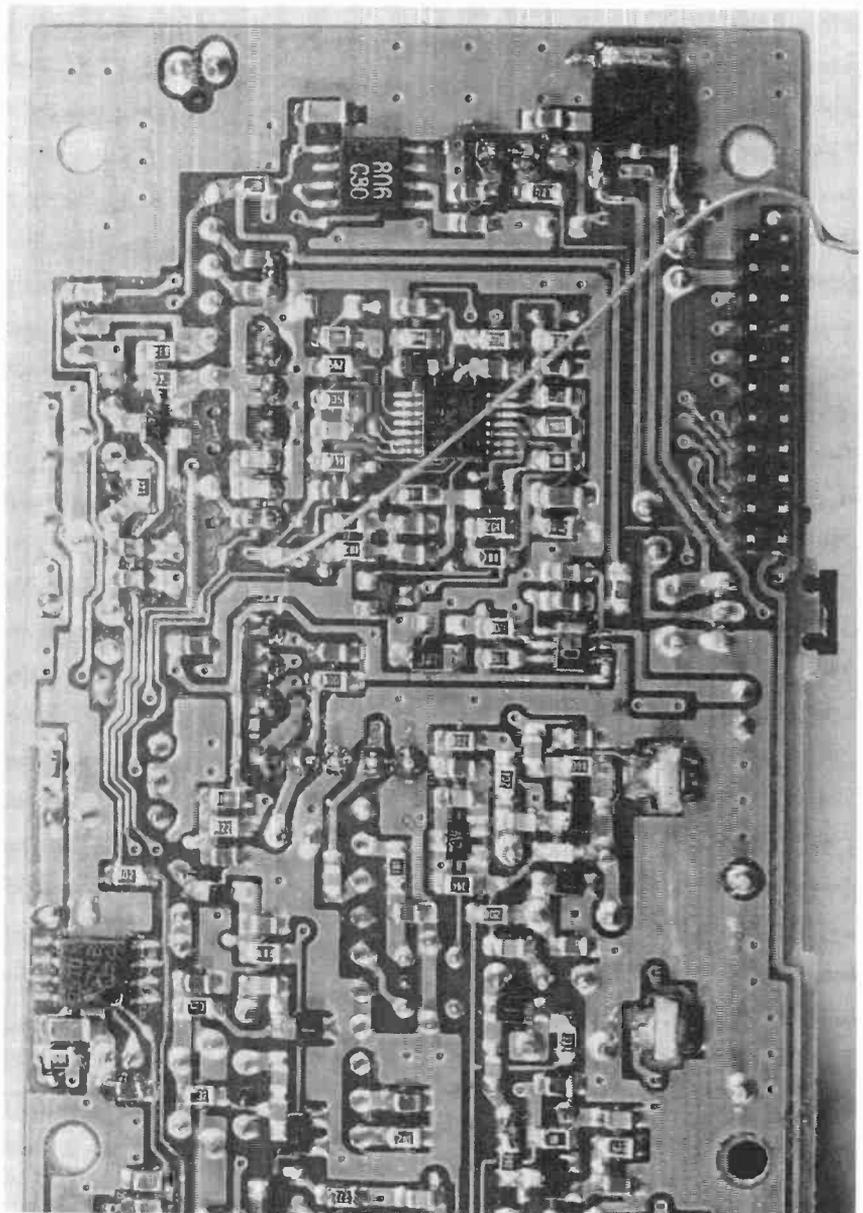
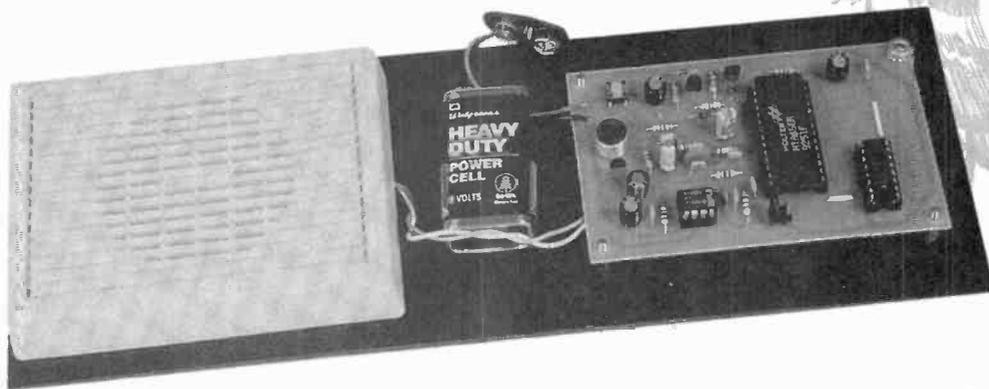


Fig. 5. Once the board from the Uniden SC-150 is removed (see text), use this photo as a guide to locating the signal-connection point for demodulator output.

Build an Electronic Parrot

Enjoy hours of entertainment with this digital little friend that realistically repeats whatever you say to it.



BY DAVID WILLIAMS

It must have been somewhat boring on the open seas a couple hundred years ago. For this reason, perhaps, you'll find that stereotyped pirates often had parrots on their shoulders. The idea is that they'd pass some time trying to get their birds to say things. Anyone who's done the same with a parrot or parakeet knows it could be quite funny when they finally speak.

Well, thanks to electronics, you can have a talking pet that *always* repeats what you say. The *Electronic Parrot* described in this article is a digital voice recorder with automatic playback. When the Electronic Parrot is powered up, it will listen for speech, record it, then automatically play it back.

The entire circuit runs on a 9-volt battery and it automatically shuts power off after two minutes of inactivity. It makes a great learning project for kids of all ages and will provide hours of fun and entertainment.

Circuit Description. Refer to the schematic of the electronic parrot as shown in Fig. 1. The circuit is based on a CMOS Large-Scale Integration (LSI) chip from Holtek Microelectronics Inc. The HT8656A (IC1) is a single-chip

voice recording/playback controller that uses an Adaptive Delta Modulation (ADM) algorithm to digitize sounds and store them in external DRAM. The chip internally generates the refresh signals required by the DRAM and can address either 64K or 256K of memory.

The ADM algorithm works by sampling the input signal and comparing the current audio level to the previously sampled level. A digital 1 or 0 is generated to represent a positive or negative signal change. The result is an encoded bit stream that represents how the audio signal is changing from instant to instant. On the HT8656A, the sampling rate is determined by an internal oscillator and can be set to either 16K or 32K bits per second. The 32K bit-rate allows 2 seconds of good quality recording capacity for the 64K DRAM and 8 seconds for the 256K DRAM. The 16K bit-rate doubles the recording times but sound quality is sacrificed. When the recorded signal is played back, it is clocked out of memory and through a 10-bit digital-to-analog converter (DAC) and then passes through a voltage follower.

The HT8656A has some unique control circuitry that makes it more than

just a digital voice recorder. The chip normally functions in an active "listening" mode. In this mode, recording starts whenever a sound input is detected. Recording continues until there is a 1/2 second of silence detected or the DRAM becomes full. At this point the HT8656A automatically switches to playback mode and repeats back whatever it heard.

The entire circuit runs from a single 9-volt battery, B1. Capacitors C1–C4 provide power filtering and bypassing. Components Q1, R1, and D2 form a voltage regulator that converts the 9-volt battery supply to a stable 5-volts for IC1 and IC2. Transistor Q2 is used to switch the 5-volt power on and off. Initially, Q2 is biased off by R2, but when S1 is pressed, Q2 switches on and IC1 receives power. The HT8656A then immediately pulls pin 17 to ground and keeps Q2 on via D1 and R3 after S1 has been released. In order to save the battery, IC1 automatically powers-off when no sound is detected after 2 minutes or when the play/record cycle has occurred 64 times. It does this by taking pin 17 high, and allowing Q2 to switch back off.

Components R5, R9, and C12 provide power filtering and bias voltage

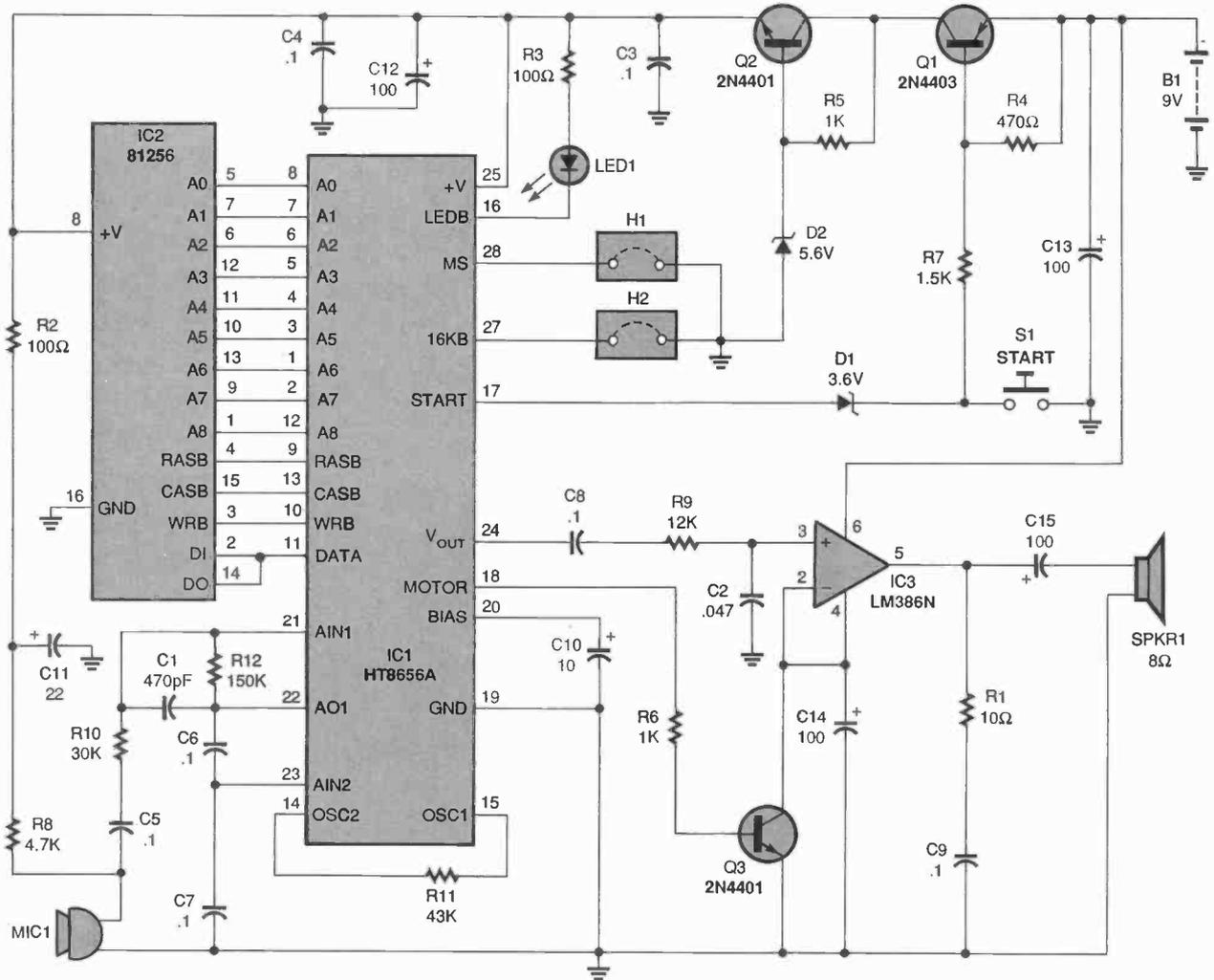


Fig. 1. Here's the schematic for the Electronic Parrot. The circuit is based around the HT8656A (IC1), which is a single-chip voice recording/playback controller.

for the electret microphone, MIC1. The microphone output signal is DC-coupled to the preamplifier input by C8, and resistors R7 and R8 set the preamp gain at 5. Resistor R8 sets the internal oscillator frequency of IC1 to 450 kHz and header H2 selects the sampling frequency as either 16KB/sec or 32KB/sec. Chip IC2 is either a 64K x 1-bit or 256K x 1-bit dynamic RAM chip. The appropriate address, refresh, and read/write signals for the DRAM are provided by IC1. Header H1 selects either the 64K or 256K memory size.

When IC1 is in playback mode, the audio signal appears at the V_{out} pin (24) and is DC coupled by C5 and filtered by R4 and C7. The audio is amplified by IC3, an LM386 amplifier, which then drives the 8-ohm speaker, SPKR1. Since IC3 is connected directly to the B1, IC1 shuts IC3 off via R10 and

Q3 to save power whenever the chip is in listening, recording, or power-

down mode. The light-emitting diode, LED1, is on

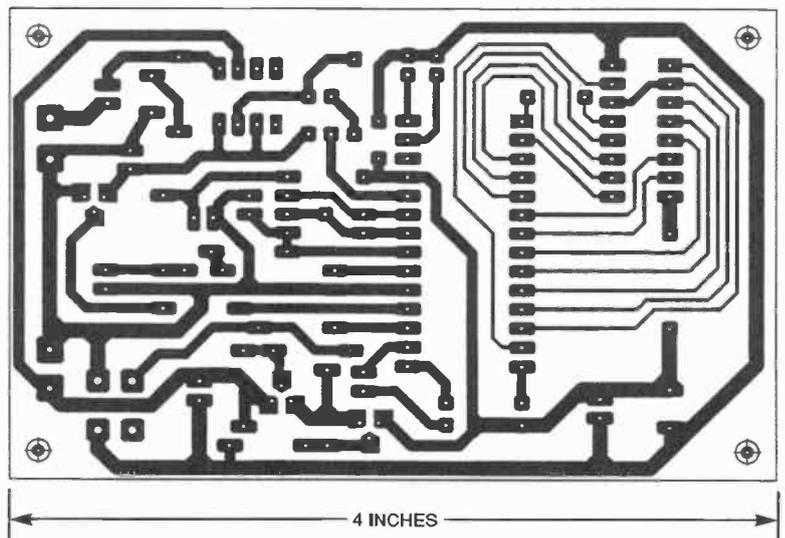


Fig. 2. If you'd like to build the Parrot on a PC board, use this foil pattern as a guide.

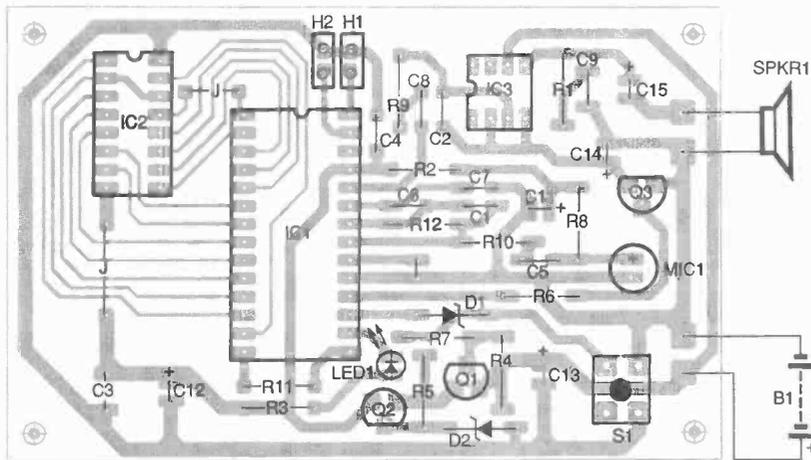


Fig. 3. This parts-placement guide should make assembly on a PC board easier.

whenever IC1 is in the "listening" mode. This LED will turn off during the record/playback cycle or upon power-down.

Construction. The easiest way to build the Electronic Parrot is to use a printed-circuit board, as was done in the author's prototype. If you'd like to

etch your own board, use the foil pattern shown in Fig. 2. Or, you can buy a pre-etched and drilled board from the source mentioned in the Parts List.

Locate all the components shown in the Parts List. If you're using a PC board, refer to the parts-placement diagram shown in Fig. 3 to make assembly easier. Begin by soldering two

pieces of solid wire to the board for the two jumpers. Next install and solder the two Zener diodes in place, noting their polarity. Then move on to the resistors and ceramic capacitors. Be sure to observe proper polarities when installing the electrolytic capacitors and transistors. It may be necessary to bend the leads of the transistors to fit the PC board.

A special note on transistor Q3: The 2N4401 specified in the Parts List can switch up to 600 mA of current for powering the LM386 amplifier. Other common NPN transistors such as the 2N3904 are rated at 200 mA and cannot be used in this circuit or IC3 will oscillate and give a distorted output.

Now solder sockets for IC1-IC3 to the board. If you use the switch specified in the parts list for S1, it can be soldered directly on the printed-circuit board as shown in Fig. 3. The electret microphone is polarized and will not work if installed backwards. Use very short wires to attach it as close to the PC board as possible.

Before continuing, clean the foil side of the PC board with alcohol or flux remover. Then wire the speaker and battery connector to the board as follows: Cut 2 pieces of 26-gauge wire about 4-inches long and strip 1/4 inch from each end. Solder a wire to each terminal of the speaker and then to the printed-circuit board. Next, attach the red and black wires from the battery connector to the PC board, observing the polarity shown in Fig. 3.

Now, locate the HT8656A integrated circuit (IC1). In addition to the source mentioned in the Parts list, the HT8656A IC is also available from Alltronics (2300 Zanker Rd, San Jose, CA 95131); please contact them for more information. Since IC1 is a CMOS device, it can be easily damaged by static electricity. Take proper anti-static precautions when handling the chip. Refer again to Fig. 3 before installing IC1 to make sure of the proper orientation of Pin 1, then press the IC firmly into the 28-pin socket. Repeat the procedure with IC2 and IC3.

Operation. If you are using the 81256 memory IC (256K) for IC2, install a shorting jumper block on header H1. Otherwise if you used a 4164 memory IC (64K) for IC2, then leave H1 open.

(Continued on page 51)

PARTS LIST FOR THE ELECTRONIC PARROT

SEMICONDUCTORS

IC1—HT8656A voice-recording/playback controller, integrated circuit
 IC2—81256 256K × 1 dynamic RAM, integrated circuit
 IC3—LM386N audio amplifier, integrated circuit
 Q1—2N4403 PNP transistor
 Q2, Q3—2N4401 NPN transistor
 D1—3.6-volt Zener diode
 D2—5.6-volt Zener diode
 LED1—Light-emitting diode, any color

RESISTORS

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

R1—10-ohm
 R2, R3—100-ohm
 R4—470-ohm
 R5, R6—1000-ohm
 R7—1500-ohm
 R8—4700-ohm
 R9—12,000-ohm
 R10—30,000-ohm
 R11—43,000-ohm
 R12—150,000-ohm

CAPACITORS

C1—470-pF, ceramic-disc
 C2—0.047-μF, ceramic-disc
 C3—C9—0.1-μF, monolithic
 C10—10-μF, 16-WVDC, electrolytic
 C11—22-μF, 16-WVDC, electrolytic
 C12—C15—100-μF, 16-WVDC,

electrolytic

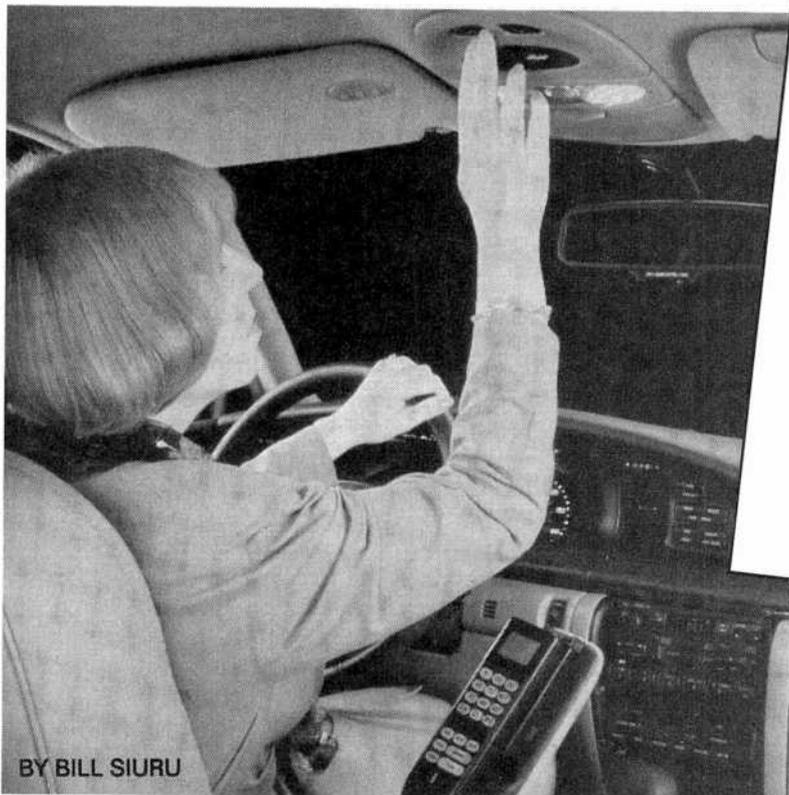
ADDITIONAL PARTS AND MATERIALS

MIC1—Electret microphone (Digi-Key #P9949-ND or equivalent)
 SPKR1—8-ohm speaker
 S1—Pushbutton switch (Digi-Key #SW403-ND or equivalent)
 H1, H2—2-pin header with shorting block
 B1—9-volt alkaline battery
 Printed-circuit materials, IC sockets, battery connector, 22-gauge twisted-pair wire, hook-up wire, solder, hardware, etc.

Note: The following are available from LNS Technologies (20993 Foothill Blvd, Suite 307R, Hayward, CA 94541-1511; Tel. 800-886-7150): complete kit of parts for the Electronic Parrot (PARROT-KIT) including etched and drilled printed-circuit board, speaker, battery holder, and all other components listed above—\$29.00; Parrot talking-back IC (ICHT8656A)—\$10.00; PC board (PARROT-PCB)—\$10.00. Please add \$5.00 shipping and handling. California residents please also add local sales tax. MasterCard/VISA orders are accepted. No C.O.D. orders.

Cars that can Call for HELP

Here's a look at how automotive electronics are helping save lives and thwart car theft.



BY BILL SIURU

Cellular phones are no longer just for the rich and famous. They can provide motorists peace of mind with instantaneous communications in case of an accident, breakdown, or medical emergency. Most cellular phone companies have special "for emergency only" services typically costing \$15 to \$25 monthly. Today, approximately 10% of the estimated 260,000 daily calls to 911 in the U.S. originate from cellular phones. The number is expected to grow dramatically, as tens of thousands of new cellular phones are installed in the U.S. daily.

Car phones and radio-frequency communications are the starting point for systems that can not only send out an "SOS," but which can also pinpoint the vehicle's precise location so help can be dispatched rapidly. Stolen cars can now be tracked so they can be recovered sometimes in a matter of minutes. Besides reaching the car before it becomes a victim of a chop shop, police can often catch the car thief in possession of the vehicle. Chop shops are common threats because most "professionally" stolen vehicles are taken for parts; individual parts are worth about three times a car's value if it is sold intact.

RESCU. Most 911 dispatchers agree that many times drivers reporting emergencies via cellular phones cannot provide their location. This is not surprising since calls are often made under the stress of an accident, breakdown, or other emergency. Indeed, the Federal Communications Commission (FCC) notes that the ability of emergency service personnel to respond is seriously hindered because cellular-phone callers to 911 do not always know their location.

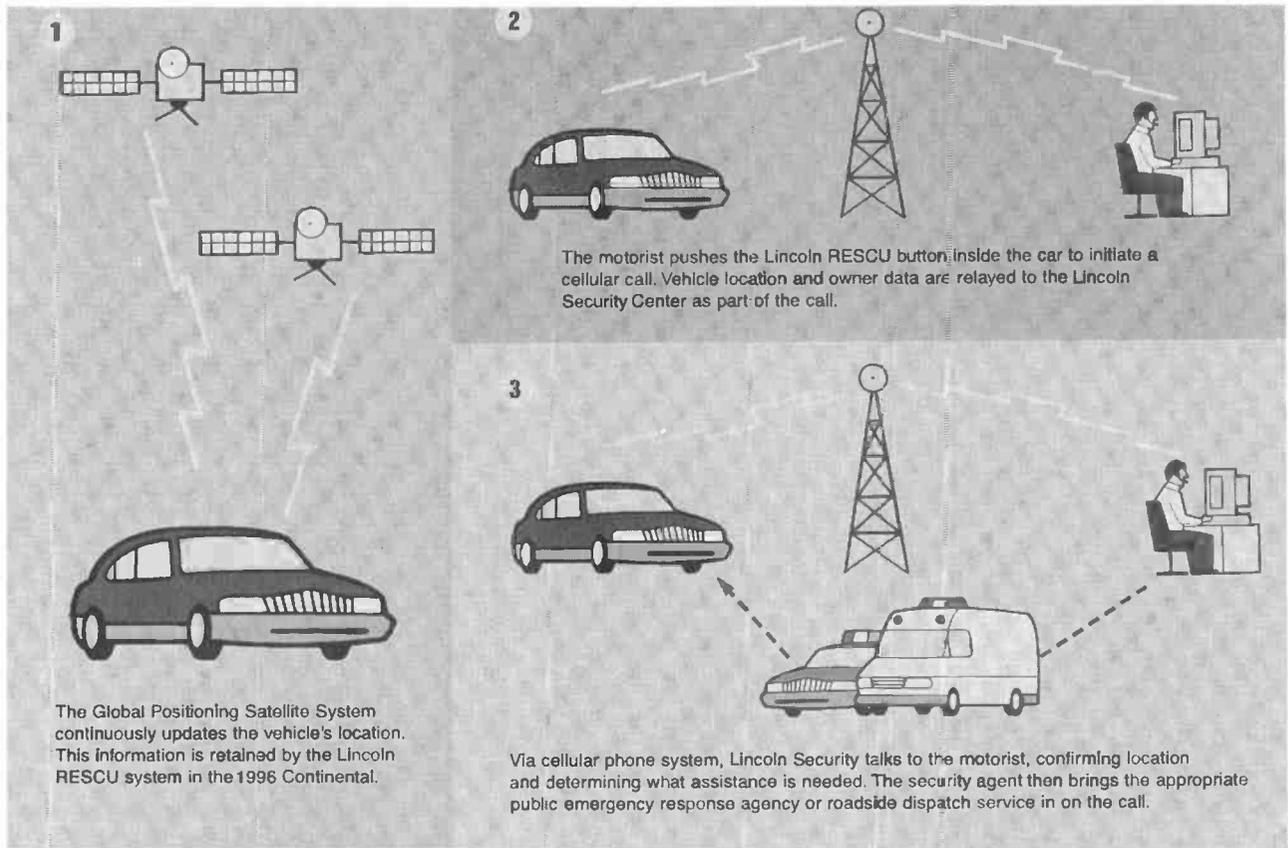
Ford's Remote Emergency Satellite Cellular Unit (RESCU) offered on the 1996 Lincoln Continentals solves this problem by tracking vehicle location and putting a driver a mere touch of a button away from roadside, medical, police, or fire-emergency assistance. RESCU is part of the optional Personal Security Package that also includes a voice-activated cellular telephone and Ford's JBL audio system.

RESCU uses a pair of buttons mounted in the Continental's overhead console, a Global Positioning System (GPS) receiver in the trunk, and a cellular telephone. One button is marked by a tow-truck symbol and the other has an ambulance icon. In either case, pressing the button results in the cellular phone automatically

dialing the Westinghouse Emergency Response Center in Irving, Texas. Westinghouse Security Systems currently handles an average of 25,000 residential and business alarms daily with response verification within an average of 20 seconds.

When the tow-truck button is activated, the operator at the center arranges for appropriate roadside assistance. If the ambulance button is pressed, the operator will contact the local 911 service to arrange police or medical assistance.

RESCU does a whole lot more than dialing the phone, which is something you could probably do yourself. This is the reason for the GPS receiver in the trunk. Using GPS's 24 geosynchronous orbit satellites in space, the vehicle's location can be pinpointed to within about 100 feet. Via the carbon-fiber antenna on the trunk lid (to avoid metallic interference with the signal), the system transmits data to the message center. This includes (1) type of alarm (emergency or roadside assistance), (2) vehicle identification number (VIN), (3) latitude and longitude from GPS, (4) the last recorded speed and direction of the vehicle, (5) a time-tag identifying when the last position was taken and (6) a call-back number.



This drawing shows the three basic steps that Ford's RESCU system uses to get help to motorists.

The system can maintain voice contact with the motorist until emergency help arrives. It can notify pre-designated family members or friends in case of an emergency. Alternatively, an estimated time of arrival of roadside assistance is provided and a call back later checks up to find out if the problem has been resolved. If there is no response from the vehicle telephone (just a press of the button) the Westinghouse dispatcher will dial the 911 number in the locality nearest the vehicle location. Local authorities knowing vehicle location and situation could then send help immediately.

Lincoln Continental owners with RESCU can register passwords with the Westinghouse Emergency Response Center when the car is purchased. With the password, the center can identify whether the call is made in error by the owner or the caller is a potential carjacker, indicated by an incorrect password. In the latter case, police are sent to the car's location.

Mobile Security Network. ADT Security Systems and Rockwell Automotive Electronics are developing a

competitive system to RESCU. This emergency response system does not require buying a new Lincoln Continental or even signing up for cellular-phone service. Instead, the system will be sold as an aftermarket item like a premium stereo system for installation in virtually any vehicle.

Rather than relying on cellular phone communications, the ADT/Rockwell system uses "packet data" communications technology. When any one of the three buttons on the device—which, for example, is mounted on the sun visor—are pressed, a distress signal is sent at the speed of light to an ADT Customer Monitoring Center (CMC). The data packet includes the vehicle's GPS coordinates, the nature of the emergency, and a description of the vehicle. There are three icons on the buttons to denote the type of assistance requested—a police badge, a white cross, and a tow truck.

There is also an optional pocket-sized key-ring activator to activate the system up to 100 feet away from their vehicle. Since a moving vehicle's location is transmitted every 20 seconds, police can use the system to

track and recover a stolen vehicle. Flashing lights on the display and an automated voice indicate that the message has been dispatched and help is on the way. If a tow truck is requested, the panel displays the estimated time to its arrival. A cancel button will reduce false alarms.

According to ADT Security Systems, their system can provide more reliable service compared to a cellular phone-based system. Besides instant communications, it is not prone to signal dropoff, interference, lack of coverage, or busy signals—the last thing you need during an emergency.

ADT Security Systems is the largest provider of security services in the U.S. offering continuous monitoring of security systems to over 1-million customers in North America and Europe, including 700,000 homeowners. As of August 1995, ADT coverage exists for more than 7000 cities and towns in the US and more are scheduled to come online over the next 18 months. Initially, the Mobile Security Network will be marketed to ADT's commercial customers and then will appear on the consumer electronics aftermarket.

LoJack. While there are several stolen-vehicle tracking systems available in many metropolitan areas where car thievery is most prevalent, the most popular by far is LoJack.

How LoJack works is demonstrated by the system in operation in Southern California. In Los Angeles County, a vehicle is stolen every 3.8 minutes. When a LoJack-equipped car is

stolen, the owner reports the theft to any law-enforcement agency in Los Angeles, Orange, or San Diego counties. Immediately, a code and VIN is entered into the California Department Of Justice Stolen Vehicle Recovery Network computer. In seconds, the computer determines if the car is equipped with LoJack. If the answer is yes, ten high-powered activation transmitters located throughout Southern California broadcast a unique coded radio signal. This signal automatically activates the LoJack transponder hidden in the vehicle so it starts transmitting a silent homing signal. Police cars and helicopters equipped with LoJack-tracking computers (this includes nearly 500 L.A. County squad cars) receive the signal that is used to track the vehicle until it is located and recovered.

Since its introduction in the early 1990s, LoJack has turned in an amazing 94% recovery rate in Southern California. Most recoveries happen within two to three hours, the record being a mere three minutes. In addition, the Southern California LoJack system has uncovered 45 auto theft rings and chop shops.

The Lojack system is installed in a vehicle for a one time cost of around \$600 and there are no further monthly fees. The LoJack transmitter is about the size of a chalkboard eraser so it can be hidden in about 30 different places in the vehicle. It has a backup battery so it works even if the main battery is disconnected. Upgrades to the system include a starter disabler and a conventional alarm system. LoJack is operating in over a half-dozen other states.

SatSting. S2RK Advanced Technologies in Canada is offering its SatSting Satellite-Based Vehicle Tracking System. Based on technology developed for police applications in Europe, stolen vehicles are tracked via an integrated GPS module in the vehicle. The SatSting unit has a built-in cellular-based communications module that calls and alerts monitoring stations if the car is stolen. The system can also be adapted to communicate via VHF or UHF radio frequencies. The unit is small enough so its installation can be completely concealed from a thief.

The SatSting computer can pin-

PHONEPRINT: THWARTING CELLULAR PHONE FRAUD

The widespread use of cellular phones has resulted in a new crime wave: cellular-phone fraud. According to the Cellular Telecommunications Industry Association (CTIA), well over a thousand illegal cellular phone numbers are activated daily.

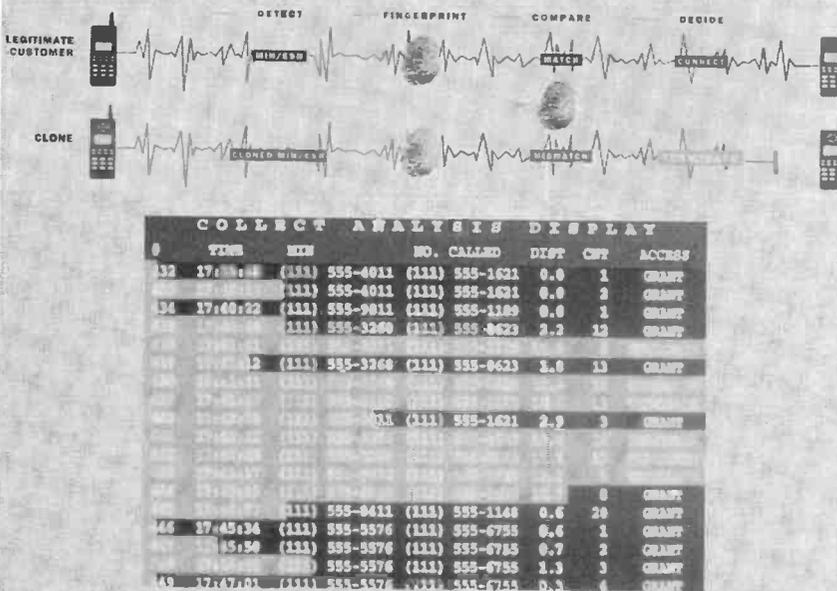
One of the most prevalent forms of cellular-phone fraud involves "cloning." Here the thief illegally duplicates the Electronic Serial Number (ESN) and Mobile Identification Number (MIN) belonging to a legitimate owner and uses it on one or more other phones, which are often also stolen. At the end of the billing period, the legitimate owner gets the bill, usually a huge one.

Cellular phones have a subtle, but unique radio-frequency signature or "fingerprint" that can be used to discriminate between legitimate and illegal phones. PhonePrint, now being marketed by Corsair Communications, measures the unique physical characteristics of each phone's radio signal as it enters the cellular system. Each call is compared against the RF signature of the legitimate user's phone stored in the system's data library. Fraudulent cellular calls are detected instantaneously and immediately terminated. This normally all happens in the time it takes to process the call setup. The check is

completely transparent to the cellular phone user—no modifications to the phone, additional numbers to punch in, PINs to remember, and, best of all, no waiting.

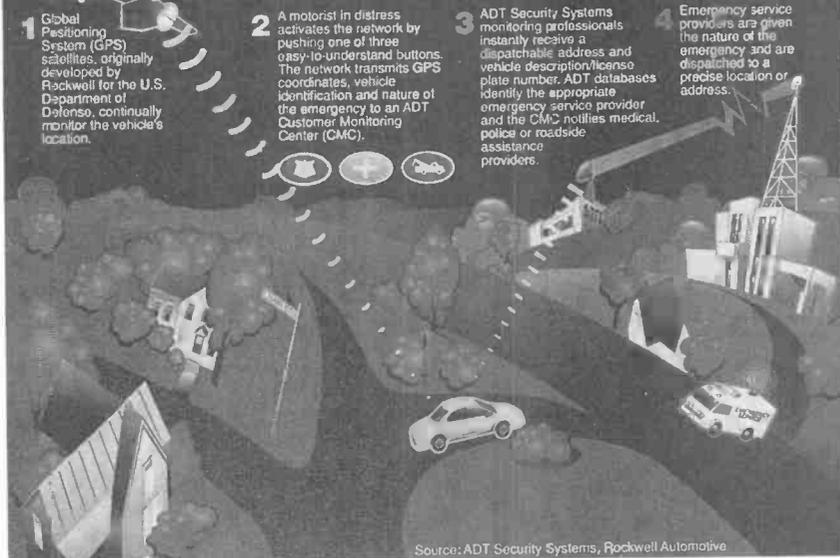
PhonePrint was put into operation with AirTouch Communications, Inc. for their huge cellular market in Los Angeles in early 1995, and is now being field-tested by NYNEX Mobile Communications and AT&T in New York City. These two cities are considered by the industry to have the most pervasive cellular-fraud problem. So far, 15-million illegal cellular calls were terminated in the Los Angeles area alone.

PhonePrint can save the cellular-phone industry millions annually by reducing the labor-intensive task of investigating fraud and reconciling customer's bills. Customers will be happier because they won't be billed for fraudulent calls and don't have to go through the often-frustrating hassle of getting them resolved. By eliminating illegal calls, cellular phone companies will gain more capacity for legitimate traffic. Finally, PhonePrint will make it more difficult for criminals to conduct a variety of "businesses" using cloned cellular phones, including credit-card fraud, stolen or counterfeit money orders and airline tickets, and drug and weapons trafficking. ■



PhonePrint compares the radio frequency signal of each cellular call to discriminate between legitimate phones and clones (see top). This sample "Collect Analysis Display" (see bottom) shows legitimate calls "granted" and calls on clones that were "terminated."

Help at your fingertips



1 Global Positioning System (GPS) satellites, originally developed by Rockwell for the U.S. Department of Defense, continually monitor the vehicle's location.

2 A motorist in distress activates the network by pushing one of three easy-to-understand buttons. The network transmits GPS coordinates, vehicle identification and nature of the emergency to an ADT Customer Monitoring Center (CMC).

3 ADT Security Systems monitoring professionals instantly receive a dispatchable address and vehicle description/license plate number. ADT databases identify the appropriate emergency service provider and the CMC notifies medical, police or roadside assistance providers.

4 Emergency service providers are given the nature of the emergency and are dispatched to a precise location or address.

Source: ADT Security Systems, Rockwell Automotive

Unlike RESCU, the ADT Security Systems/Rockwell Automotive Mobile Security Network can be added to any car. This illustration shows how it works.

point the location of the stolen vehicle and call up all pertinent information (year, make, model, color, etc.). This information is then transmitted to a local police department. The computer can also fax a copy of a street map showing exactly where the vehicle is located. If the car is moving, the monitoring station will keep police advised of location changes, direc-

tions, and even ground speed of the vehicle. Positional data, accurate to 10 to 20 meters (33 to 66 feet), is transmitted every 10 seconds. A concealed panic button can be triggered in the case of a carjacking or after an accident.

In Canada, the system is monitored by Chubb Security Systems, the country's largest network of Central Station alarm monitoring centers. Combining the capabilities of Chubb Security Systems, S2RK's Base Station and proprietary software, and the MAPINFO database, the system provides a graphical display of all Canadian and major U.S. cities down to street-level detail. Vehicles are tracked on digitized street maps that are automatically selected while simultaneously tracking multiple vehicles across diverse geographic regions.

S2RK is currently negotiating with Tommy Lasorda's MetroCell Security to offer a similar capability in the U.S. Besides recovering stolen vehicles, S2RK is also offering SatSting for security for truck fleets, especially those carrying very valuable or hazardous materials, heavy equipment rental fleets, taxi companies, military-arms shipments, and so forth.

Audiovox POSSE. The Audiovox Corporation's POSSE is another approach to keep stolen cars from becoming victims of chop shops or just joy riders. For example, in a car-jack-

ing situation, the driver simply leaves the POSSE-equipped car without any resistance. Using the nearest touch-tone phone, including coin-operated and cellular ones, the motorist places a toll-free 800 call to the POSSE Communications Center to report the theft. In seconds, the Communications Center sends out a signal to activate the POSSE. Once POSSE receives the signal, the car's horn and headlights began to sound and flash. Once the thief has stopped the car and turned off the engine, the car cannot be started again.

The POSSE system offers more than just theft protection. If the driver locks the car with the keys inside, a call to the POSSE Communications Center will remotely unlock the car provided the car is equipped with power-door locks. Or when you return from a long flight on a cold winter night you can call to have the engine turned on. The car will be toasty warm by the time you reach it in the parking lot. In the summer, you can have a cool car provided you remembered to leave the air-conditioning controls on. ■

ELECTRONIC PARROT

(Continued from page 47)

Install a 9-volt battery and press S1 to start the Electronic Parrot. The LED should come on, indicating that the HT8656A is in the listening mode. Now speak a short phrase into the microphone. The LED will turn off as the Parrot records your voice, and LED1 will remain off as the circuit automatically repeats back what you just said. After a brief pause, LED1 will come back on showing that your Parrot is ready to perform again!

If no sound is detected after 2 minutes, or when the play/record cycle has occurred 64 times, the HT8656A automatically powers-off to preserve the battery. Another press of S1 restarts the circuit. The microphone gain is sensitive enough to pick up voices from several feet away, while still ignoring most background noises. Experiment with the best location for your new electronic pet.

Your friends will probably be amazed and delighted by your Parrot. But the best part is that you won't have to feed it or clean out the cage! ■

FOR MORE INFORMATION

ADT Security Systems
300 Interpace Parkway
Parsippany, NJ 07054-1177

Audiovox Corporation
150 Marcus Blvd.
Hauppauge, NY 11788

Lincoln-Mercury Division Communications
301 Renaissance Center
Room 2730
Box 43342
Detroit, MI 48243

LoJack Corporation
9911 West Pico Blvd.
Suite 1000
Los Angeles, CA 90035

S2RK Advanced Technologies
1 Holiday Drive
Suite 530
Pointe Claire, Quebec
CANADA H9R 5N3

Rockwell Automotive
2135 W. Maple Road
Troy, MI 48084-7186

Line voltage is serious business, and it should always be handled with respect. There's enormous potential energy lurking at each and every AC outlet in your home, ready to power an appliance or possibly cause a lethal shock. But lifeforms are not alone when it comes to possible AC dangers. If the voltage coming out of an outlet is not of the proper level, possible hazards exist to equipment. At the very least, improper AC line voltages can damage one of your precious appliances.

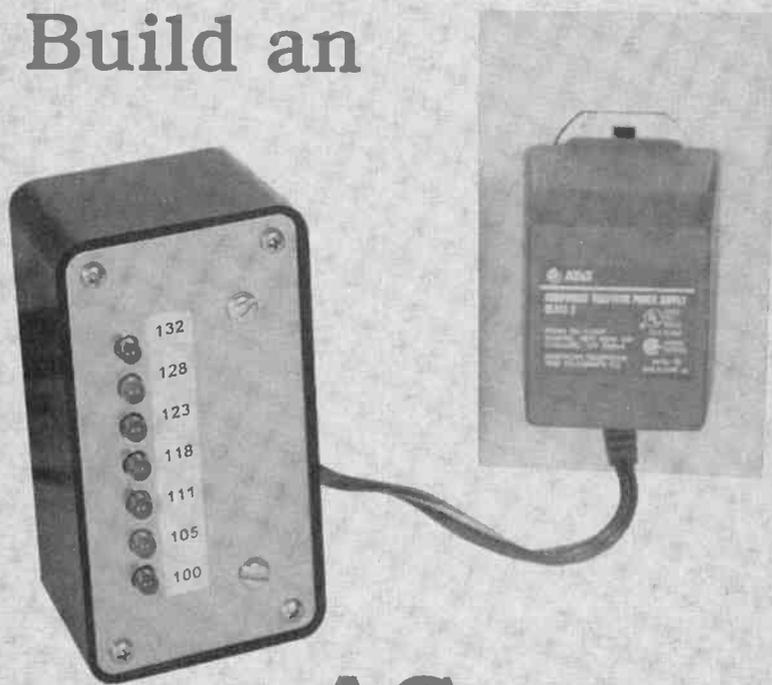
Because the AC voltage level in your home is so important, it's good to know what that level is. Especially if you have computer equipment plugged in or have been encountering strange problems with certain appliances. And because leaving a voltmeter plugged into an outlet is hazardous, wastes batteries, and ties up your voltmeter, it's good to have some kind of inexpensive line-powered device dedicated to monitoring line voltage.

In about an hour or so, you can build the *AC Line-Voltage Monitor* described in this article. Best of all, the low time investment involved in the project is matched by an equally low economic investment. You can buy the Monitor as a kit (from the source mentioned in the Parts List) for only \$10.95! Of course, you can also build the circuit from scratch.

The Monitor works with a makeshift bargraph, composed of seven LEDs, that displays the AC line voltage in seven steps from 100 to 132 volts, in approximately 6-volt steps. The AC voltage in your home or office should always be, and usually is, within those limits. But should you see that none of the LEDs are lit, or if all of them are brightly lit, then you know there's a problem. The circuit is also a good indicator of how stable the AC voltage in your home is.

By now, the presence of the letters AC in this article might have startled a few cautious hobbyists. Not to worry, though, it's very safe to work on this circuit because there are no harmful voltages present on the board. But how can you monitor AC voltage without ever touching it? Simple: use a transformer. The Monitor uses a 120-volt AC to 12-volt DC line-voltage adapter to supply the voltage input. That not only eliminates harmful volt-

Build an



AC Line-Voltage Monitor

Keep tabs on the level of the AC line voltage in your home or office with this inexpensive circuit.

BY MARC SPIWAK

ages from the circuit, but it also provides a ready-made DC operating voltage for the Monitor's circuitry. The transformer simply supplies about one-tenth of the line voltage, rectified, to the unit. Larger voltage changes in the AC line cause smaller, but proportional changes to the DC output of the transformer; the Monitor can detect these smaller changes.

Circuit Description. Figure 1 shows the schematic of the AC Line-Voltage Monitor circuit. As mentioned before, the circuit receives 12-volt DC power from a wall transformer. The circuit is centered around two quad LM324 op-amp ICs (IC1 and IC2) that receive

regulated operating power from a clamped portion of the DC supply provided by a 5.1-volt Zener diode, D3. The op-amps drive an LED bargraph consisting of LED1 through LED7.

The op-amps receive an adjustable reference voltage from the center contact of potentiometer R16 and an input voltage from the voltage divider consisting of resistors R1, R2, R4, R6, R8, R10, R12, and R18. Those resistor values were chosen so that the op-amp outputs sequentially turn on and light the LEDs as the AC line voltage, or one-tenth of it, varies from 100 to 132 volts. Potentiometer R16 sets the midpoint of the LED bargraph—usually 118 volts—which can be shifted if you like.

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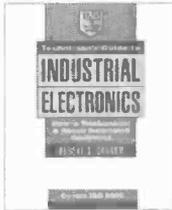
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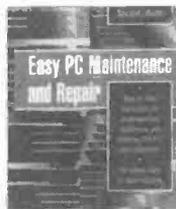
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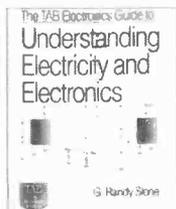
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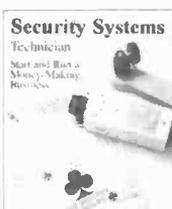
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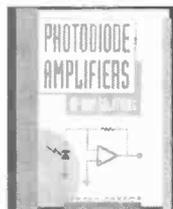
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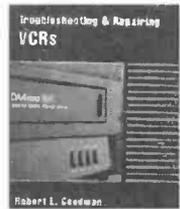
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PE397

March 1997, Popular Electronics

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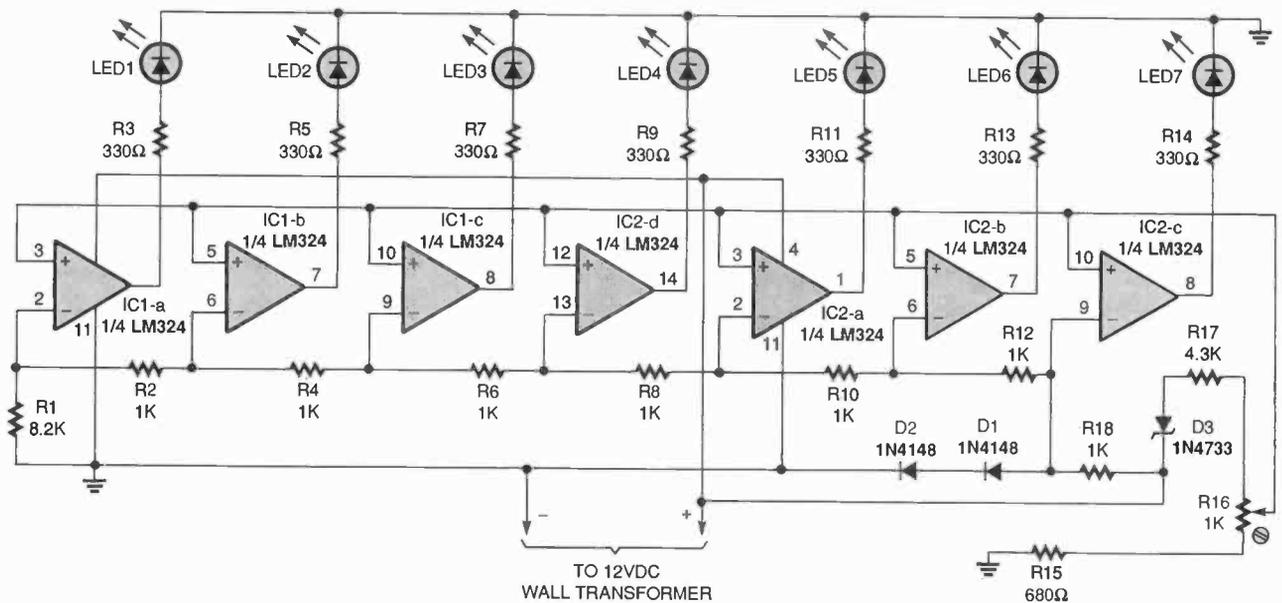


Fig. 1. Here is the schematic for the AC Line-Voltage Monitor circuit. A wall transformer steps down the line voltage and converts it to 12-volts DC to supply the circuit with both power and a small-scale indicator of how the voltage fluctuates.

Construction. The circuit is very simple, so point-to-point wiring can be used if you like. However, the use of a PC board makes construction easier and makes mounting the finished circuit in a case easier as well. You can make your own PC board using the foil pattern in Fig. 2 if you like, or you can simply buy the kit and use the board that comes with it.

You're probably going to want to mount the PC board in a small case, so a few minutes work on the case before you start working on the PC board can save hours of work measuring things later on. Any small case will do, as the PC board is very small. You don't have to do this if you use the drill guide in Fig. 3 (or a copy of it), but if you don't want to ruin your magazine and don't have a photocopy machine, then you should do the following:

First place the PC board, copper side down, on a piece of thin cardboard—I used the blank side of a business card. Align the LED side of the PC board and one end of it to edges of the business card to make positioning easier later on. Transfer the cathode mounting holes of the LEDs on the PC board onto the cardboard with a pin or awl. There are four mounting holes for screws on the PC board included with the kit. We'll use only the two holes that are farthest from the

row of LEDs. Mark the right edge of those two mounting holes on the cardboard with the awl.

Now, or later, you can tape this cardboard to the cover of the mounting case and drill the holes in the marked locations. Select drill bits based on the size of the LEDs and mounting hardware you use. If you are using the drill guide in Fig. 3, or if you are done with the above procedure, then you can proceed with assembly.

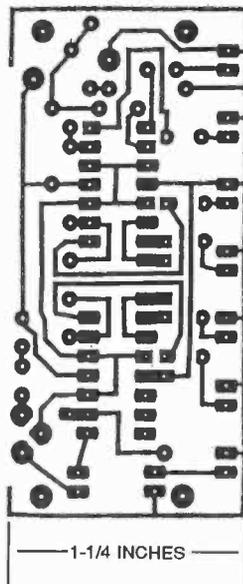


Fig. 2. This full-size foil pattern can be used to make your own PC board.

PARTS LIST FOR THE AC LINE-VOLTAGE MONITOR

SEMICONDUCTORS

IC1, IC2—LM324 quad op-amp, integrated circuit
 D1, D2—1N4148 silicon diode
 D3—1N4733 5.1-volt Zener diode (or equivalent)
 LED1—LED7—Light-emitting diode, any color (see text)

RESISTORS

(All fixed resistors are 1/4-watt, 5% units.)
 R1—8200-ohm
 R2, R4, R6, R8, R10, R12, R18—1000-ohm
 R3, R5, R7, R9, R11, R13, R14—330-ohm
 R15—680-ohm
 R16—1000-ohm, trimmer potentiometer
 R17—4300-ohm

ADDITIONAL PARTS AND MATERIALS

Printed-circuit materials, enclosure, 120-volt AC to 12-volt DC plug-in voltage adapter, half-inch spacers (2), wire, solder, mounting hardware (see text), etc.

Note: The following is available from Marlin P. Jones & Associates, Inc. (P.O. Box 12685, Lake Park, FL 33403-0685; Tel. 800-652-6733): AC Line-Voltage Monitor Kit (#6797-RB) including everything except a case—\$10.95 plus \$4.50 shipping and handling.

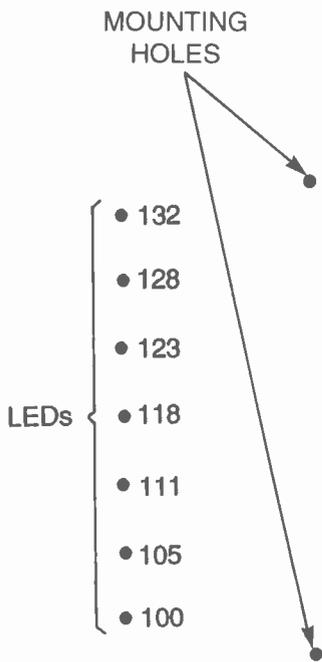


Fig. 3. This drill guide matches the positions of the LEDs and the hardware mounting holes on the PC board. Preparing the cover for the Monitor's enclosure should now be simple.

bling the PC board.

Figure 4 is a parts-placement diagram for the circuit. Some of the resistors have to be mounted vertically depending on space provided. Mount the parts basically in size order starting with the resistors. Don't forget to install a jumper in the location marked "J." The kit includes IC sockets, which are always a good idea to use but aren't necessary if you don't have them.

The kit includes two red LEDs, two orange, and three green. The red LEDs are intended for the high and low ends, the green for the three mid-range, and the orange for in between each. You can of course use any color scheme you like. The LEDs have to be mounted evenly, and at a certain height off the board, depending on the length of the spacers you use to mount the board to the case cover later on. With half-inch spacers, the base of the LEDs has to be about 3/8-inch above the board. I used a 3/8-inch wide strip of cardboard, folded over and taped to the board, to maintain the height of the LEDs. Alternatively you can cut 3/8-inch spacers for the LEDs from plastic tubing, coffee stirrers, or whatever. It's a good idea to lightly

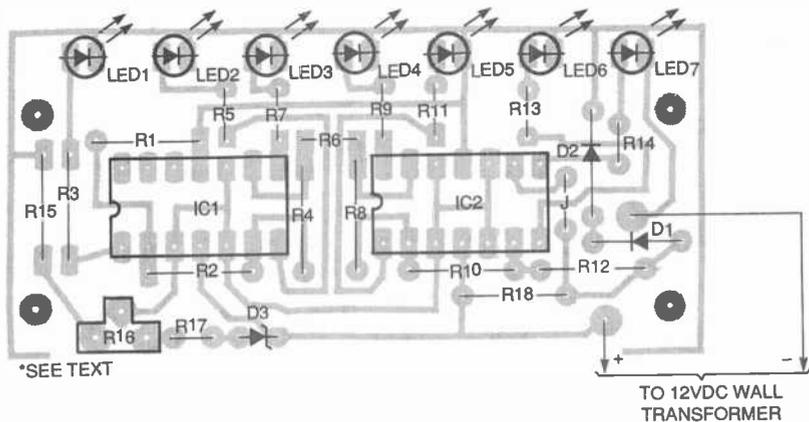


Fig. 4. Use this parts-placement diagram when assembling the circuit on a PC board. Some of the resistors have to be mounted vertically depending on space provided.

solder one leg of each LED, then re-heat each one individually for any necessary repositioning. Finally, solder the second leg of each LED and then go back and firm up the first ones after the second ones cool. Check the finished board for proper soldering and component orientation.

After you drill the holes in the case cover as described before, drill a hole in the side of the case for the power cord from the AC-to-DC wall adapter. Drilling the hole in the side of the case allows the finished unit to stand on end or flat depending on the setting. Pull the end of the cord through the hole to the inside of the case and tie a knot in it about four inches away from the end. Now solder the wires to the PC board paying careful attention to

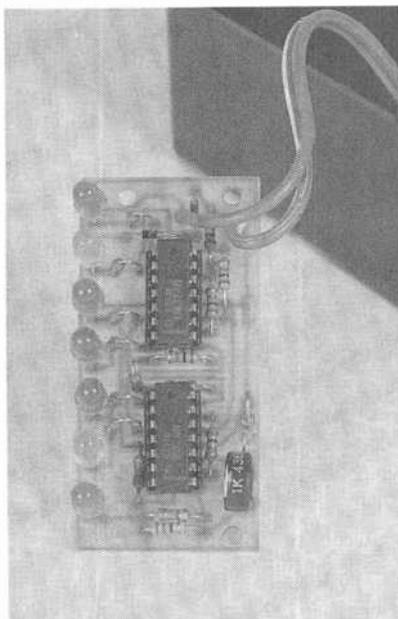
the polarity indicated in Fig. 4—remember that this is a DC input, not AC.

At this point you can plug the thing in and see if it lights up at all—most likely it will. Check your soldering and parts placement if it doesn't, because that's usually the culprit. The holes you drilled in the case cover should match the positions of the LEDs and mounting holes on the PC board. With half-inch spacers and appropriate screws holding the board against the case cover, the LEDs should fit like a glove. Close up the case and it should look like a store-bought product!

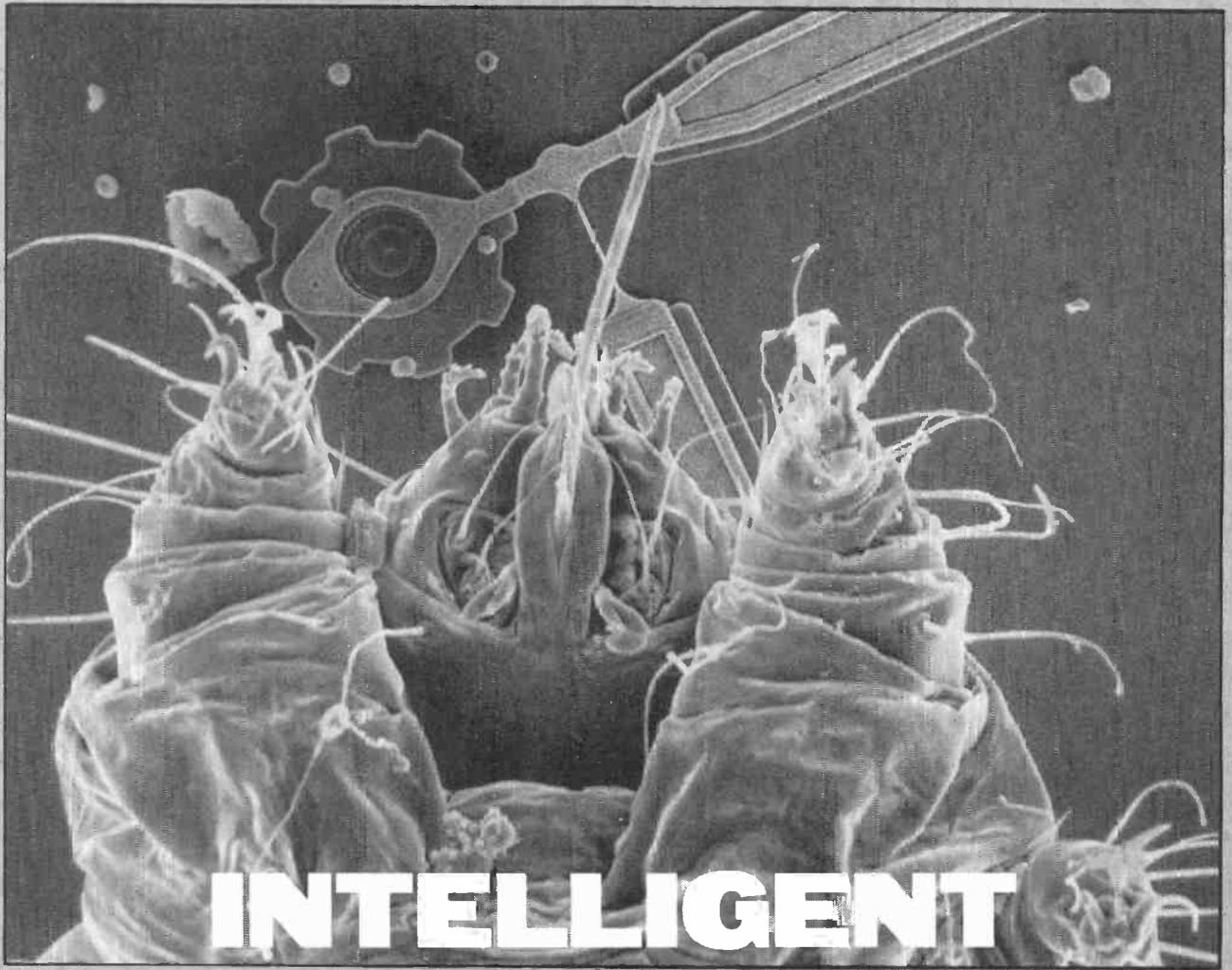
Labeling a case can be a pain in the neck. But I found the easiest way in the world to make the labels for this project. Because of how the LEDs are arranged, I was simply able to print a column of double-spaced, 11-point bold Arial text from a word processor. With a piece of double-sided tape, that instant label went on the case like a charm. You can do the same, or experiment with your own label ideas.

Calibration. It's easy to calibrate the line-voltage monitor. All you have to do is set potentiometer R16 so that the center LED (LED4) turns on with an AC supply of 118 volts.

However, if you don't have a variable AC source (most people including myself don't!), then simply—and carefully—measure the voltage at the outlet that your Monitor is plugged into with an AC voltmeter. Then adjust R16 so that the LED closest to that voltage turns on. The brightness of each LED indicates the relative voltage within each step. You now have a simple way of knowing what the AC voltage at any outlet in your home is. ■



The finished PC board makes a very compact assembly.



INTELLIGENT MICROMACHINES

Learn how artificial intelligence is being brought to microscopic motors.

The makers of micromachines are not only mass producing their tiny creations, now they're making them smart. The intelligence, added to the micromachines in the form of integrated circuits, will allow the machines to signal for more power, communicate operating conditions, and perform automated activities—continuing the microworld revolution that has been called the greatest scientific frontier of this century.

Using methods similar to those of the integrated-circuit fabrication industry, researchers at Sandia National Laboratory in Albuquerque, New Mexico, have succeeded in mass-producing micromachines that can perform work, and think about what they're doing—all on one chip.

BY DOUGLAS PAGE

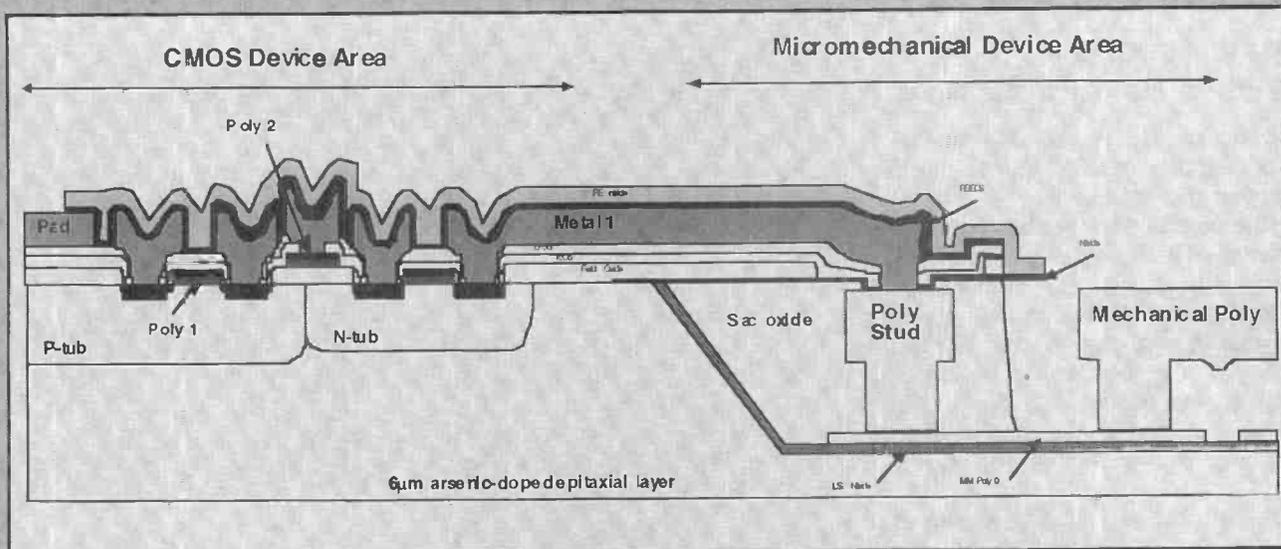
The Micro Motors. What kind of machines are we discussing here? They are microscopic motors fabricated by being sunk in etched trenches along with integrated-circuit "brains" on individual silicon chips (more on how they're made later). The machines turn two similarly sized gears, each one-hundredth the weight of a dust mite, at the rate of 200,000 revolutions per minute. Each gear is approximately one-hundredth the thickness of the paper this page is printed on—much thinner than a human hair.

"This is definitely a substantial advance they've come up with," said Roger Howe, director of the University of California, Berkeley's, Sensor and

Actuator Center. "A lot of people are champing at the bit to access this technology."

Applications. The technology was first developed to enhance the safety and security of nuclear weapons by making their locking mechanisms smarter and more reliable. Now it has possible applications in several industry sectors, from air-bag sensors to gyroscopes to medicine.

The motors, which develop 0.5 microwatts of power delivered through a gear that's 50 microns in diameter, could be used medically, where they are seen as serving as tiny drug-delivery devices within the body. Imagine pumps that are no larger than the period at the end of this sentence floating around the bloodstream



This Sandia National Laboratory diagram shows their micro innovation. The trench at the far right, which is only microns deep, makes possible the fabrication of a wide variety of micromachines. Microcircuitry, on the left, provides the brains of the machine.

searching, for instance, for HIV-infected cells. The blades of mini gears could one day churn through arteries chopping up plaque.

This new micro technology process also allows for the development of small, inexpensive, and durable electronics, such as gyroscopes. The latter have military and civilian uses that could have a dramatic impact on the design of future automobiles and military systems. Eventually we may even employ armies of the tiny little things to clean up polluted rivers or toxic dumps.

"This will be a big enabler for a variety of new products to be produced that are small, smart, and cheap," said Paul McWhorter, project manager in Sandia's Microelectronics Development Laboratory. "We've created a generic manufacturing process."

Manufacturing. Sandia manufactures the machines using breakthrough technology that etches minuscule trenches in silicon chips, then fabricates the machines within these depressions, like hot tubs sunk in backyard decking. The heat-treated machines are then submerged and preserved, like insects in amber, in a slight drop of hardening silicon dioxide.

"If you first sink the machine in a trench and then fill in around it, in effect you've created a pristine wafer for doing electronic processing," said Steve Montague, inventor of the ap-

proach. The hardened silicon dioxide recreates a level chip surface upon which circuitry is fabricated by the usual method of photolithography. Removal of the silicon dioxide at the end of the process liberates the micromachines.

Circuits fabricated only microns from a machine eliminate ghost signals—parasitic currents—created by excess electrical capacitance in longer connecting wires. "Without this interference, by applying a mechanical load you can measure the capacitance change in the drive-gear teeth as they move in and out," explains Sandia engineer Ernest Garcia. "Then you know how fast the machine is moving."

Montague's method of assembling a machine and circuit on a single chip allowed the researchers to overcome a basic problem. The difficulty with joining a microcircuit to a micromachine has been that the aluminum circuit connectors, if formed first, melt when the micromachines are heat-treated. If the gears are not heat-treated to approximately 900° Centigrade, researchers say they curl like potato chips. If the micromachines were fabricated first, their elevation above the chip surface would create bumps that distort the delicate process of etching accurate microcircuits. At this scale five microns is a mountain.

Sandia's micromachines are approximately one-millimeter square. The machines currently are embed-

ded in chip trenches six-millimeters deep, producing a single-level structure suitable for accelerometers and other sensors. Three-level structures have been fabricated to a depth of 18 microns. These are capable of turning external gearing and are completely compatible with the new integrated technique.

"The process can produce a wide range of micromachine systems because it allows independent optimization of micromachine and microcircuit performances," said McWhorter, thereby achieving the "paradoxical but desirable result of larger, more powerful micromachines with smaller transistors."

The Sandia engine and gearing extend a micromotor construction technique first developed at UC Berkeley. The basic batch process, which, when perfected, should allow production of thousands of fully assembled, operational micromachines, begins on a silicon substrate. Scientists deposit a layer of electrically insulating material, followed by a film of polycrystalline silicon for use as electrically conducting lead-ins. On top of these a temporary veneer of silicon dioxide is put down, so called because its purpose is to serve merely as a support while the rest of the structure is built.

When the silicon dioxide is removed by several etching processes, openings through the oxide allow the next layer of polysilicon to anchor to the insulating layer on the substrate. The

(Continued on page 62)

PAGER DECODER

(Continued from page 44)

for obvious ground planes. If the demodulator is an MC3361, then pin 15 of that chip is ground.

Be careful when working on your scanner! Its internal circuitry is probably densely packed surface-mount components. Use a small, low-power soldering iron, a steady hand, and a magnifier if necessary. It is easy to really mess things up if you are not careful. When closing up the case, be sure not to crush any wires you added.

Using a Uniden SC-150 Scanner.

Although not the best choice for a high-tech feature-rich scanner, the Uniden SC-150 is a good choice for dedicated pager-data monitoring because of its price (approximately \$160) and its coverage of the 929-932 MHz paging bands. To use this scanner with the Decoder you have two options, which we mentioned earlier: filtered (speaker) and unfiltered output.

The SC-150 presents filtered audio from a 3.5-mm monaural phono jack at the top of the unit next to the antenna connector. To connect this to the

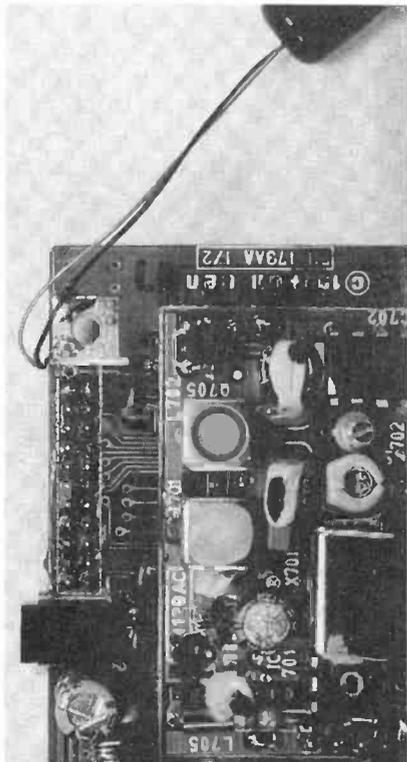


Fig. 6. This close-up shot shows you where to make the ground connection for demodulator output on a Uniden SC-150.

POCSAG MESSAGES

POCSAG transmissions are always preceded by a "preamble" consisting of a series of alternating 1 and 0 bits, at least 576 bits in length, at the same baud rate as the upcoming data. This is done to accommodate battery-saving functions in pagers.

The remainder of a transmission consists of one or more "batches." A batch consists of exactly 17 codewords of 32 bits each. Each codeword is transmitted in high-order-bit-first sequence.

The first codeword in every batch is a synchronization word. Although 8-sync codes have been defined, the only one currently in use is (in hex): 7CD215D8.

The other 16 codewords in a batch are defined as 8 consecutive frames of 2 codewords each. The frames are numbered 0 through 7 in the order transmitted.

Each data codeword in a frame may be one of three types: an address codeword, a data codeword, or an idle codeword. An idle codeword is (in hex): 7A89C197. Address and data codewords are distinguishable by their high-order bit, which is 0 for an address codeword and 1 for a data codeword. Idle codewords are used as space fillers in frames corresponding to pager-address groups in which there are no messages to be sent.

For the remainder of this discussion, we will number the bits in a codeword from 1 to 32, where bit 1 is the high-order bit and bit 32 is the low-order bit. This is non-standard to most software programmers, but it is the convention used in the official POCSAG document from British Telecom.

Bits 2 through 19 of an address codeword contain the high-order 18 bits of the 21-bit address of a pager that is to be triggered. The low-order 3 bits of the pager's 21-bit address are implicitly defined by the frame number (from 0 to 7) in which the address codeword appears. Bits 20 and 21 of an address codeword are defined as the "function code." The pager may ignore these bits, or it may use them to determine whether to decode the message that follows as 4-bit or 7-bit data, and/or it may use them to select one of several different alert sounds. Bits 22 through 31 contain the error-correcting redundancy bits corresponding to a BCH(31,21) code (more on that later). Bit 32 contains a simple parity bit that causes the entire codeword to have even parity.

The address of a pager, also known as its "capcode," is usually specified as a 7-digit decimal number ranging from 0000000 to 2097151. Each time an address codeword is transmitted, it is (optionally) followed by one or more data codewords containing the message to be displayed on the pager. All the data

codewords for a message are transmitted immediately after the address codeword, without regard for frame number. The message ends when another address codeword or idle codeword is transmitted. Bits 2 through 21 of a data codeword contain the actual message data. Bits 22 through 31 contain the error-correcting redundancy bits corresponding to a BCH(31,21) code. Bit 32 contains a simple parity bit that causes the entire codeword to have even parity.

Table 1

Code	Character
0000	"0"
0001	"1"
0010	"2"
0011	"3"
0100	"4"
0101	"5"
0110	"6"
0111	"7"
1000	"8"
1001	"9"
1010	" (space)"
1011	"U"
1100	" (space)"
1101	"_"
1110	"#"
1111	"P"

Message data may be defined as either 4 bits per character or 7 bits per character. Originally, the function bits in the address codeword were to be used to distinguish these message formats, but there is now no universal standard. Usually, the pager itself receives only one of these formats and the paging terminal must be configured appropriately. Reliably selecting the correct format for decoding requires prior knowledge of the pager type. Generally, numeric-only pagers use the 4-bits-per-character format, while alphanumeric pagers use 7 bits per character (even for numeric messages). Message characters are "packed" into the 20 bits available in each codeword, with the result that there are 5 characters per codeword in 4-bit format, and two and six-sevenths characters per codeword when using 7-bit format. Characters are transmitted in the order that they are to be displayed, but within each character the bits are transmitted in reverse order relative to the convention used in the address codeword. The low-order bit of each character is transmitted first.

The characters of the 4-bit format are shown in Table 1. The characters of the 7-bit format are standard ASCII.

When the last codeword of a message is partially filled, the unused portion is filled with "space" codes (1100b) in the case of 4-bit data, or zero bits in the case of 7-bit data.

The BCH(31,21) error-correcting code allows up to 2 erroneous bits per codeword to be corrected by the receiving device. Bits 22 through 31 of each POCSAG codeword contain 10 redundancy bits based on this code. Note that this applies to ALL codewords, including synchronization and idle codewords. A POCSAG decoder is expected to run an error-correction algorithm as the first step in processing received data, even before synchronization codeword detection, since synchronization words may themselves contain errors.

The BCH code used here is based on an 11-bit "generator" of (binary)

11101101001. The 10 redundancy bits are created by performing a "polynomial division" operation between the zero-padded original data and the generator.

The example of redundancy-bit calculation shown in Listing 1 is extracted from the British Telecom document. It is set up to resemble the paper-and-pencil "long division" procedure. Note that all column operations are not subtraction, but are instead exclusive-or operations. No carry bits propagate in either direction.

The full POCSAG codeword would consist of the 21 bits of data, followed by the 10 redundancy bits, followed by a parity bit: Codeword = 11010001011000100100011000110110.

A receiving device, of course, must run the complementary procedure, using the redundant information to cor-

rect erroneous bits. Several different methods can be used to do this; all are too involved to explain here. A good reference work is the book *Error-Correcting Codes, Second Edition* by W. Wesley Peterson and E. J. Weldon, Jr., published by the Massachusetts Institute of Technology Press, Cambridge, Massachusetts (ISBN 0 262 16 039 0) (Library of Congress 76-122262).

It is possible to receive and decode POCSAG by simply ignoring the error correction information and extracting the data portion of each codeword; however, in the real world reception quality is variable and errors will be frequent. In particular, a single-bit error in a synchronization or address codeword can cause the entire message to be lost. The error-correction algorithm is a necessity in practical decoders. ■

LISTING 1

Starting conditions:

Data pattern: 110100010110001001000
Generator: 11101101001

```

11101101001 | 11010001011000100100000000000000 <- quotient is irrelevant
               11101101001 <- pad data with 10 zeros
               ----- <- XOR with generator
                 11110001000 .
                 11101101001 <- XOR with generator
                 ----- .
                   11100001010 .
                   11101101001 <- XOR with generator
                   ----- .
                     11000110100 .
                     11101101001 <- XOR with generator
                     ----- .
                       10101110100 .
                       11101101001 <- XOR with generator
                       ----- .
                         10000111010 .
                         11101101001 <- XOR with generator
                         ----- .
                           11010100110 .
                           11101101001 <- XOR with generator
                           ----- .
                             11100111100 .
                             11101101001 <- XOR with generator
                             ----- .
                               10101010000 .
                               11101101001 <- XOR with generator
                               ----- .
                                 10001110010 .
                                 11101101001 <- XOR with generator
                                 ----- .
                                   11000110111 <- this is the answer

```

page decoder, you will need a 2-conductor cable with a 3.5-mm phono plug on both ends (twisted pair is fine; coax is not necessary). It's acceptable to use stereo 3.5-mm plugs; the "ring" contact will simply remain unused in the mono jacks.

Beware of pre-made cables sold for the purpose of connecting the earphone output of one cassette player to the microphone input of another; these cables contain attenuator resistors and *will not* work. If you buy a pre-made cable rather than making your own, use an ohmmeter to verify that the ground-to-ground and tip-to-tip resistances are low (they should be well under 10 ohms).

After connecting the cable (to J1 of the decoder), follow the volume-control-adjusting procedure described earlier in this article. Note that plugging in the cable will disable the SC-150's internal speaker. This configuration will allow you to decode 512 and 1200 baud POCsAG, but not 2400 baud.

If you want to be able to decode 2400 baud POCsAG, and decrease the number of errors at lower baud rates, you will need to tap the scanner's unfiltered audio. To do that you will need the 3.5-mm cable just described, a 3.5mm in-line phono jack, and a small amount of 26-gauge or smaller insulated wire.

Slide the battery cover downward and remove it. Lift out the NiCd battery pack and unplug its connector from the unit. Using a small Phillips screwdriver, remove the four screws holding the back half of the case; lift away that half.

Lay the unit face down on the table. Using your fingers, gently pry upward on the uppermost circuit board at the end nearest the battery compartment. This will disengage the dual in-line 22-pin connector between the two circuit boards. The upper board together with the plastic case top, control knobs, and antenna connector can then be lifted away from the unit.

Flip over the board you just removed. Its "bottom" side will match the photograph shown in Fig. 5. Cut a 6-inch length of 26-gauge or smaller insulated wire and strip approximately $\frac{1}{32}$ inch of insulation from one end. Carefully solder the wire to the loca-

tion shown in the photograph. Orient the wire so that it leads diagonally toward (and past) the bottom end of the 22-pin connector.

Flip the board back over to its original position. Just beyond the bottom end of the 22-pin connector there is a large square area of bare metal, centered around a hole through which one of the case screws passes. This is a ground point (see Fig. 6). Cut a 4-inch length of wire and strip approximately $\frac{1}{8}$ inch of insulation from one end. Orient the board so that the antenna connector is "up" and solder the wire to the upper right corner of this pad. Avoid creating a "mound" of solder, as this will prevent the case from closing properly.

Even up the other ends of the two wires, strip a small amount of insulation from each, and solder them to the terminals of the in-line 3.5-mm jack. The ground wire from the SC-150 board goes to the "outer" or case connection on the jack. The other wire connects to the "tip" terminal; be careful not to erroneously select the "middle-band" terminal if you are using a stereo jack.

Re-install the circuit board back into its proper location within the SC-150, making sure to avoid trapping the signal wire between the pins of the 22-pin connector as it mates together. Bend the two new wires over the nearest edge of the front half of the plastic case, avoiding the small case-alignment "tooth". Re-install the back half of the case. Do not excessively tighten the screw nearest where the new wires exit, as this can damage or cut the wires. If you are willing to do so, it is best to use a small file or Dremel tool to cut a small notch in the edge of the case to allow room for the wires.

Re-connect the battery pack, insert it into its compartment, and replace the battery cover. Use the 3.5-mm, two-plug cable described earlier to connect the new in-line jack to J1 of the Decoder. Be sure that the pins on headers H1 and H2 are not installed. Follow the setup procedure described earlier in this article for demodulator/discriminator outputs. Note that the volume and squelch controls of the SC-150 have no effect on the demodulator output signal. An auxiliary speaker will not be needed in this case since the unit's internal speaker will still work. ■

INTELLIGENT MICROMACHINES

(Continued from page 59)

process forms vertical axles for gears and elastic supports for the engine. Additional layerings and removals of the oxide free the gears and linkages.

During these steps researchers add a hard, smooth substance, silicon nitride, which functions as a kind of grease to permit the gears to rotate more freely. In the final step hydrofluoric acid is added to remove all the temporary supporting layers of silicon dioxide.

Gear Systems. Micro motors consist of two tiny silicon combs separated by a shuttle. The edges of the shuttle form combs with teeth that interdigitate with those of the stationary combs. These stationary combs, energized by on-off electric pulses, alternate pulling the shuttle by an electrostatic attraction similar to that which causes a balloon to adhere to a shirt, or dust to stick to a television screen.

An attached shaft turns a drive gear in a quarter of a circle during the shaft's power stroke. Another comb-drive engine, at right angles to the first, is timed to turn the gear on the second quarter of its rotation. The two drives, alternating their force, turn reciprocating motion into rotary motion to drive the gear completely around.

Efforts are underway to transfer the technology to industrial partners for large-scale production. That in effect makes the machines plug-compatible so other integrated circuits can be added to achieve novel uses.

The inexpensive manufacturing process can be used either to produce thousands of units a day, significantly reducing costs for government and industrial manufacturers, or to produce unique motors and circuits for specialized medical and research work. ■



Volunteers
Welcome

SCANNER SCENE

Entering the Information Age

BY MARC SAXON

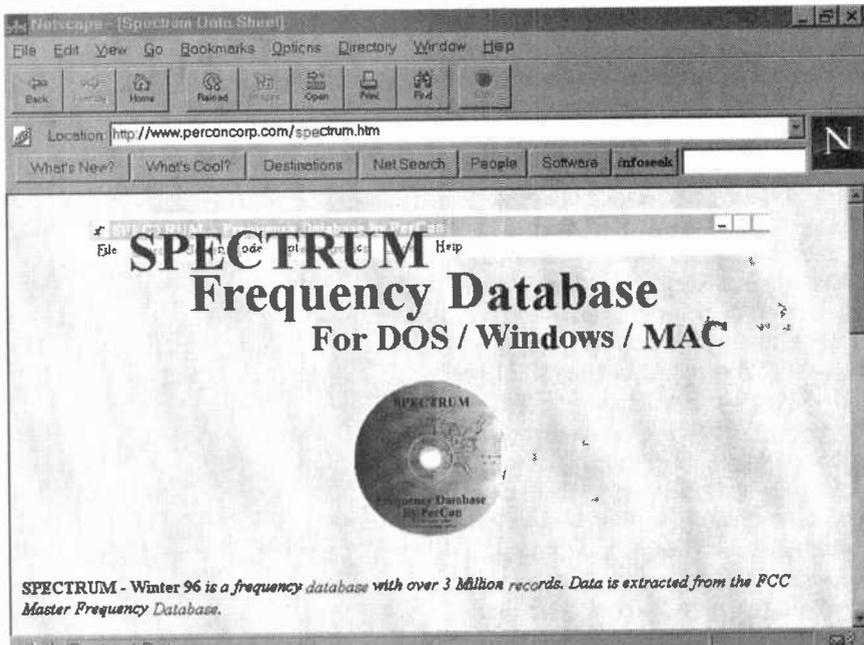
For those monitors who want to have virtually the entire FCC licensee database at hand, there's good news. Several CD-ROM databases now available allow the average hobbyist to have instant and convenient access to that mountain of valuable information. All you need is a personal computer with a CD-ROM drive. And, naturally, you'll need one of the proper CD-ROMs with FCC databases to provide the information.

Of the several that we have seen, the one we liked best was *Spectrum*, which covers more than three-million FCC listings in the United States. You can run the mouse-operated program through Windows (3.1 or higher, Windows 95, or NT), DOS, and Mac (System 7 or higher). What type of hardware is required? A PC with at least a 386 microprocessor with a VGA monitor for Windows (CGA for DOS) is suggested. You'll need at least 4 megabytes (MB) of space on the hard disk and another 4 MB of RAM. Mac owners should have color monitors with 16-color capabilities, and will also need 4 MB free on the hard disk, plus 4 MB of RAM.

You're going to find pretty much everything licensed by the FCC on the Spectrum CD-ROM. It includes listings for public-safety agencies, business radio, broadcasters, coastal stations, experimentals, microwave, and more. There aren't any hams or listings for specific maritime mobile or aircraft stations. And, of course, no federal stations because the FCC doesn't license federal stations.

The CD-ROM offers FCC data searches by licensee name, call letters, county, operating frequency, frequency range, FCC Radio Service Code, or class (type) of station. Each listing provides call letters, frequency, licensee name, class and type of station, city and county of the transmitter, and latitude and longitude, as well as the number of land, air, marine, portable, and pagers authorized.

The amount of data you'll retrieve on any particular station is up to you, so you can call up just the basics or the



The Spectrum CD-ROM contains more than three-million U.S.-based FCC listings, easily retrieved by instant database searches. Get more information at the PerCon website.

whole *enchilada*. Listings are viewed on your monitor and/or run off on your printer.

No user's manual is included with this CD-ROM. You can select what you want by pressing various on-screen buttons, and then following easy on-screen instructions. I found installation to be a tad finicky when following the information provided. The CD-ROM does not practically "install itself" as many others on the market seem to these days.

The Spectrum CD-ROM costs \$29.95 plus shipping and handling. Similar CD-ROMs in the Spectrum series are available: *U.S. Amateurs* costs \$19.95 plus shipping, and one for all Canadian services is \$49.95 plus shipping. For more information, contact PerCon Corporation (4906 Maple Springs/Ellery Road, Bemus Point, NY 14712; Tel. 716-386-6015; Web: <http://www.perconcorp.com>).

MORE FCC DATA

FCC applications accepted for filing in a number of different two-way communications services are now com-

bined into a single weekly publication, available free on the World-Wide Web. This publication also includes applications that were returned for correction, amended substantially since prior acceptance for filing, and resubmitted after being bounced.

The following FCC services are covered: Broadcast Auxiliary, Marine Public Coast, Alaska Public Fixed, Aviation (Ground Advisory, En Route, Fixed, and Control Tower), Commercial Mobile Radio Services, and Fixed Microwave Services.

The weekly notice is updated to the Web at the URL: <http://www.fcc.gov/Bureau/Wireless/Public-Notices/index.html>. That file name is based upon the week of publication and is displayed as "WTB Applications Released XX Week of the Month." These notices remain on the Web for one month, and then they are overwritten with the following month's publication.

Questions about this service can be answered by the FCC's Wireless Telecommunications Bureau Consumer Assistance Branch, which is located in

continued on page 66

ANTIQUE Radio

Back to the Star Roamer

BY MARC ELLIS

Well, at long last I managed to break out the soldering iron, dust off the workbench, and get back to work on the Star Roamer project—begun in the September and November 1996 issues, and put aside for various reasons these past three months.

For those of you who didn't happen to see the earlier issues, the Star Roamer was a Knight Kit (Allied Radio's house brand) low-end communications receiver that was a popular starter set for SWLs and would-be hams in the mid-1960s. My Star Roamer came to me (along with the Heat Q-Fiver and Holstrom Associates preselector that apparently had been used with it) courtesy of a sharp-eyed friend who had spotted the unit in someone's trash.

During the time that the project was on the back burner, I at least managed to order a copy of the original Star Roamer construction manual. It included a pictorial diagram (Fig. 1) and large schematic (Fig. 2) that I will share with you this month. The art will take up a lot of space, so I'll have to keep my text quite short!

THE CIRCUIT

As long as we now have the Star Roamer's schematic, it's probably appropriate to review a few details of the circuit. The set is essentially a conventional broadcast superheterodyne receiver enhanced with shortwave and long-wave bands and a few additional niceties of importance to the serious shortwave listener.

In Fig. 2, V-1 (6BE6) is the oscillator-mixer (otherwise known as the "converter") and V-2 (6HR6) serves as the single IF stage. Diode CR-1 is the detector, and is followed by V-3, a 12AX7 dual triode—which is connected as two stages of audio amplification. The audio-output stage, V-4, is either a 6AK6 or a 6AR6—which are interchangeable in this circuit. The power supply is transformer-operated and uses diode CR-3 as a half-wave rectifier.

The set has a front-panel-mounted antenna trimmer (C-3) and bandspread

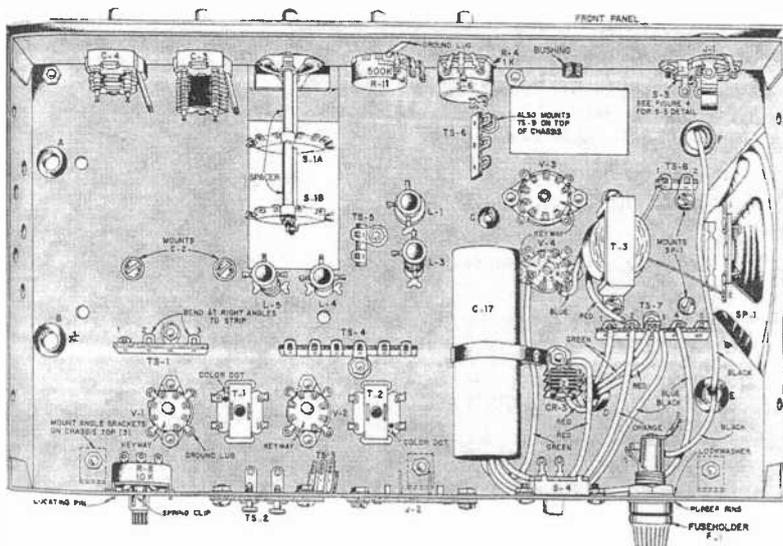


Fig. 1. Here's the Star Roamer schematic as printed in the original Knight Kit manual.

(C-4) capacitors. Another control (R-4), with the deceptive label "sensitivity," actually introduces a controlled amount of oscillation into the IF stage to make it serve as a beat-frequency oscillator into the IF stage for CW (code) reception. Switch S-2 is the AVC on/off control, and S-3 switches diode CR-2 into the circuit, when necessary, to act as a noise limiter. Potentiometer R-11 is the volume control.

Phone jack J-1 automatically disconnects the speaker when headphones are plugged in. S-meter M-1 is connected across the AVC line and can be calibrated by the rear-apron-mounted "S-Meter Adjust" control, R-8. Also on the rear apron is "key" jack J-2, paralleled by S-4—which is labeled "Code-Normal." When open, S-4 places a key plugged into J-2 in series with one of the speaker leads, which, with the IF stage set to oscillate, makes it possible to use the receiver for code practice.

WHAT'S BEEN DONE ALREADY

In the September and November issues, we gave the Star Roamer a careful inspection, noting that the original owner had done a very competent

job of wiring this kit. We also cleaned off the grime and checked the tubes. After replacing the electrolytic capacitors (a standard procedure prior to recommissioning any antique set) and installing a modern silicon diode rectifier in place of the old selenium job, we powered up the radio and tried it out. The results were disappointing. A few weak stations were heard on the broadcast band; nothing on the shortwave bands.

At the close of the November column, we announced the strategy for future work sessions. Once the manual was obtained, we would make a detailed check of the set's construction to be sure that the wiring was done correctly. If the Star Roamer could be brought back to life through finding a mistake, fine. Otherwise, we would proceed with a realignment of the radio.

CONTINUING THE TROUBLESHOOTING

The comprehensive Knight Kit manual, supplied as an excellent-quality reproduction by Hi-Manuals (P.O. Box 802, Council Bluffs, IA 51502) made it really easy to do the wiring check. In the past, I've been annoyed at the relatively high prices of manuals for units origi-

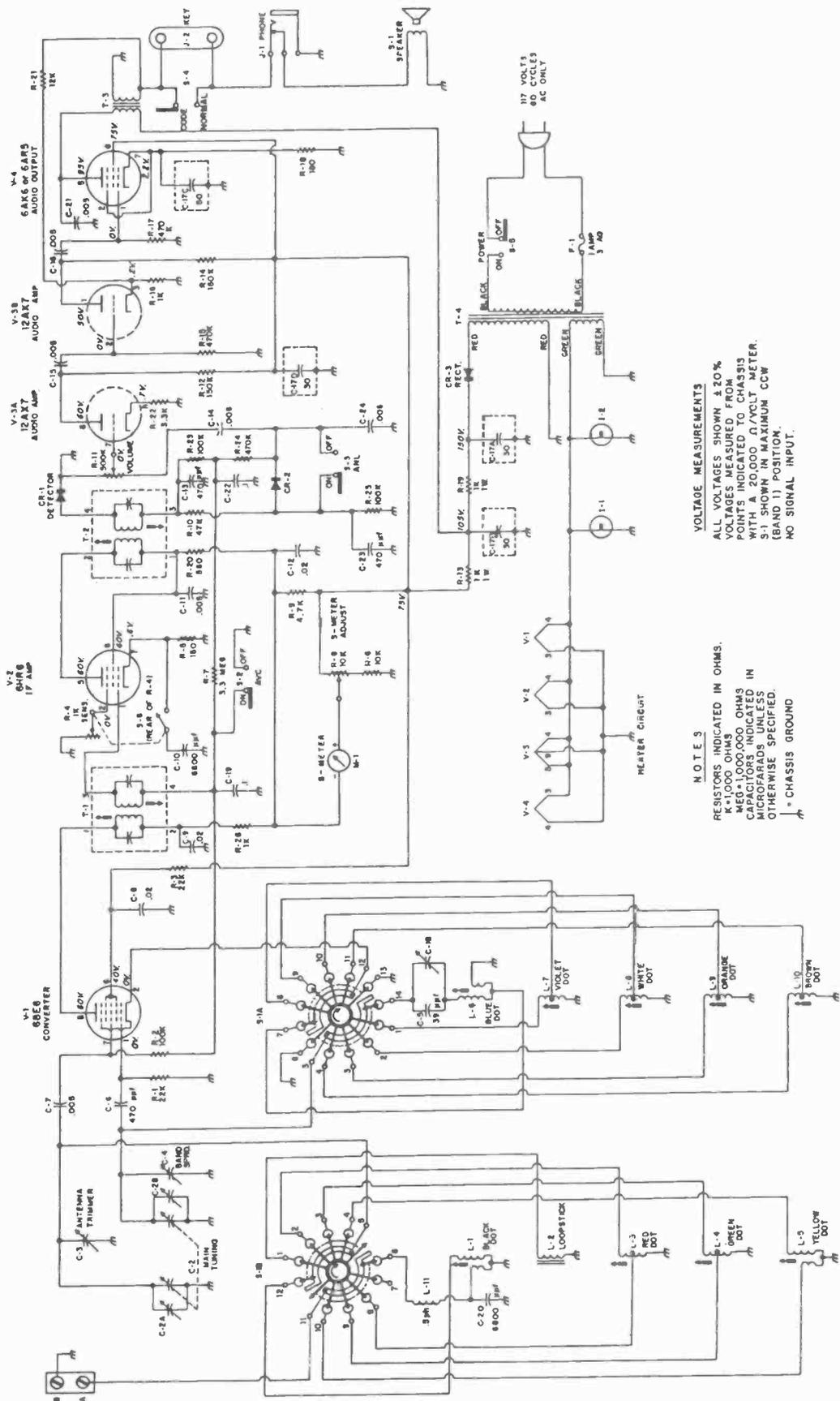


Fig. 2. This pictorial diagram for an early stage of construction shows most of the controls. Along the top (left to right): Antenna Tuning, Bandspread, Bandswitch, Volume, and Sensitivity. Along the bottom: S-Meter Adjust (at left) and Code-Normal Switch (next to fuse holder).

VOLTAGE MEASUREMENTS

ALL VOLTAGES SHOWN $\pm 20\%$
 VOLTAGES MEASURED FROM
 POINTS INDICATED ON CHASSIS
 WITH 500 OHM / VOLTMETER.
 S-1 SHOWN IN MAXIMUM CCW
 (BAND 1) POSITION.
 * NO SIGNAL INPUT.

NOTE 3

RESISTORS INDICATED IN OHMS.
 1000 OHMS
 10000 OHMS
 CAPACITORS INDICATED IN
 MICROFARADS UNLESS
 OTHERWISE SPECIFIED.
 — = CHASSIS GROUND

nally sold as kits. It seemed silly to have to buy all those extra pages of kit-building instructions for a radio that had already been assembled. Well, I was wrong!

I started to check the Star Roamer by comparing its wiring against the schematic. Starting at the front end (antenna end) of the radio, I quickly got tangled up in the hard-to-follow connections associated with the bandswitch. I thought, maybe I should resort to a pictorial diagram from the kit instructions. That way I could see if the switch connections are right without actually tracing them electrically.

That worked out so well that I continued using the pictorials as I checked the remainder of the wiring. The organization of the Knight manual really made it easy. The parts are wired in "layers" with a separate pictorial diagram provided for each group. The pictorial for each successive layer includes all of the parts and connections for the previous one. The previously installed parts and wires are "grayed down;" the ones to be installed in the current layer are in white. It's a system that works as well for methodical "after-the-fact" checking as it did for the original construction.

My thorough check of the wiring revealed no problems or mistakes, but it did clarify some points that I hadn't been sure of earlier: (a) Was the antenna loopstick an original part of the receiver or had it been wired in later to avoid the necessity of using an outside antenna for the broadcast band? (b) Was the disconnected "Code-Normal" switch on the rear chassis originally the BFO switch for code reception? (c) What had been removed from the rectangular opening labeled "key"—now being used for a jerry-rigged IF strip connection, probably for the Heath Q-Fiver?

Though the original loopstick looked like a casual later addition, it was indeed original with the receiver and is, in fact, the only antenna for the broadcast band. (The receiver's antenna and ground terminals function only on the other bands.) The "Code-Normal" switch, S-4 on the schematic, which has already been discussed in our circuit description, enabled the receiver to be used for code practice. The missing part was J-2 (see circuit description), a double-tip jack used for connection to the code-practice key.

The wiring check having revealed no problems, I next took care of a few last-minute details in preparation for the realignment to be attempted next. The composition-board rear panel, which had snapped horizontally along a row of ventilation holes, was neatly repaired with a pair of small mending plates fastened through conveniently located holes. The plates were installed out of sight on the inner side of the panel, their mounting screws dressed up with decorative washers. The loopstick antenna was then securely fastened to the panel and wired in as shown in the manual.

Finally, I was ready to try a realignment—but here I was frustrated. Turning on the receiver, I found that a really annoying intermittent connection had developed in the dense tangle of wiring associated with V-3 (the 12AX7 dual triode). So far, no amount of prodding and probing has identified the culpable connection, which makes the audio cut in and out at irregular and unpredictable intervals.

We should, hopefully, have that problem solved by next month. See you then! ■

SCANNER SCENE

(continued from page 63)

Gettysburg, Pennsylvania. The phone number is 800-322-1117.

ROLLING TOWER

Manny W., of Chevy Chase, Maryland, writes that when he went to an air show at an area airport, the air show activities were being run from a mobile control tower parked next to the runway. His scanner was programmed with the airport's regular frequencies, so he was thrown into a tailspin when confronted with this mobile tower that wasn't using any of the field's usual communications channels. Manny asks if anyone has knowledge of this type of arrangement and the frequencies that might be used with it.

According to the Radio Monitors Newsletter of Maryland (P.O. Box 94, Hampstead, MD 21074), what Manny encountered is something known as "Air Boss." It's a 26-foot, portable aircraft tower, adapted for use with a trailer. The Air Boss is towed around the country to air shows to serve as a temporary control tower and public-announcement system. It contains one UHF and three VHF aeronautic radios,

and a cell phone, as well as other communications, a signal light gun, and wind-data instrumentation.

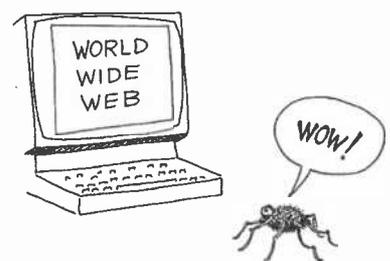
The Air Boss is privately owned and not operated by the FAA, although certainly it is used with FAA permission. Its frequencies will be different from show to show, but the primary air operations are said to be on 123.975 MHz, with a secondary frequency of 126.0 MHz. Military aircraft communicate on 388.0 MHz. Monitors have also reported it on 122.925 MHz, the 121-MHz ground-control frequencies, and even 122.92 MHz (5 kHz off the authorized 122.925 MHz channel). My personal guess is that it also operates on 123.1 MHz, as that's a big air-show channel.

BETWEEN A ROCK AND A HARD PLACE

How many of you remember the olden days when scanners were frequency controlled by plug-in crystals? That was before programmables came into existence. Apparently, there are still loads of ancient crystal-controlled scanners floating around out there—at least that's what my mail lets me know several times per month. The problem seems to be that nobody knows where to obtain the crystals that those scanners require in order to install new frequencies.

We have looked around for crystal sources, but couldn't find any. If there are any places that can supply crystals for RadioShack (Realistic), Regency, Sonar, and similar vintage scanners, please let us know about them. We will run that information here and make many people very happy.

We are always interested in hearing from you with information, questions, new frequencies, suggestions, and whatever. If it relates to VHF/UHF, monitoring, or scanning, then our readers want to know. Feel free to write to *Scanner Scene*, **Popular Electronics**, 500 Bi-County Blvd., Farmingdale, NY 11735. ■



Scanner

HAM Radio

Bands You've Never Used

BY JOSEPH J. CARR

Ham-radio operators use the medium-wave (MW), shortwave (HF), very-high-frequency (VHF) and ultra-high-frequency (UHF) bands for communication. Most of us think that the lowest band for ham communications is 160-meters (1.8-MHz band). In the USA, that's true for the official ham bands. But there are other transmitting opportunities available in the low-frequency (LF) and very-low-frequency (VLF) bands below the AM broadcast band. One is an unlicensed service under Part 15 of the FCC Rules and Regulations, while another is a small ham band recently allowed by the British for their hams.

VLF AND LF

At one time, the VLF and LF bands were all that were available for any kind of reasonable communications. These bands are those frequencies below the 540-kHz lower end of the AM broadcast band.

The LF bands are roughly 100 to 540 kHz, while the VLF bands are from about 5 to 100 kHz. Below 5 kHz are the ELF (extremely low frequency) and what I call ULF (unbelievably low frequency) bands.

1,750 METERS

Part-15 of the FCC Rules and Regulations allows operation on many bands, on a non-interference basis, of transmitters not exceeding one-hundred milliwatts (100 mW) into an antenna not longer than 10 feet long (that 10 feet, by the way, includes the wire in any loading coils!). The 160- to 190-kHz (1,750-meter) LF band is used for communication using these low power levels. There are no call signs assigned by the FCC, so users of 1,750-meters tend to make up their own (usually their initials).

Many users of 1,750 meters operate "beacons" that can be detected (with skill and difficulty, at times). Users report on hearing the various beacons, and specialty (or club) publications will publish lists of those heard (and when).

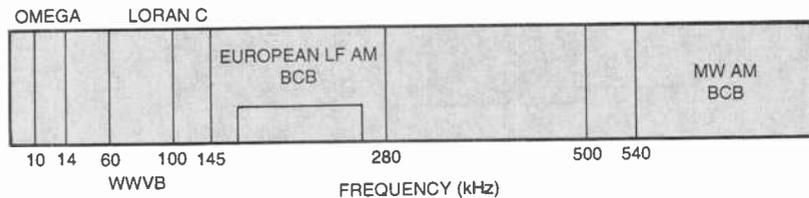


Fig. 1. This diagram illustrates the VLF/ILF frequency spectrum.

Other users of the same portion of the spectrum are European broadcasters. In Europe, the 145- to 280-kHz band is the LF AM broadcasting band (they also use the 540- to 1,700-kHz MW AM BCB as well). Some of those stations are megawatt blowtorches (such as Radio 252 from Ireland, which runs megawatt level power). It is interesting to see if these stations can be picked up in North America. I've had some success using both loop and long-wire antennas, but so far it has been sketchy as to results.

Figure 1 shows some of the activity to expect in the LF/VLF region. Between about 10 and 14 kHz are the Omega navigation stations. Up around 100 kHz are other navigation stations of the LORAN C category. At 60 kHz, you will find the National Institutes of Standards and Technology (NIST) time and frequency station WWVB. This station is more accurate (especially at a distance) for frequency measurements than the HF stations WWV and WWVH. You can spot the WWVB signal because it uses a binary coding scheme that depends on a 10-dB amplitude shift for 0 and 1 binary levels. WWVB can be received all over the lower 48 states, plus a considerable distance into Mexico and Canada (some even tell me it's hearable in Alaska, but I don't know about Hawaii). In the region between Omega and WWVB are a number of communication stations used by various nations to communicate with submarines at sea.

73 KHZ (4,100 METERS!)

In the United Kingdom amateurs may now use 73 kHz with very limited RF power levels. The Radiocom-

munications Agency (RA) of Great Britain allows "Class-A" licensed amateur radio operators to use any mode of operation in a narrow band of 71.6 to 74.4 kHz, or 73 ± 1.4 kHz. The total bandwidth is only 2.8 kHz, which is about what a single-sideband signal requires. I suspect CW will be quite popular on 73 kHz. Hams are allowed to use power levels up to one watt effective radiated power (1-W ERP). To use the band, UK hams must give seven days written notice to their district Radio Investigation Service (which I take to be similar to our FCC Field Engineering Offices); no mobile or maritime operation is allowed.

Other VLF/LF news from the European amateur-radio front is an International Amateur Radio Union (IARU) paper proposing an amateur allocation around 190 kHz on a shared basis with other services. The French are suggesting a common European frequency near 143 to 144 kHz. Other proposals from other semi-official and official groups include amateur operation in 132 to 140 kHz, and 148 to 149 kHz.

What's really funny about these allocation recommendations is that early hams operated on precisely those frequencies! After World War I, however, when amateurs were allowed back on the air, the comment was made "put 'em on 200-meters and down, they'll never get out of their backyards with that!" In terms of wavelength, "200-meters and down" is the HF shortwaves ... which is really great for "getting out of your backyard." It seems that radio experts of the late teens and early twenties had not heard of ionospheric propagation!

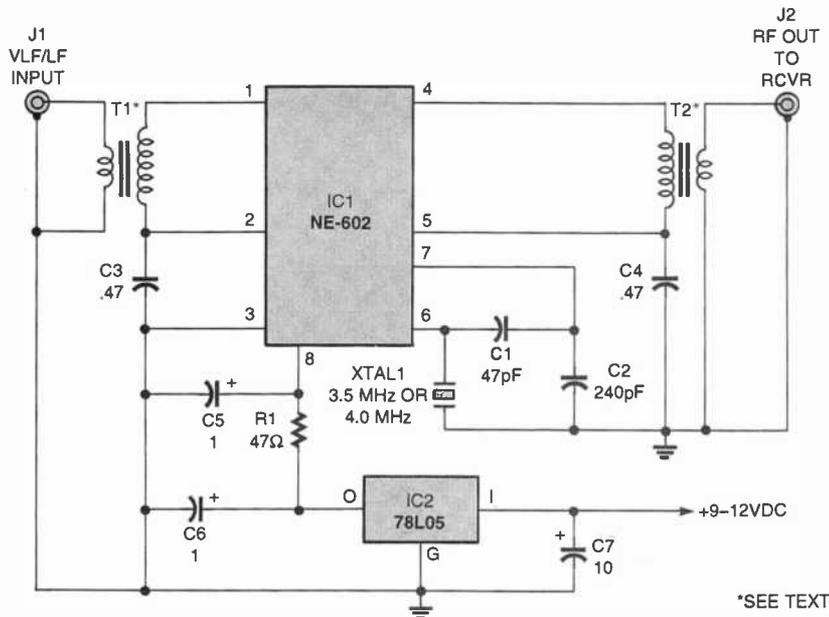


Fig. 2. Here's a simple VLF/ILF-to-HF converter circuit that you can build.

LF/VLF-TO-HF CONVERTER PROJECT

Many ham-radio receivers today are also general coverage receivers, even when part of a ham-bands-only transceiver. It is not uncommon to find amateur-radio receivers that go down to 100 kHz or even 30 kHz. But many receivers do not cover such low frequencies. And some of them that do cover LF/VLF frequencies are not all that wonderful at those frequencies. Sensitivity seems pukey at best for many models. You can, however, build a converter that will translate the LF/VLF frequencies to either 3.5 to 4 MHz or 4 to 4.5 MHz. Figure 2 shows a sample LF/VLF-to-HF converter circuit you can build.

This converter is based on the NE-602 chip (IC1). It contains the circuitry necessary to make the front-end of a superheterodyne receiver. It contains an oscillator that can be operated from very low frequencies up to about 200 MHz. It also contains a transconductance cell double balanced mixer (DBM) that works to 500 MHz or so. The DBM is the preferred mixer because it passes only the mixer products ($RF \pm LO$) to the output, and suppresses the original products (RF and LO). Thus, the output selector for IF need only concern itself with the sum and difference frequencies.

The LO circuit in Fig. 2 consists of capacitors C1, C2 and crystal XTAL1. If XTAL1 is a 3.5-MHz crystal, then the

10- to 500-kHz band will be found between 3.510 and 4.0 MHz on your HF receiver. Similarly, if the 4.0-MHz frequency is selected for XTAL1, then the LF/VLF frequencies are translated to between 4.01 and 4.5 MHz. The latter is preferred because the readout makes more sense to the user, however, not all ham receivers actually cover 4-4.5 MHz.

In either case, the lower end is specified as 10 kHz, but the real lower end depends on how close you can get to the LO crystal frequency. The LO is suppressed in the output of the NE-602, but that doesn't mean it is "eliminated altogether." Also, if the converter is not well shielded internally, LO energy from the oscillator will couple to the output circuits and get through to the receiver. In that case, the lowest frequency covered may well depend on how close your receiver can get to the LO without overloading or otherwise responding. In many

cases, judicious building and layout might produce a converter capable of receiving frequencies below 10 kHz. Most cases, however, will permit operation down to about 10 kHz unless really sloppy layout and shielding practices are used (in which case, the builder will definitely get what he or she deserves).

The input circuit consists of a single broadband RF transformer (T1). If you want to restrict operation to below 100 kHz, then T1 can be an audio inter-stage or output transformer. The output-style works well. Select a unit with 600 or 1000 ohms on one side and 4 or 8 ohms on the other. Use the low impedance winding for the primary (connected to the antenna), and the high impedance winding to connect to the NE-602 input pins (pins 1 and 2). I've tested garden-variety cheap transformers from a number of mailorder sources, as well as both types available from Radio Shack, and found them usable to about 120 kHz (though they work well up to only 100 kHz). Some higher-priced professional-grade microphone transformers (usually with 50- to 600-ohm ratios) work well to around 250 kHz, but cost in the \$15 to \$30 range (as opposed to \$1.98 for the cheapies).

The output transformer is made from a toroid core. Either a T-50-2 or T-50-6 core can be used. Wind 25 turns of wire for the primary winding, and 3 turns for the secondary winding of the transformer.

SOUPING UP YOUR RECEIVER

Suppose you have a LF/VLF band on your station receiver, but the best you can say about it would not be printable in a family publication. The usual problem is sensitivity, and results from the fact that many of these

continued on page 70

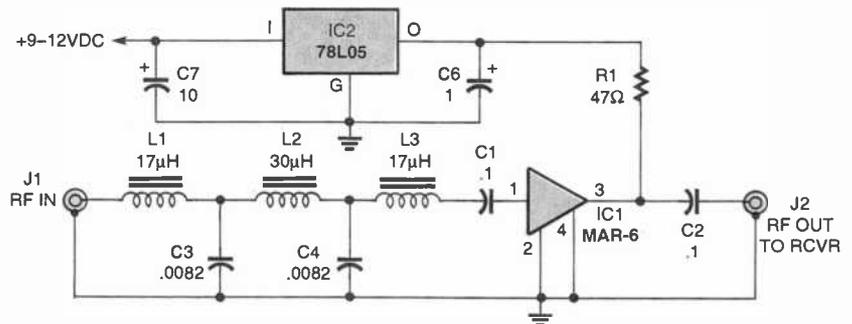


Fig. 3. Soup up your receiver with this VLF/ILF preamplifier.

COMPUTER BITS

Your Own Greatest Hits— Web Style

BY JEFF HOLTZMAN

Many people make their own "greatest hits" tapes by recording songs from several CDs (or LPs) onto cassettes. You can do the same thing with Web pages. And here you won't run up against any artificial 45-minute-per-side limits.

Next time we'll provide details on how to customize it to your liking. Along the way, you'll learn about several beginning and intermediate aspects of using HTML. As written, the page should function correctly on any modern browser capable of handling tables. I

Open the file in your browser. If all has gone well, you should see something that looks like Fig. 1. If not, you should check your typing against the printed listing.

To use the page, just click on a link. Note that it has both internal and external links. External links take you to other Web sites. Internal links allow you to jump around different portions of the page. For example, all those "back" links redisplay the TOC at the top of the page.

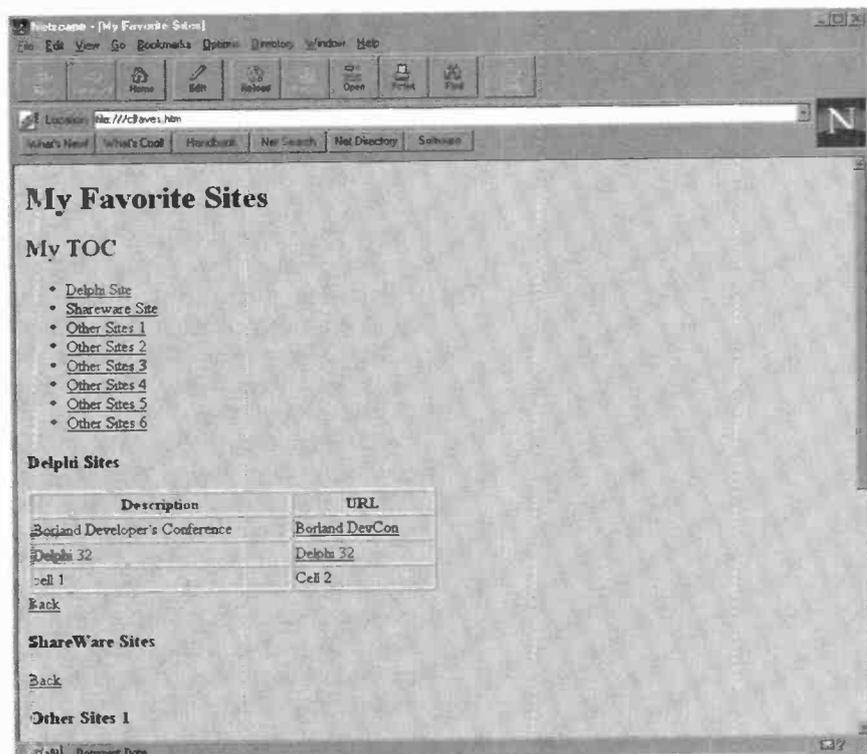


Fig. 1. Create your own Greatest Web Hits page. It runs under both Netscape and Explorer.

All you need to do is create a simple text file containing about a dozen different kinds of HTML tags. In so doing you'll end up with a highly functional Web page complete with a table of contents, which allows you to organize your favorites by topic. After the TOC comes one section containing all the URLs for each topic type. When you're done, you'll end up with a page that you can load at any time to quickly navigate to all of your favorite Net sites.

This month we'll talk about how to use the page and integrate it with your browser for maximum productivity.

specifically tested it with Microsoft Internet Explorer 3.0 and Netscape Navigator 2.0. (by the way, version 3.0 is now available)

INSTALLING AND CUSTOMIZING

Using any text editor (e.g., DOS Edit or Windows Notepad), enter the file shown in Listing 1, or obtain it from the Gernsback FTP site (ftp.gernsback.com). If you type it in yourself, be very careful to enter all the special characters correctly, or your page may display incorrectly or not at all. Save the file in any convenient directory.

URL BASICS

URL stands for Uniform Resource Locator; it's the official name for an Internet address. A URL typically consists of an address preceded by a protocol spec, usually "http" or "file," but possibly "ftp" or other designations. A URL like the following loads a page called mypage.html across the Internet from a site called mysite:

`http://www.mysite.com/mypage.html`

If mypage.html were located on a local drive, the spec would appear like this:

`file:///C:/mydir/mypage.html`

That is the naming convention accepted by Netscape. Note that there are three forward slashes following "file:," and there is a vertical bar after the letter C. The v-bar stands for a colon. Internet Explorer accepts the Netscape convention, as well as a more natural looking:

`file://C:/mydir/mypage.html`

Most browsers provide a drop-down box in which you can manually enter a URL, or select a previously used one from a list. Most browsers also have menu commands (like File/Open Location) that accomplish the same thing.

HTML BASICS

HTML stands for Hypertext Markup Language; it's really just a way of

LISTING 1-BASIC HTML FILE

```

1. <HTML>
2. <HEAD>
3. <TITLE>
4. My Favorite Sites
5. </TITLE>
6. </HEAD>
7.
8. <BODY>
9. <H1><A Name="TOP">My Favorite
Sites</H1>
10. <H2>My TOC</H2>
11. <UL>
12. <LI><A HREF="#Delphi
Sites">Delphi Site</A>
13. <LI><A HREF="#ShareWare
Sites">Shareware Site</A>
14. <LI><A HREF="#Other Sites
1">Other Sites 1</A>
15. <LI><A HREF="#Other Sites
2">Other Sites 2</A>
16. <LI><A HREF="#Other Sites
3">Other Sites 3</A>
17. <LI><A HREF="#Other Sites
4">Other Sites 4</A>
18. <LI><A HREF="#Other Sites
5">Other Sites 5</A>
19. <LI><A HREF="#Other Sites
6">Other Sites 6</A>
20. </UL>
21.
22. <H3><A Name="Delphi Sites">Delphi
Sites</A></H3>
23.
24. <TABLE BORDER WIDTH=50%>
25.
26. <TR>
27. <TH>Description</TH>
28. <TH>URL</TH>
29. </TR>
30. <TR>
31. <TD>Borland Developer's
Conference</TD>
32. <TD><A
HREF="http://www.dbex.com/bdc96.htm"
>Borland DevCon</A></TD>
33. </TR>
34. <TR>
35. <TD>Delphi 32</TD>
36. <TD><A HREF="http://www.del-
phi32.com/">Delphi 32</A></TD>
37. </TR>
38. <TR>
39. <TD>cell 1</TD>
40. <TD>Cell 2</TD>
41. </TR>
42. </TABLE>
43. <A HREF = "#TOP">Back</A>
44.
45.
46. <H3><A Name ="ShareWare
Sites">ShareWare Sites</A></H3>
47. <A HREF = "#TOP">Back</A>
48.
49. <H3><A Name ="Other Sites
1">Other Sites 1</A></H3>
50. <A HREF = "#TOP">Back</A>
51.
52. <H3><A Name ="Other Sites
2">Other Sites 2</A></H3>
53. <A HREF = "#TOP">Back</A>
54.
55. <H3><A Name ="Other Sites
3">Other Sites 3</A></H3>
56. <A HREF = "#TOP">Back</A>
57.
58. <H3><A Name ="Other Sites
4">Other Sites 4</A></H3>
59. <A HREF = "#TOP">Back</A>
60.
61. <H3><A Name ="Other Sites
5">Other Sites 5</A></H3>
62. <A HREF = "#TOP">Back</A>
63.
64. <H3><A Name ="Other Sites
6">Other Sites 6</A></H3>
65. <A HREF = "#TOP">Back</A>
66.
67. </BODY>
68. </HTML>

```

marking document structure and formatting using plain ASCII text files, rather than the binary formats used by products like WordPerfect and Word. The basic structure of an HTML file appears in Listing 1.

Note that there are several strings of characters enclosed within angle brackets <like this>. Each of those things, including the brackets, is called a tag. There are many tags in HTML; our Greatest Hits page uses the most common, as well as a few extra powerful ones.

By convention, tags are capitalized. Any text that appears outside of a tag will be displayed on the web page. Some text within tags is also dis-

played, depending, of course, on the type of tag.

I'll provide more HTML details next time, but by studying the listing, you can probably figure out how to customize the page yourself. In the meantime, here are a few hints to help you get started with HTML:

1. Tags usually come in pairs, e.g., <HTML> and </HTML>.

2. Tags containing "A HREF . . ." are reference tags, which specify go to URLs.

3. Tags containing "A NAME . . ." are anchor tags, which specify a place in a document, and a name by which that place is known. Anchors provide the capability of jumping to a specific

point on a page, via either an internal or an external jump.

4. For specifics on HTML tags and standards, browse through <http://www.w3.org>, the official standards body for Web-related activities.

Next time we'll provide a detailed discussion of how the page works, how to customize it, and how to make it the "home base" for all your browsing sessions. See you then. ■

HAM RADIO

(continued from page 68)

receivers use no RF amplifier ahead of the mixer at LF/VLF. The solution for you might be the preamplifier circuit shown in Fig. 3.

This preamplifier will provide around 15 to 18 dB of gain at LF/VLF frequencies. It is based on the Mini-Circuits MAR-6 device (Ocean State Electronics, P.O. Box 1458, Westerly, RI, 02891; Tel. 401-596-3080). They also stock the toroid cores. Although normally thought of as a VHF-to-microwave amplifier, the low-noise MAR-6 actually works to near-DC frequencies (with the low end being set by the value of capacitors C1 and C2, for all practical purposes).

The frequency response in the circuit in Fig. 3 is limited to lower than 500 kHz by the use of a low-pass filter with a -3 dB cut-off at 500 kHz. One purpose of the LPF is to eliminate interference from AM BCB stations that could overload the MAR-6 device. With the filter in place, more of the device's dynamic range is available for amplifying LF/VLF signals.

You can contact me at P.O. Box 1099, Falls Church, VA, 22041; via e-mail at carrjj@aol.com, or through the magazine. I look forward to hearing from you. ■



"The villagers are coming up our driveway carrying torches."

DX LISTENING

Antarctica's Broadcaster

BY DON JENSEN

Antarctica is one of the more remote spots on the globe. And over the years, only two shortwave broadcasting stations have operated from this most southern of all the continents.

Though the American Forces Antarctic Network's SW outlet at McMurdo Base has been silent for years, the other Antarctic broadcaster, Argentina's LRA36, Radio Nacional Arcangel San Gabriel reportedly is alive and well after an impressive 17 years of operation (though it has been transmitting sporadically).

While most nations have forsworn territorial claims to the frozen continent, where the thermometer reads 30 degrees below zero on a typical mid-winter day, Argentina has claimed sovereignty for decades. It backs this contention with nearly 20 Antarctic outposts, scientific bases, military detachments, and, since 1980, a shortwave station.

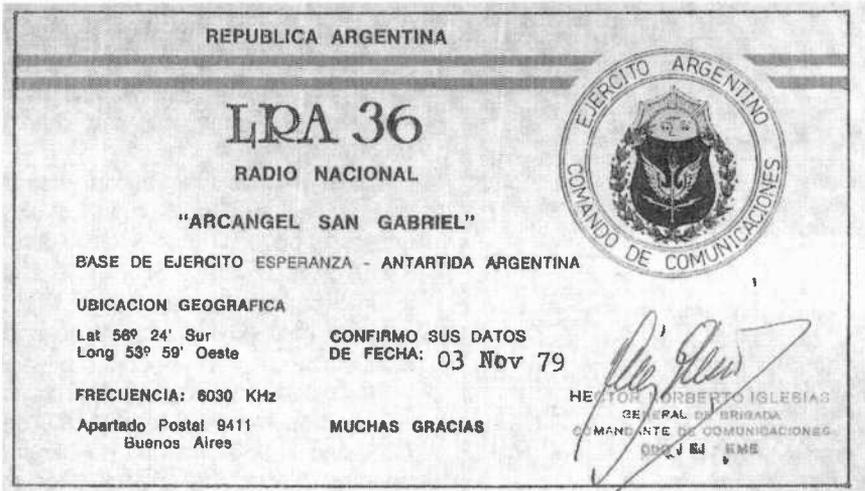
LRA36 is located at an Argentine Army installation known as Base Esperanza, or Hope Base, at latitude 63.24 south and longitude 56.59 west, on the long Antarctic peninsula that juts northward below the tip of South America. At that extreme latitude, it is without a doubt the most southerly SW station on the air today.

The polar station is, sometimes, heard as far away as the United States and Canada on its frequency of 15,476 kHz. That's an impressive signal.

A longtime DXing friend, Gabriel Ivan Barrera, writing from Argentina, provides some interesting background about this very fascinating SW radio operation.

Radio Nacional Arcangel San Gabriel, he says, is operated by Argentine army personnel, headed by Lt. Col. Luis Alberto Dupuy, who also is the commander of the Esperanza military base, a remote outpost of just 14 build-

CREDITS: Bill Bergadano, NJ; William McGuire, MD; Ed Newbury, NE; Dan Ziolkowski, NY; North American SW Association, 45 Wildflower Road, Levittown, PA 19057.



Here's a verification card from Radio Nacional Arcangel San Gabriel, operated from Antarctica by the Argentine military.

ings. The staff is headed by two sergeants, Jose Luis Amat and Luis Ramirez, along with Vivana Lopez, Adriana Arias and Mari Dupuy.

The station broadcasts Spanish language programs just two hours a day, 1800 to 2000 UTC, Mondays through Fridays.

The transmitter, a vintage, low-powered 1-kilowatt Dutch-made Phillips sender, was already nearly two decades old when it was installed on the Antarctic peninsula in 1980. Since then, Barrera reports, the harsh elements of wind and snow have taken their toll, making it somewhat difficult to transmit from this old unit.

The station's music library still relies mostly on old 33.3-RPM LP records, some 1200 of them, although in 1996, LRA36 received its first batch of 13 CDs of Argentine music.

As a part of Argentina's Servicio Oficial de Radiodifusion and its Radio Nacional, the Antarctic outlet hopes that there will be funding made available for modernization of the aging facility, says Barrera.

Its programming is, frankly, curious. One of its regular Spanish language programs, *Descubriendo la Argentina*, or *Discovering Argentina*, focuses on tourist attractions of the home country. One can only wonder who station offi-

cialists hope to reach with this bizarre broadcast!

For SWLs, if the signal is strong enough, the musical programs are varied and enjoyable, although it is a bit surprising to hear romantic Argentine tangos aired by a radio station in such a remote and frigid locale.

It is evident that the local military personnel and their families prefer the broadcasts of two, 24-hour-day short-range FM relay operations that receive Argentine mainland programs via satellite from FM Feeling and FM Horizonte in Buenos Aires. Satellite signals also are received from Argentine TV stations.

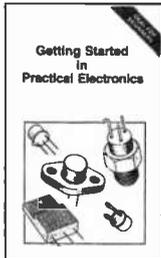
Barrera says that as of this writing, Radio Nacional Arcangel San Gabriel is best heard after 1900 UTC, when interference ends from shortwave neighbor Africa No. 1 in Gabon, West Africa, on 15,475 kHz.

The sign off at 2000 UTC, he notes, is nominal, and can vary from as early as about 1945 UTC. The SW outlet leaves the air with an instrumental anthem, "Aurora."

LRA36, Radio Nacional Arcangel San Gabriel will usually verify any correct reception reports with a QSL card. Its mailing address is in care of Base de Ejercito Esperanza, 9411 Antartida Argentina.

You can Build Gadgets!

Here are 3 reasons why!

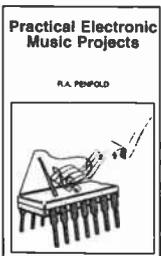
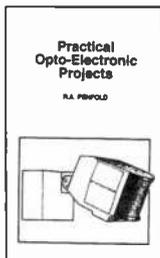


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THEN AND NOW

What happened to all those transmitters once operated by the vast Soviet shortwave broadcasting apparatus within the former USSR?

A lot of these stations, under new management, are still broadcasting. Here are some selected English broadcasts from some of these ex-Soviet SWers. This data has been collected by DXer Kevin Hecht, who invites SWLs to submit additions and corrections to his e-mail address: khecht19@mail.idt.new.

Radio Ukraine International broadcasts to eastern North America and Europe at 0000 UTC on 5,905, 5,915, 6,010, 6,080, 7,150, 9,550, 9,560 and 9,735 kHz., and to the rest of North America at 0300 UTC on 7,150 and 9,550 kHz.

Radiostantsiya Belarus has English on Tuesdays from 1845 to 1900 UTC on 7,210 and 11,960 kHz, and via Ukrainian transmitters, 7,180 and 9,875 kHz.

Radio Vilnius, Lithuania, has English at 0030 UTC, relayed by a 100-kilowatt German transmitter on 9,560 kHz.

Radio Dniester International, supposedly transmitted from Pridnestrovye, a separatist territory of Moldova, has English programming on a sporadic basis from 2030 UTC on 11,750 kHz.

Uzbekistan's Radio Tashkent is reported from 0100 to 0130 UTC on 6,160, 7,190 and 9,715 kHz, and from 1200 to 1230, and 1330 to 1400 UTC on 7,190, 9,715 and 15,295 kHz.

Voice of Armenia is on the air Monday through Friday at 1745 UTC on 4,810, 4,990, 7,480 and 9,965 kHz. It also is scheduled daily at 2030 on 9,965, 11,615 and 11,665 kHz.

Radio Almaty in Kazakhstan is on 6,230 kHz from 0030 to 0100 UTC, and, via a Ukrainian transmitter, 0530 to 0100 UTC on 11,705 kHz.

INSIDE THE VOA

Skip Arey, host of the Listener's Library column in *The Journal of the North American SW Association*, recently reviewed an interesting book about the inner workings of the Voice of America and its news operations.

The book, *A Basement Seat to History: Tales of Covering Presidents Nixon, Ford, Carter and Reagan* from the Voice of America was written by Philomena Jurey, (Linus Press, P.O. Box 5446, Washington DC 20016; \$16.95).

Ms. Jurey was employed by the VOA for some 28 years, half of that as its White House news correspondent. During that period she was responsible for the presidential news coverage that was heard by listeners around the world.

Arey says that the stories Ms. Jurey relays of those administrations are told in a personal and very anecdotal style.

"Along the way, the radio enthusiast gets a taste of how the VOA was run through this era, including issues such as programming and budget problems."

Though the average American knows little about our overseas shortwave broadcasting, Jurey makes it clear that American presidents have seldom doubted the VOA's power as a diplomatic tool.

"This is a well-written memoir," says Arey, "worth the time of any radio hobbyist with an interest on how this business of international shortwave is conducted."

DOWN THE DIAL

Looking for some interesting SW signals? Try these. Remember that Universal Coordinated Time, abbreviated as UTC, is equivalent to EST+5 hours, CST+6 hours, MST+7 hours or PST+8 hours.

GERMANY—6,085 kHz. Bayerischer Rundfunk in Munich is one of the private German shortwave outlets. This has been reported around 0045 UTC with German-language programming, but American country and western music.

GUATEMALA—4,835 kHz. Radio Tezulutlan has been logged both morning and evening on this frequency. Try around 1125 UTC and 0145 UTC. Programming is, of course, in Spanish, and local marimba music is often heard.

IRAN—6,050 kHz. Voice of the Islamic Republic of Iran, VOIRI, in Teheran can be heard on this frequency around 0030 UTC with English programming.

SWITZERLAND—6,135 kHz. Swiss Radio International, has an English newscast at 0400 UTC.

ZIMBABWE—3,396 kHz. Zimbabwe Broadcasting Corp. in southern Africa suffers from some interference from a radioteletype signal but still can be logged on occasion around 0350 UTC with African highlife music and English commentary.

Circuit Circus

Power Up

Welcome, circueteers. Let's pop the lid off of the old circuit pot again, stir it a little, and select a few hopefully, useful and interesting items to look over.

Our first three circuits are offered in response to a fellow experimenter who wanted a cheap and simple way to light a neon lamp using just two 9-volt batteries and without using a transformer or any solid-state devices. He also wanted to double the output voltage of a 9-volt battery and supply a negative low-current bias voltage in a similar manner.

So, without further delay, let's get right to those circuits, as well as a few others.

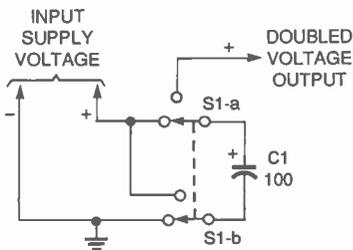


Fig. 1. Move switch S1 to its other position, and the charged capacitor will double the voltage output of this circuit.

PARTS LIST FOR THE VOLTAGE DOUBLER (Fig. 1)

C1—100- μ F, 35-WVDC (or other rating to handle input voltage), electrolytic capacitor
S1—DPDT toggle switch
Wire, solder, etc.

VOLTAGE DOUBLER

A simple voltage-doubler circuit is shown in Fig. 1. In the circuit, a 100- μ F electrolytic capacitor is connected to the wipers of a DPDT switch and, as shown, is charged to the input supply voltage.

Throwing the switch to its opposite position places the negative side of the capacitor to the positive side of the power source. As a result, the positive output voltage of the circuit will be temporarily doubled.

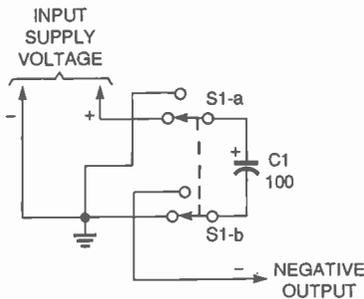


Fig. 2. Move S1 from the position shown here to the other one, and you'll have a negative voltage supply.

PARTS LIST FOR THE NEGATIVE VOLTAGE SOURCE (Fig. 2)

C1—100- μ F, 35-WVDC (or other rating to handle input voltage), electrolytic capacitor
S1—DPDT toggle switch
Wire, solder, etc.

NEGATIVE VOLTAGE SOURCE

The negative voltage circuit, shown in Fig. 2, is very similar to the previous circuit but has a different output switching arrangement. As shown in the schematic, C1 is tied across the power source and is fully charged. Switching S1 to the other position takes the capacitor's positive lead to ground and its negative lead to the output terminal.

The negative supply may be used as a low-current bias source. Or, if you

BY CHARLES D. RAKES

were to add a larger-value capacitor, the circuit could, in a pinch, operate as the negative supply for an op-amp circuit.

If a larger capacitor is used, though, add a low-value resistor in series with one input lead to protect the switch from arcing during the initial charging cycle. A 10- to 100-ohm resistor with a wattage rating high enough not to go up in smoke during the charging cycle should be used.

A quick flip of the switch to first position and back renews the negative supply.

5 \times VOLTAGE SOURCE

Our last switching power supply is the 5 \times voltage source shown in Fig. 3. Here we have five DPDT switches (S1-S5) and five 100- μ F, 35-WVDC, electrolytic capacitors (C1-C5) connected together to multiply the voltage of two 9-volt batteries in series by five. The result will be a 90-volt output, which can light neon-lamp NE1.

As shown in the schematic, switches S1-S5 are in the charge position with all five capacitors tied across the

PARTS LIST FOR THE 5 \times VOLTAGE SOURCE (Fig. 3)

R1-R5—22-ohm, 1/2-watt, 5% resistor
R6—470,000-ohm, 1/4-watt, 5% resistor
C1-C5—100- μ F, 35-WVDC, electrolytic capacitor
NE1—Neon lamp, type NE-2
S1-S5—DPDT switch
B1, B2—9-volt alkaline battery
Wire, solder, etc.

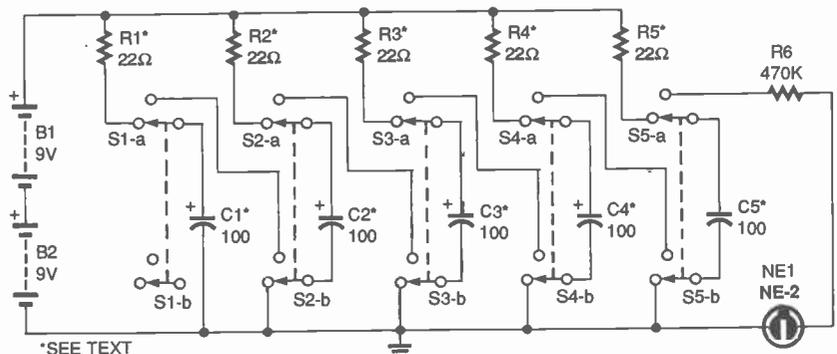
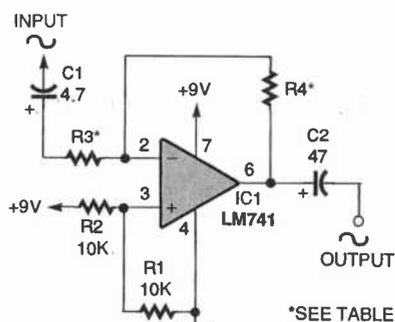


Fig. 3. With this circuit, you can turn 18 volts into 90 volts, which is enough to power neon-lamp NE1.

18-volt source. Five 22-ohm, 1/2-watt resistors, R1-R5, limit the charging current and protect the switch contacts. When all five switches are switched to the opposite position the five capacitors are connected in series to produce the 90-volt output. When the neon lamp begins to dim, flip the switches over to charge, and bring them back for a bright light.

Some of you might think these antique voltage multipliers are of little value in today's high-tech arena. In the majority of cases, you'd be correct too. But if you had no other method available at the time, you'd be surprised how some of these simple circuits might become very useful, indeed.



A

R3	R4	GAIN
1K	1K	1
1K	10K	10
1K	100K	100
1K	500K	500
10K	10K	1
10K	100K	10
10K	1 MEG	100
10K	2 MEG	200

B

Fig. 4. Add some gain to a project with the circuit shown in A. The values of R3 and R4 determine the gain of IC1; use the table in B to select them.

PARTS LIST FOR THE GAIN PROVIDER (Fig. 4)

IC1—LM741 op-amp, integrated circuit
 R1, R2—10,000-ohm, 1/4-watt, 5% resistor
 R3, R4—1/4-watt, 5% resistor (see table in Fig. 4B for value)
 C1—4.7-µF, 35-WVDC, electrolytic capacitor
 C2—47-µF, 35-WVDC, electrolytic capacitor
 Wire, solder, etc.

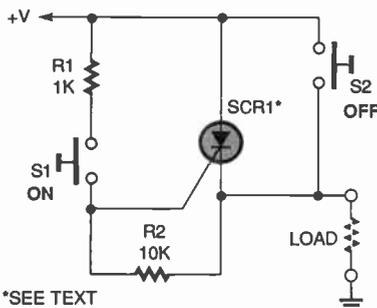
GAIN PROVIDER

Sometimes it's easy to forget that

not everyone has been there and done that, and that's one reason for presenting the next circuit. The LM741 op-amp is probably older than many of our readers, but for those who have not played around with this versatile semiconductor yet, here's a very simple and useful circuit application to start with.

A single-supply, LM741 inverting AC amplifier circuit is shown in Fig. 4A. This circuit may be added to just about any existing project for additional gain where needed. The circuit's input impedance is equal to the value of input-resistor R3, and the output impedance is somewhere around 100 ohms.

The amplifier's gain is equal to R4 divided by R3. A table in Fig. 4B shows several resistor values for R3 and R4 that you'll need to obtain for gain figures of 1 to 500.



*SEE TEXT

Fig. 5. This latching circuit can be used as an on/off switch with a memory.

PARTS LIST FOR THE MEMORY POWER SWITCH (Fig. 5)

SCR1—50-volt, 1-ampere silicon-controlled rectifier (or select type for desired load)
 R1—1000-ohm, 1/4-watt, 5% resistor
 R2—10,000-ohm, 1/4-watt, 5% resistor
 S1, S2—Pushbutton switch, normally open
 Wire, solder, etc.

MEMORY POWER SWITCH

Our next entry (see Fig. 5) uses an SCR in a latching circuit. This can be added to a DC-operated circuit as a type of on/off switch that actually has a memory.

Pressing S1 momentarily supplies current to the SCR's gate, thereby turning it on and supplying power to the load. As long as the load current is greater than the SCR's minimum holding current the power will remain on. Closing S2 momentarily shunts the

load current around the SCR allowing it to turn off and opening the circuit to the load. This occurs as soon as you release S2.

The SCR type should be selected to meet the demands of the load circuit and power supply. Always select a device with a higher current and voltage rating than the application calls for. A little safety factor here is a cheap insurance policy, and will save the trouble and cost of buying more thyristors.

STEPPER AND DRIVER

Our last, and slightly more involved, entry (see Fig. 6A) this time around is a sequential stepper and driver circuit. This was originally designed as the sequential driver for a setup that performed six different tests on an electronic component. The circuit uses a seven-segment LED display, DISP1, to show the step position.

Two gates of a quad two-input NAND gate IC (4011), IC1-a and IC1-b, are connected in a bounceless switch set and reset latch circuit (make sure to ground pins 8, 9, 12, and 13 of IC1 to ground).

Each time S1 is moved from the position shown to the other position and back, the output at pin 3 of IC1-a toggles, sending a clock pulse to the clock input of IC2 (a 4017 CMOS decade counter/divider). That 4017 is connected in a counter circuit that counts from one to six and then repeats over and over as long as pulses are received from IC1.

A 4511B BCD to seven-segment latch and driver, IC3, supplies drive

PARTS LIST FOR THE STEPPER AND DRIVER (Fig. 6)

SEMICONDUCTORS

IC1—4011 quad two-input NAND gate, integrated circuit
 IC2—4017 decade counter/divider, integrated circuit
 IC3—4511B 7-segment latch and driver, integrated circuit
 DISP1—7-segment display, common-cathode
 D1-D9—1N914 silicon diode

ADDITIONAL PARTS AND MATERIALS

R1-R6—100,000-ohm, 1/4-watt, 5% resistor
 R7-R13—680-ohm, 1/4-watt, 5% resistor
 C1-C3—0.1-µF, ceramic-disc capacitor
 S1—SPDT switch
 Wire, solder, etc.

excessive zooming, shaky pictures, poor focus, and lack of editing and continuity.

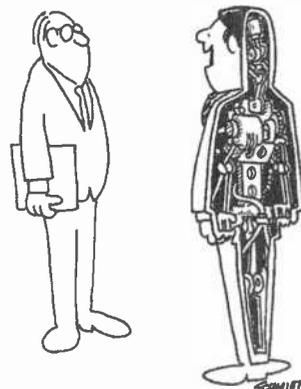
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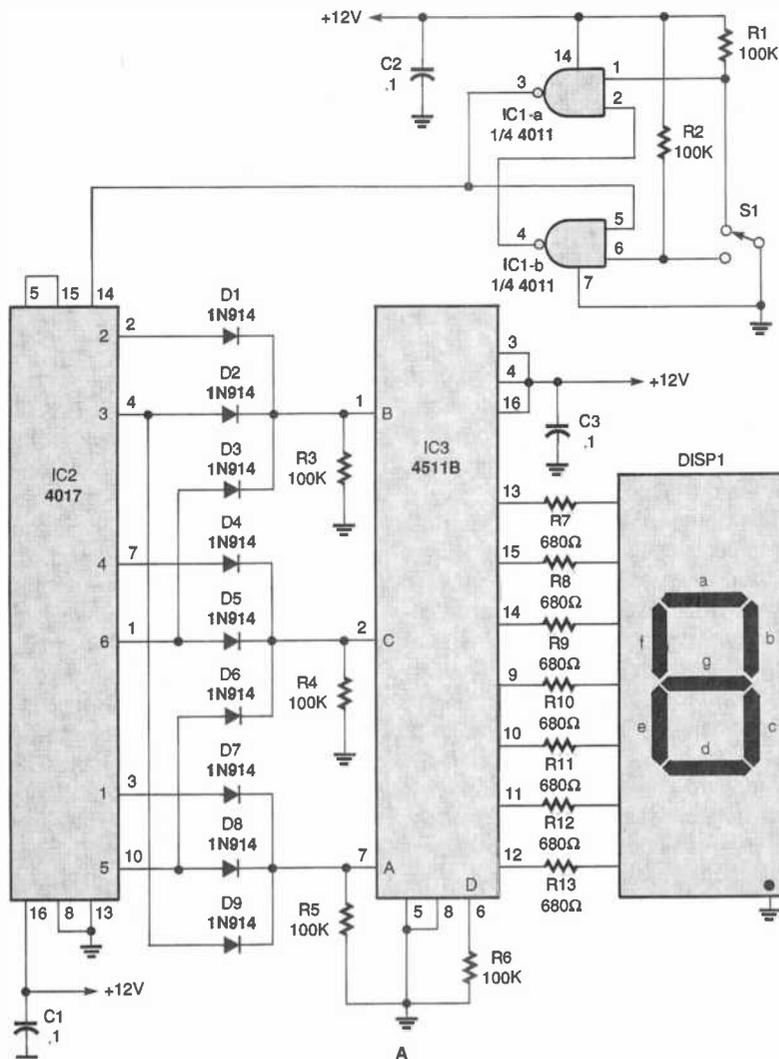
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IC3 INPUTS				RESULTING DISPLAY
D	C	B	A	
0	0	0	0	0
0	0	0	1	1
0	0	1	0	2
0	0	1	1	3
0	1	0	0	4

IC3 INPUTS				RESULTING DISPLAY
D	C	B	A	
0	1	0	1	5
0	1	1	0	6
0	1	1	1	7
1	0	0	0	8
1	0	0	1	9

Fig. 6. This sequential stepper and driver (A) uses a seven-segment LED display, DISP1, to show the step position. Follow the truth table (B) for input data.

current for DISP1. The 4017's 1 to 6 decimal output count is converted through a diode matrix to a BCD format to input the 4511B. Resistors R7-R13 limit current for the display. The 4511B's truth table is shown in Fig. 6B. For example, to produce a "0" reading all four of the 4511B's BCD inputs must be low. To find out what all of the

other display readings are, you just have to follow the truth table for IC3 input data.

It's about closing time here at the circus, so here's hoping that at least one of the above circuits will in some way be helpful to you. In any case, good circuitry until we meet here again next issue.

Think Tank

Doorbell Circuits

BY JOHN J. YACONO
TECHNICAL EDITOR
WINDOWS MAGAZINE

This month's contributors have all provided circuits to enhance doorbells. We'll get to their circuits after we continue our discussion of semiconductors.

We were up to PN junctions last time, and I posed the question: "What simple component is made of just a single junction?" Well, a diode consists of one junction. Its structure is shown in Fig. 1A and its schematic symbol is shown in Fig. 1B.

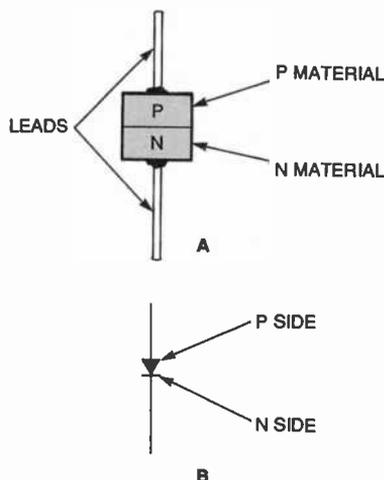


Fig. 1. A diode consists of one junction; its structure is shown in A and its schematic symbol is shown in B.

The most typical use for a diode is to make sure current flows in only one direction. For conventional current (where we envision the flow of positive charges) current flows across the junction from the P material to the N material. For the electron-current view (the flow of actual electrons), current flows from the N material to the P material. However, for obvious reasons, you can't easily force electrons to flow from the electron-poor P region into the electron-rich N region, while pulling holes from the electron-rich N region into the hole-glutted P region.

In simpler terms, conventional current will not flow from the N to the P region, and electron current will not flow from the P to the N region. So the diode only allows current flow of either type in one direction. The action of

applying voltage in the correct direction is called "forward biasing," while applying voltage in the other direction is called "reverse biasing."

Now we know enough about diodes to mention a little more nomenclature. The P region and its wire form the "anode" of the diode. The N region and wire are the "cathode."

The barrier potential mentioned last month produces a voltage drop across any diode even when it's forward biased. That is called the "forward-voltage drop," and it depends on the substrate the diode's made from. The two most-common materials are silicon and germanium, with forward drops of around 0.7 and 0.3 volts, respectively. The forward current a diode can handle is not limitless. The actual amount for a given unit depends on the area of its junction, the heat dissipation of its case, etc. This characteristic is called the "maximum forward current."

When there is a gentle reverse bias, a tiny amount of current does actually flow through an electron. It's called the "leakage current." You can get large amounts of reverse current to flow, but you have to apply a very large potential to break the diode's spirit. The voltage at which this "breakdown" occurs is called the "reverse breakdown" or "peak-inverse" voltage of the diode,

and varies; from design to design. But that's enough theory let's check out what's ringing.

THE COMPLETE SMART-BUTTON CIRCUIT

I wanted a circuit I could add to my doorbell system to unlock the door after the right number of button presses occurred in a specific amount of time. My first concept is shown as a block diagram in Fig. 2. The doorbell pushbutton, S1, is debounced by R1, C1, and IC1-a. Integrated-circuit IC4 counts the closures of S1 until a pause causes IC4 to reset at the trailing edge of the IC3-a pulse. The two most-common materials are silicon and germanium, with forward drops of around 0.7 and 0.3 volts, respectively. The forward current a diode can handle is not limitless. The actual amount for a given unit depends on the area of its junction, the heat dissipation of its case, etc. This characteristic is called the "maximum forward current."

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and varies; from design to design. But that's enough theory let's check out what's ringing.

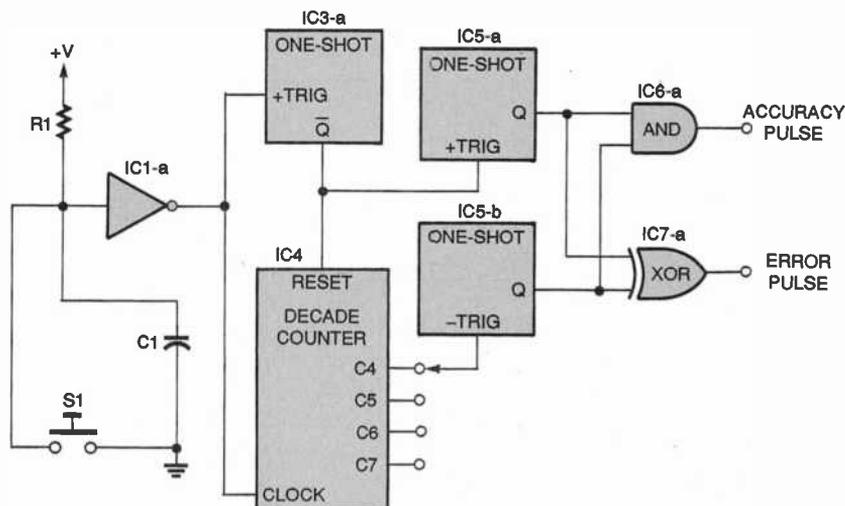


Fig. 2. This block diagram is an early concept for a circuit that unlocks a door after the right number of button presses occur in a specific amount of time.

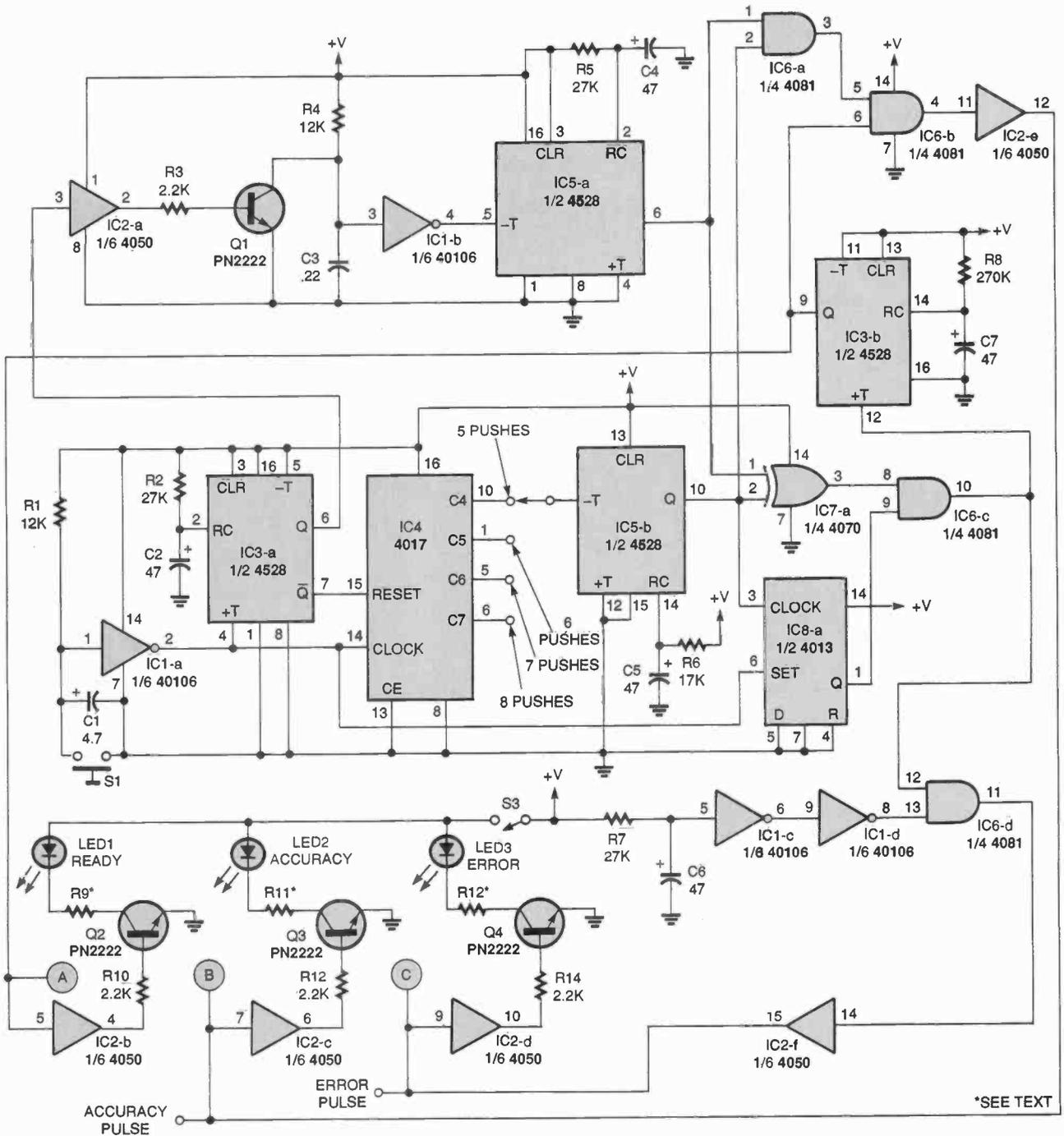


Fig. 3. This complete circuit makes the idea in Fig. 2 workable.

pulses could be conditioned to disengage a door-lock solenoid.

However, there are some bugs in this basic design, solved by the more complex circuit in Fig. 3. Pushbutton S1 is debounced by R1, C1, and IC1-a. The first push of S1 removes the high on the reset line of counter IC4 by triggering one-shot IC3-a. The reset line is then held low by subsequent pushes of S1 thereby allowing IC4 to count the subsequent pushes of S1 as

long as S1 is pushed rapidly enough. Too long an interval between the pushes of S1 will cause IC4 to reset by allowing the pulse from IC3-a to time out. That interval is determined by R2 and C2. Four of the output lines of IC4 are selectable: Counts 4 through 7. Count 4 output represents 5 pushes of S1- count 5 represents 6 pushes, and so on. The output of IC4 will be a pulse even if S1 is stopped after the correct number of pushes because the pulse

from IC3-a will time-out, resetting IC4.

The output of IC3-a is delayed by R4 and C3 so that IC5-a is not triggered before IC5-b. The delay is necessary to ensure that false error pulses that accompany the accuracy pulse are blanked out by IC8-a. Integrated-circuit IC5-a is then triggered (after a slight delay) at the trailing edge of the pulse from IC3-a. Integrated-circuit IC5-b will always trigger a little before IC5-a (which is delayed) because IC5-

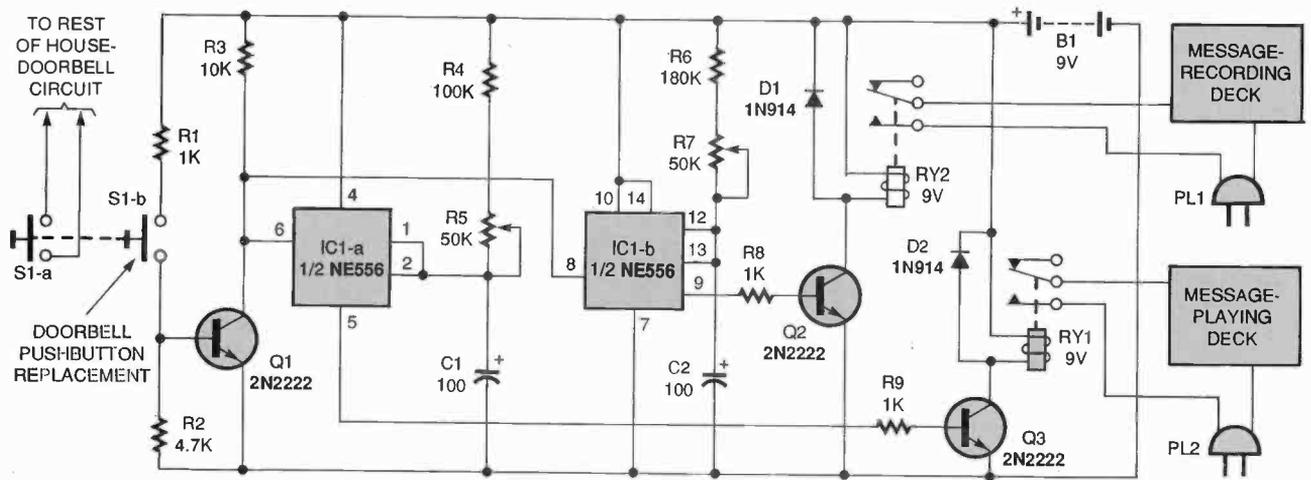


Fig. 4. Here's a circuit that is similar to a telephone-answering machine; however, it takes messages from those who ring your doorbell.

b is triggered by the trailing edge of the IC4 output, which coincides with the trailing edge of the pulse from IC3-a.

The pulses from IC5-a and IC5-b are gated by IC6-a and IC7-a. A pulse from IC5-a results from S1 subsiding, while pulse from IC5-b results from S1 closing the correct number of times. When both pulses are present at the input of IC6-a an output occurs. The IC6-a output is then gated with the pulse from IC3-b (in IC6-b) in order to blank out any over counts (such as 15-18, or 25-28 pushes of S1). Integrated-circuit IC3-b triggers on the error pulse caused, in part, by exceeding the correct number of S1 closures and multiples thereof. The IC3-b output pulse is approximately 3.5 seconds. (By the way, the RC values used for the one shots in this circuit may not prove out mathematically, but the pulses are stable enough for this application.)

The error pulse is derived from gating the outputs of IC5-a and IC5-b in IC7-a. If the output pulse of either IC5-a or IC5-b is present when the other is absent, then there will be an output pulse from IC7-a. If, however, the pulses from IC5-a and IC5-b are either both present or both absent, then no pulse will appear at the output of IC7-a unless those present pulses don't completely overlap each other. So to prevent false error pulses from this source, the output of IC7-a is gated with the output of IC8-a (a "D" flip-flop), which goes low when IC5-b is triggered (IC5-a is delayed) if S1 has stopped being pushed.

Charging C1 at power on causes a false error pulse, which is suppressed by gating the output of IC6-c with a pulse derived from the charging of C6.

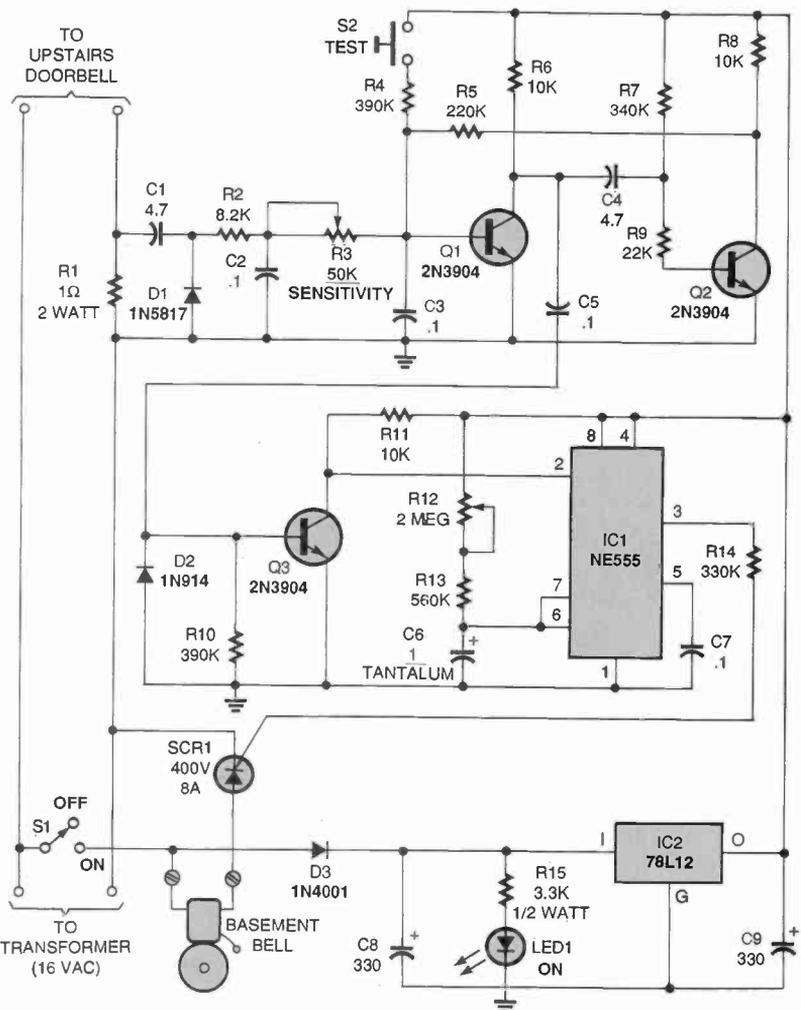


Fig. 5. Hear your doorbell in the basement with this circuit.

To achieve an accuracy pulse you must push S1 at least 3 times per second for the pre-selected number of times. If you push too many times, or if you push too few times, or if you push too slowly, then an error pulse will trigger IC3-b and you must wait about 4

seconds before trying again.

Light-emitting diodes LED1+LED3 could be mounted either on the circuit board or on a panel and, in either case, used for practice. Resistors R9, R11, and R12 should be about 220 ohms for +5VDC, 390 ohms for

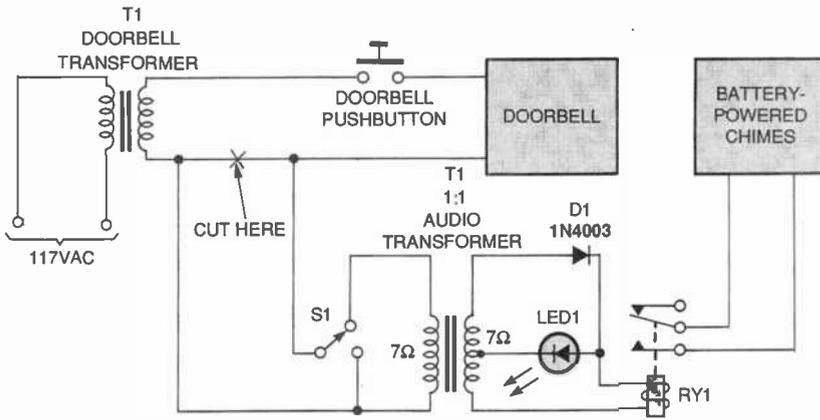


Fig. 6. This circuit enables you to ring additional door bells in adjacent areas such as basements, work shops, or garages.

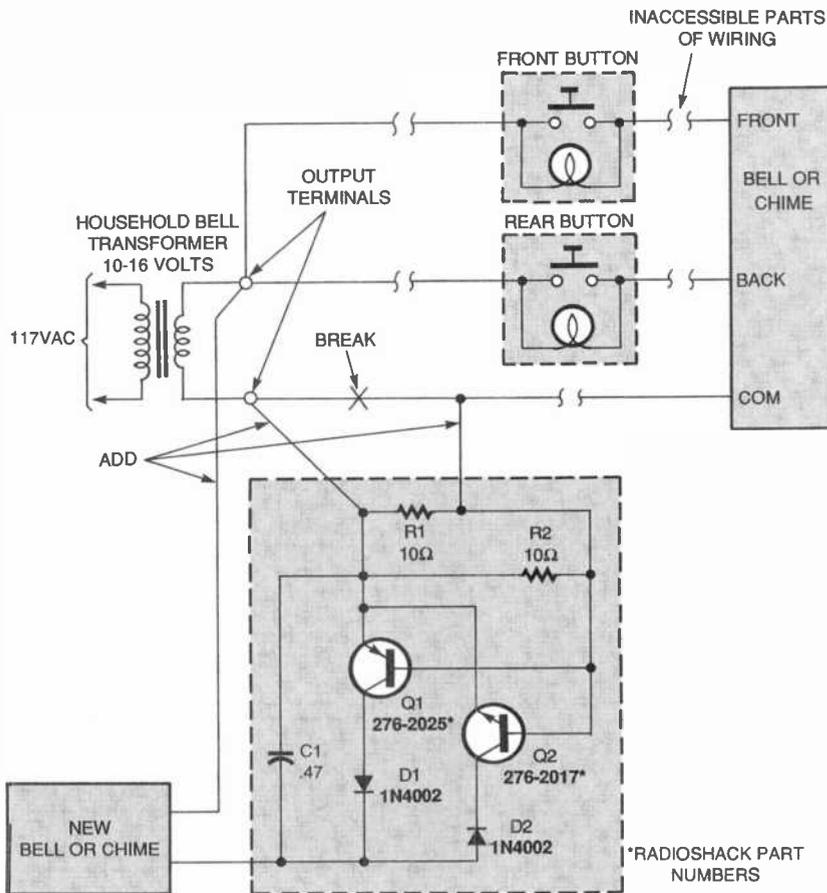


Fig. 7. With this circuit, you can add a remote bell to an existing doorbell circuit, without tearing out walls to access the wiring between the door button and chime.

+9VDC or 560 ohms for +12VDC. Therefore +V could be either 5, 9, or 12 volts DC.

—George T. Kysor, San Jose, Costa Rica

Wow! Great design work! I recommend an optical coupling to the solenoid circuit. Using a relay or a plain solid-state switching device common to the solenoid could be compromised

by ripping out the switch and flooding the circuit input with high voltage.

BELL-ANSWERING MACHINE

Want to know for sure if a friend or maybe the cable guy has stopped by your house? Build the circuit shown in Fig. 4. It is similar to a phone answering machine, but it is for your doorbell!

The circuit is simple. When someone depresses S1 (which replaces your doorbell pushbutton) the doorbell rings, and Q1 switches on. The transistor in turn triggers both monostables. The first one will energize relay RY1 for approximately 13 seconds, which will cause a tape deck to play a message from a looped cassette (a cassette that repeats without rewinding). The second monostable will energize relay RY2 for approximately 23 seconds via Q2, starting a deck set to record your playing message (as a separator between messages) plus a message from your visitor for the remaining 10 seconds.

The two variable resistors allow you to adjust the outgoing and incoming message length. Note that the values of the resistors are not critical.

—Sohail A. Bahzad, Doha-Qatar

This is easily one of the most interesting ideas I've seen: a doorbell that takes a message. This sort of thing should be available retail, but I haven't seen anything like it. I wonder if RY1 and RY2 could be wired to the memo and OGM (Out-Going Message) switches on a regular answering machine to replace the two decks? It'd be neat if you could use one device to get both phone and door messages.

BASEMENT BELL

On my street there is a retired person who works in his basement and cannot always hear the doorbell. Since the doorbell transformer is in the basement and the rest of the wiring is upstairs, I built the following circuit (shown in Fig. 5) that senses the current flow through the transformer and rings a bell in the basement.

The 1-ohm resistor, R1, serves as a current shunt to sense the one to two amperes of current. The wave shape is clamped to ground to increase its positive amplitude. And then low-pass filtering is used so that line-noise will not trigger the one-shot multivibrator. The "Sensitivity" control is part of the low-pass filter; increasing the resistance improves the filtering, but decreases sensitivity. Set the control low enough to ensure triggering.

The trailing edge of the multivibrator wave shape is used to start the timer. That provides a delay for the basement bell; thus both bells are not pulling a high current from the transformer at the same time. The timer can be adjusted

to ring the bell from one to five seconds. There is a "Test" button for ringing the bell to aid in set-up. The "Off-On" switch allows the circuit to be disconnected so the basement bell will not ring.

—Richard W. Johnston, Troy, MI

Nice work; I like how it doesn't need its own supply. I wonder how you'd have to condition the signal to use a 555 as the one shot. It might take a bit of thinking, but then a 556 could be used for both the timer and one-shot circuits.

SHOP BELL

Enclosed is a circuit I designed to enable you to ring additional door bells in adjacent areas such as basements, work shops, or garages (see Fig. 6). The circuit steals a little current from the main doorbell system via a center-tapped audio transformer to drive relay RY1 (RadioShack number 275-005 or 275-004). The relay closes the contacts to a battery-powered chime box making it sound out when the main doorbell is activated.

All the circuit does is operate the relay, not the additional chimes, so you can add as many battery-powered

chimes as you'd like without disturbing the operation of the existing doorbell. Since I have a garage that's 24-feet long and an attached shop the same length, I used a chime for each, setting them at different tones.

I hope this circuit is of some value as it needs no current or voltage source other than its own.

—Edward B. Worman, Roscommon, MI

I'm definitely going to add the audio transformer/relay circuit to my secret-recipe book. I never thought to power a small circuit from an audio transformer before.

EXTRA BELL

The enclosed circuit (see Fig. 7) is offered as a possible contribution to your *Think Tank* section. Initially, I thought of it as a construction project, but realized it may not appeal to a broad readership. Basically, it allows a remote "bell" to be powered from an existing doorbell circuit, without tearing out walls to access the wiring between the door button and chime. Only the doorbell transformer must be accessible, and they usually are.

When the front or rear bell is activat-

ed, return current flowing through the common circuit creates a voltage drop across the two resistors. Depending on its direction it activates either Q1 or Q2 after a brief delay (caused by the charging of C1). That diverts current briefly to the new chime which sounds off.

The device can be housed in a small metal box, such as a 4-inch junction box (that's what the dashed box in the diagram represents). Variations on the circuit will allow the use of a piezoelectric alarm, or special purposes can be accommodated, since the circuit essentially routes power upon sensing current flow.

—Russ Head, Marshalltown, IA

Very interesting. I'll bet I know what everyone's thinking: Replace R1 and R2 with a single 5-ohm resistor. Right?

The *Tank* is empty for now. So until next time, if you've got some cool circuits, please send a schematic and a complete description of how it works to *Think Tank*, **Popular Electronics**, 500 Bi-County Blvd., Farmingdale, NY 11735. If it appears in the column, you'll receive a book from our library. Send enough for a whole column and you'll also get a special chip and a kit. ■

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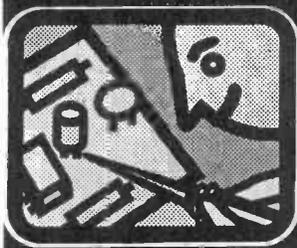


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microphone that operates from 80MHz to 120MHz FM, the frequency of any broadcast FM radio. Includes a mini-electret mike. 6 to 12v DC. SIZE: 1.25" x 1

WM2 KIT \$14.95



MICRO-MINIATURE PHONE TRANSMITTER

We haven't seen a smaller phone transmitter than the MMPT2 kit. Powered by the phone, it requires no battery. Transmits both sides of a

phone conversation to an FM radio up to a 1/4 mile away. Tunable from 88 to 108MHz FM. Attach it to one phone or add it to the line to pick up all incoming calls. The MMPT2 is undetectable if properly installed. Urat has surface mounted parts, you install the leaded parts. Size .45" x .6"

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MICRO-MINIATURE WIRELESS MIKE

So small you could hide this one on some real bugs! It's the smallest we've ever seen. With it's super sensitive mike it transmits a whisper or a room of conversation to an FM radio, tunable from 88 to 108MHz FM. With a proper antenna it transmits about 1/2 mile. The kit is made with surface mounted parts, we have already mounted these parts. You install the leaded parts. Power requirement 6 to 12v DC. Size .35" x .9"

MMWM5 KIT \$34.95



STROBE LIGHT

Do you need an attention getter, warning light, or flashing light for model airplanes? Then this kit is for you. Use it as an emergency light for your auto,

radio tower, even use it on your bicycle. Has a variable flash rate. Power requirement 6 or 12v DC. Size 3.5" x 1.9"

ST-1 KIT \$11.95

FM STEREO TRANSMITTER

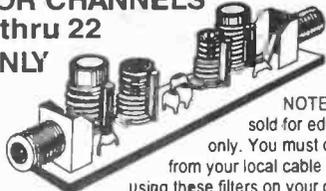
Own your own FM radio station. Any stereo signal you plug into the FMST-100 will be transmitted to any FM radio

tunable from 76 to 108MHz FM. Transmit a wireless link through an auditorium, from your car to your camper, listen to your CD's while mowing the lawn. Play music on one channel sing on the other. Clarity is excellent, approx. 40dB stereo separation. Length of antenna determines the distance of transmission. Complete with stereo input level controls & crystal for stereo separation. 9v battery operation. SIZE: 1.5" x 2.5" x 3"

FMST-100 Cabinet \$8.95 KIT \$29.95

TV NOTCH FILTERS FOR CHANNELS 2 thru 22 ONLY

Our TV filters eliminate unwanted TV channels or interference that alters both sound and video with a beep beep beep. Works on cable channels (2 thru 22) only.



NOTE: All TV Filter Kits are sold for educational purposes only. You must obtain permission from your local cable company before using these filters on your cable system.

DF-222

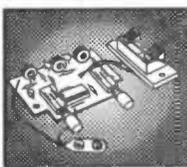
KIT \$14.95



This Manual contains schematics, parts lists & P.C. board layouts for many of the Rainbow Kits. Use your own parts to construct our kits.

KIT BOOK \$14.95

\$9.95 with the purchase of any kit.



INDUCTANCE METER

This is the kit everyone has been asking for. Turn your digital volt ohm meter into an inductance meter. It will read inductors 3uH to 7MH. Power requirement 9v DC. SIZE: 1.75" x 2.5"

IA-1 KIT \$14.95

IA-1 CABINET \$8.95

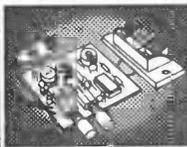


DIGITAL THERMOMETER

The DT-3 kit will turn your digital volt ohm meter into an accurate digital thermometer with .1 degree resolution. Measure temperatures from -40° to 250F°. The remote sensor is .25" sq. and can be mounted many feet from the meter. Power requirement 9V DC. SIZE: 2" x 1.35"

DT-3

KIT \$8.95

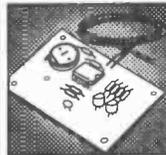


CAPACITANCE METER

This kit will turn your digital volt meter into a capacitance meter. Turn that junk box of unmarked capacitors into a fortune of usable parts. Measure capacitors from $2.2pF$ to 2.2uF. Power requirement 9v DC. SIZE: 1.80" x 2"

CA-1

KIT \$12.95



TEMPERATURE GENIE

Ever lost frozen food because your freezer stopped? The TC-2 kit would have saved you money. An alarm activates when the temperature reaches a critical point. Turn ceiling fans on automatically when it gets too hot. This kit gives you 100mA of output. SIZE: 2" x 1.4" Power requirement 6 to 15V DC.

If you want to switch more power see our Triac (TP-1) or Relay (RP-1) Power kit.

TC-2

KIT \$7.95



PHONE TRANSMITTER

Small but mighty, it fits anywhere. Phone line powered, never needs batteries. Transmits both sides of a phone conversation loud and clear, wireless, to any FM radio at great distances. Variable tunes from 70MHz to 130MHz FM. You can also use it as a speaker phone. SIZE: 1.25" x .6"

TEL-B1

KIT \$12.95



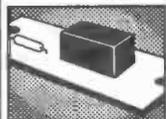
SUPER SNOOPER BIG EAR

Listen through walls, hear conversations across the room. Add a parabolic reflector and hear blocks away. The BIG EAR can be hidden about anywhere. Makes an ultra sensitive intercom. Can be used as a 1.5W AMP. We supply a mini-electret mike in the kit. Power requirement 6 to 12v DC. SIZE: 1.75" x 1"

AA-1

BUILT \$29.95

KIT \$10.95



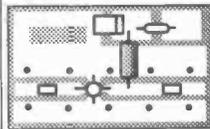
RELAY POWER KIT

Increase the output of any kit from 100mA to 3 Amps. If you need to switch more power, up to 300 Watts, with the Light Genie,

Temperature Genie, Timer or Vox kits, use the Relay Kit. We supply a two pole relay 1.5 Amps ea., tie both poles together and get 3 Amps. Size .75" x 2"

RP-1

KIT \$9.95



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- 1MHz to 2.5 GHz 2.8dB NF
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- Power requirement: 12v @ 6Ma

WBA-6

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We recently made a large
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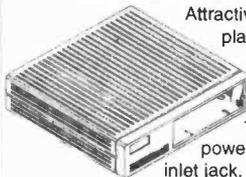
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case for Zip drives,
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Interior area: 16" X 6" X 2.5". These are new
bags with a company logo (Interactive Network)
on a patch on one side.



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Attractive, heavy-gauge gray
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to hold a 1/2 height
CD ROM drive.
Contains a 5 Vdc /
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power supply, IEC power
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PURCHASE!

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125/250 Vac. Prepped with 5" long wire leads
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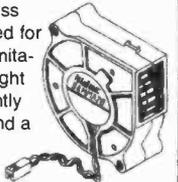
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12 Vdc, 0.18 amp brushless
centrifugal blower designed for
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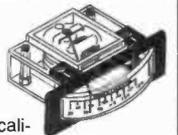


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Mura
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Scale is labeled



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4' cable with miniature 4 pin mini
DIN plugs on both ends.

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- Ultra-miniature surface mount construction.
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- Worlds smallest FM radio.
- As small as a hearing aid.
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- Use any TV or VCR with a video input connector.
- Includes power cube.
- About half the size of a pack of cigarettes.
- See entire room through pin sized hole.

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16 levels of digital voice changing. Sound tougher, older or younger, female or male. Powered by 4 AA batteries. (Batteries not included).

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- Uninterrupted coverage of the 800 to 950 MHz band.
- Works with any 400-550MHz scanner.
- Gain: 6 dB typical.
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- Has built-in microphone.
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Solar Cell Powered
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Auto/Manual ranging
Energy saver
Student & hobbyist's favor



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Inductance: 2mH-20H
Capacitance: 2nF-200μF
Resistance: 200-200MΩ
Frequency: 2KHz-20MHz
3.5 Digit, 0.5% accuracy
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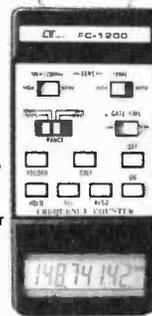
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Best Resolution LCR
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Capacitance: 200pF-20,000μF
Resistance: 2Ω-20MΩ
Resolution of 0.1μF, 0.1pF, and
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Records Max/Min/Average
Data hold, relative mode
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& EMF adapter, Sound level meter,
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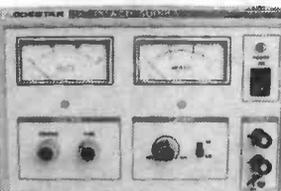


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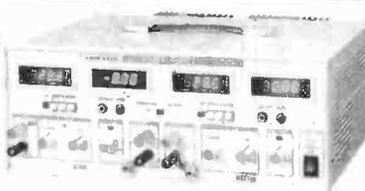
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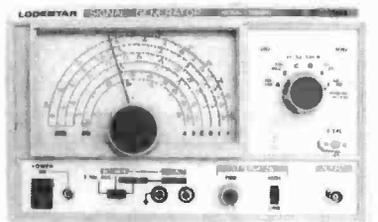
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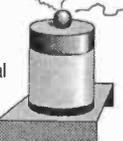
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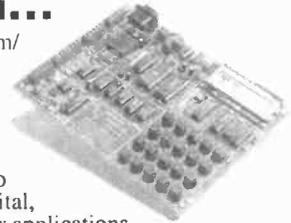
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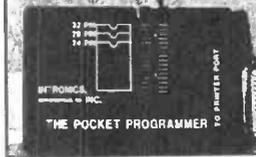
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Power: 9V Alkaline or Carbon-Zinc Battery (NEDA 1604)

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

Net Weight: 400g

DC Voltage (DCV)

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

Maximum Allowable Input: 1000V DC or Peak AC.

DC Current (DCA)

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

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

AC Voltage (ACV)

Range:	Resolution:	Accuracy:
200V	100mV	±(1.2%rdg+10dgt)
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
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Range:	Resolution:	Accuracy:
200Ω	100mΩ	
2000Ω	1Ω	
20KΩ	10Ω	±(1.2%rdg+2dgt)
200KΩ	100Ω	
2000KΩ	1KΩ	
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Measures forward voltage drop of a semiconductor junction in mV test current of 1.5mA Max.

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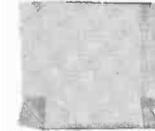
Single-Sided, 1oz. Copper Foil on Paper Phenolic Substrate

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

Double-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

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



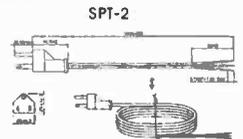
Etching Tank This handy etching system will handle PC boards up to 8" x 9", two at a time. Ideal for etching your PCB's! System includes an air pump for etchant agitation, a thermostatically controlled heater for keeping etchant at optimum temperature and a tank that holds 1.35 gallons of etchant. A 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

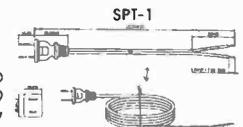
AC Power Cords

Our power supply cords are economical and practical for OEM and replacement applications. We stock 6' lengths, with the open end conveniently stripped and tinned (5mm).



CAT NO	SIZE	TYPE	RATING @ 125V (A)	LENGTH (ft)	COLOR	TEMP
SPT-1BLACK	18/2	SPT-1	10	6	Black	60°
SPT-1GRAY	18/2	SPT-1	10	6	Gray	60°
SPT-2BLACK	18/3	SPT-2	10	6	Black	60°

CAT NO	DESCRIPTION	PRICE EACH			
		1	10	100	500
SPT-1BLACK		\$.88	\$.57	\$.51	\$.46
SPT-1GRAY		.92	.61	.55	.49
SPT-2BLACK		1.97	1.21	1.07	.97



Switchable Scope Probe Sets

(Selectable X1/Ref/X10) These high quality scope probe sets are for oscilloscopes up to 60MHz (model HP 9060) or 150MHz (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	1	10	100
HP-9060	Scope Probe Set DC~60MHz	\$16.49	\$14.49	\$11.58
HP-9150	Scope Probe SetDC~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.

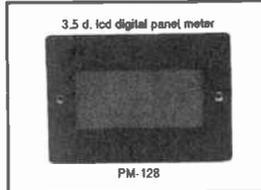
CAT NO	DESCRIPTION	1	5
ER-3	Makes 1 pint	\$3.50	\$2.75



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<http://www.cir.com>

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.



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

CAT NO	DESCRIPTION	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

3-1/2 Digit LCD 3-1/2 Digit LED 4-1/2 Digit LCD

PM-328: 4-1/2D LCD Digital Panel Meter

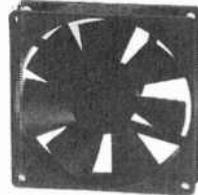
Features

- 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)

Specifications - PM-328

Maximum Input : 199.99mV DC
 Maximum Display : 19999 counts (4-1/2 Digits)
 w/Automatic Polarity Indication
 Indication Method : LCD Display
 Overrange Indication : "1" Shown in the Display
 Input Impedance : >100 Mohm
 Accuracy : +0.05% (23+5°C, <80% RH)
 Power Dissipation : 1mA DC
 Decimal Point : Selectable w/Wire Jumper
 Supply Voltage : 9V DC
 Size : 67mm x 44mm

AS LOW AS \$5.25 ea.



Ball Bearing 12V DC Fans

These High Quality Fans feature Ball Bearings and Brushless DC Motors. All of them are designed to meet UL, CSA & VDE Standards. Design these fans into power supplies, computers or other equipment requiring additional air flows for heat removal. These fans are regular Circuit Specialists stock items — they are not surplus.

INDUSTRY BEST PRICING!

CAT NO	1	10	25	100
CSD 4010-12	\$ 9.88	\$ 6.38	\$ 5.48	\$ 4.87
CSD 6025-12	9.38	5.91	5.41	4.71
CSD 8025-12	8.88	5.85	5.19	4.49
CSD 9225-12	8.95	6.14	5.29	4.59
CSD 1225-12	11.45	8.96	7.82	6.85

Specifications

CAT NO	DIMENSIONS (MM)	RATED VOLTAGE (V)	START VOLTAGE (V)	INPUT CURRENT (A)	AIR FLOW (CFM)	STATIC PRESSURE (INCH-H ₂ O)	SPEED (RPM)	NOISE LEVEL (dB)	WEIGHT (g)
CSD 4010-12	40x40x10mm	12	7	0.06	5.1	0.19	5,500	26	20
CSD 6025-12	60x60x25mm	12	5	0.13	13.7	0.165	4,500	28	65
CSD 8025-12	80x80x25mm	12	5	0.16	37.8	0.177	3,000	31	80
CSD 9225-12	92x92x25mm	12	5	0.32	42	0.18	2,800	37	95
CSD 1225-12	120x120x25mm	12	5	0.35	62	0.180	2,500	42	135

- SOLDER
- SOLDER
- SOLDER
- SOLDER
- SOLDER
- SOLDER

We stock high quality 60/40(Sn%/Pb%), .031" and 63/37, .031" diameter. This is prime JIS certified solder that we maintain as a regular stock item (It is not "Left-overs, Rejects or Surplus") and you can buy it from us at a fraction of the price that you are used to.



Tired of Paying Inflated Prices for Solder?

CAT NO	DESCRIPTION	1	10	25
RH60-1	1-lb. Spool, .031", 60/40	\$ 6.90	\$ 5.96	\$ 5.30
RH63-1	1-lb. Spool, .031", 63/37	6.95	6.10	5.41
RH60-4	4.4-lb. Spool, .031", 60/40	24.00	21.90	17.92
RH60-TUBE	6-oz. Tube, .031", 60/40	.99	.89	.79

CAT NO	DESCRIPTION	1	5
CA-H34A	PCB Mounted IRCCD Camera	\$99.00	\$85.00
A34	Power Supply Regulating Kit	\$6.95	----

CCD Camera - IR Responsive

As Low As \$85!!

This black and white monochrome CCD Camera is totally contained on a PCB (70mm x 46mm). The lens is the tallest component on the board (27mm high from the back of the PCB) and it works with light as low as 0.1 lux. It is IR Responsive for use in total darkness. It comes with six IR LED's on board. It connects to any standard monitor, AUX or video input on a VCR or through a video modulator to a TV. Works with a REGULATED 12V power supply (11V-13V). Hooks up by connecting three wires: red to 12V, black to ground (power & video) and brown to video signal output.



Power Supply Regulating Kit for CA-H34 This simple kit is designed to fit onto the back of the CA-H34 CCD camera. It resolves the problem of hooking up the camera to an UNREGULATED supply (which damages the camera) by providing safe regulated power from any 12V-14V DC supply. It also provides regulated 12V DC from a 12V AC source.

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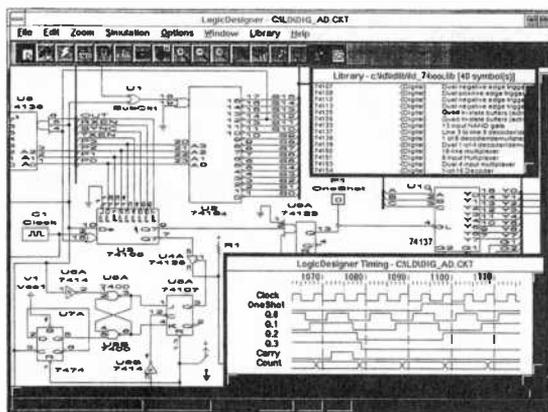
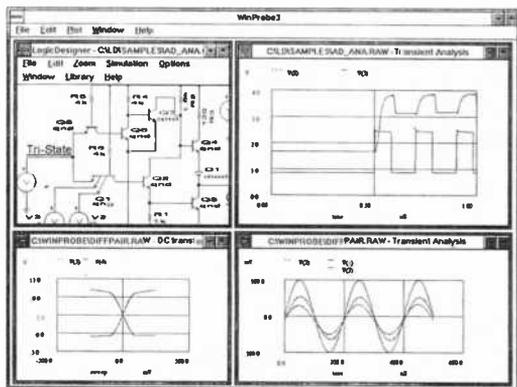
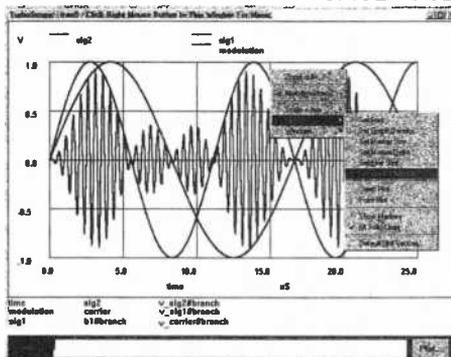
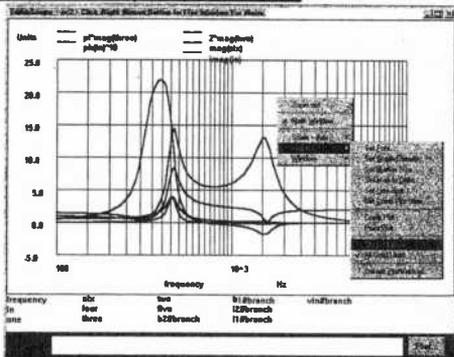
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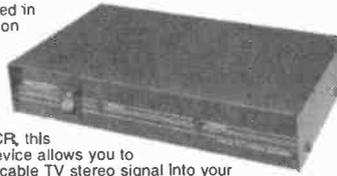
**HOT
NEW
ITEM!**



#PO-219-055 **\$12⁹⁰**

Cable TV Stereo Decoder

When used in conjunction with a cable TV converter or cable ready VCR, this handy device allows you to feed the cable TV stereo signal into your home sound system for superb audio reproduction of your favorite shows, movies, and sporting events.



#PO-189-110 **\$19⁹⁰**

Digital Video Stabilizer

The digital video stabilizer will eliminate the constant picture distortion caused by the copyright protection on movie videotapes. This unit is fully automatic and operates on one 9V battery which is included.

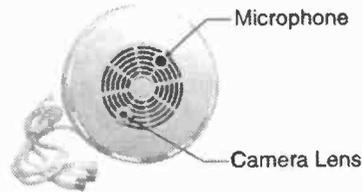


#PO-180-320 **\$17⁹⁵**

Decoy Cameras

These 1/3" CCD cameras offer a clever means of disguise. Both feature a 3.6mm wide angle lens, built-in electronic shutter, and a 12 VDC power supply. Minimum illumination: 0.3 lux. 400 line resolution. Smoke detector decoy camera includes an audio output.

**AFFORDABLE
HIGH TECH
SURVEILLANCE!**

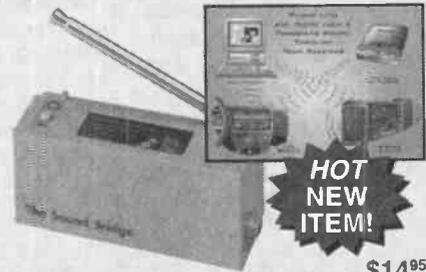


Part #	Description	Price
PO-335-535	Smoke detector decoy	\$249.50
PO-335-540	Decoy clock camera	299.95



**"The Sound Bridge"
FM Stereo Wireless Transmitter**

The Sound Bridge is a mini FM wireless transmitter that can be used to broadcast stereo sound from any audio source like portable CD players, TVs, electronic games, CD-ROM, even computer soundcards, to your home stereo receiver! Adjustable from 89 to 95.5 MHz.



**HOT
NEW
ITEM!**

#PO-249-220 **\$14⁹⁵**

**Portasol/Weller Butane
Soldering Tool**

**NO CORDS,
NO BATTERIES!**



This cordless, refillable, butane powered soldering tool is ideal for any on-site soldering job. Provides up to 35 watts with a temperature range up to 700 degrees F. Includes flint ignitor in plastic case, safety cut off switch, and C-2 chisel tip.

#PO-372-150 **\$25⁹⁵**

**150 MHz Oscilloscope Probe
Kit**

Deluxe probe kit features a modular design for longer life, switchable 10:1 probe with 150 MHz bandwidth, 2.8 ns rise time, and adjustable capacitance from 10-35 pF. 60" in length.

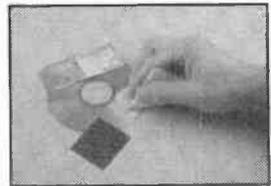


**GREAT
VALUE!**

#PO-390-100 **\$29⁹⁵**

**Memorex CD Repair And
Maintenance Kit**

Don't throw away expensive CDs because of annoying mistracking and skipping errors! The Memorex CD Repair kit contains enough solution and materials to clean and repair 12 compact discs.



#PO-249-032 **\$1⁹⁵**

5" Sealed Back Midrange

5" heavy duty sealed back midrange with deluxe mesh grill, 1" aluminum voice coil. Popular midrange for auto sound installations. ♦Power handling: 35 watts RMS/50 watts max ♦Voice coil diameter: 1 inch ♦Impedance: 8 ohms ♦Frequency response: 800-10,000 Hz.



#PO-280-030 **\$7⁵⁰**

1", Titanium Dome Tweeter

Features a ferro fluid cooled Kapton voice coil and a rubber surround. Very natural sounding high frequency reproduction with extended response to 30KHz.

♦Power handling: 50 watts RMS/75 watts max
♦Voice coil diameter: 1", ♦Impedance: 8 ohms
♦Frequency response: 2500-30,000 Hz.



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**RESPONSE
TO 30KHz!**

#PC-275-050 **\$16⁵⁰**

3 Channel Color Organ Kit

This sound to light unit features three separate outputs, which can be controlled independently. Each output reacts to three different bands of the musical spectrum: bass, midrange, and treble. Has built-in microphone, so no connection is required to music source, but a line input is provided.



**SUPER
QUALITY
KIT!**

#PO-320-210 **\$59⁹⁵**

6-1/2" Woofer

Polymer resin treated paper cone with poly foam surround. Long throw voice coil design helps to deliver powerful bass output. Perfect for bookshelf type speakers. Mfg. #C16LD20-51F. ♦Power handling: 60 watts RMS/120 watts max. ♦Voice coil diameter: 1-1/4 inches ♦Impedance: 8 ohms ♦Frequency response: 57-7000 Hz.



PIONEER

#PO-290-023 **\$19⁹⁵**

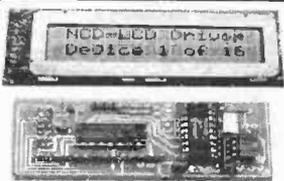


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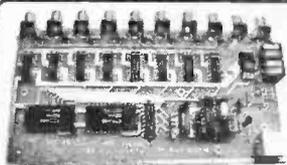
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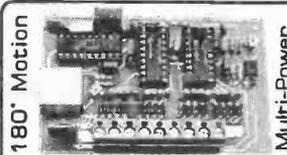
RS-232 Networkable Devices



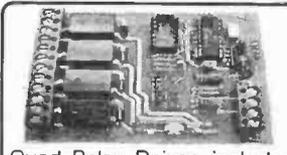
LCD Display Driver, for Displays up to 40x2 (not inc). Two AUX outputs for Relay & Light. Combine 16 per RS-232 line or w/other devices. NCD-LCD Kit \$34 Asm \$44



Audio/Video Switcher: 8 Inputs, 2 Outputs, Infrared Controllable, Routes Any Input to Any Output. 12-18 volt DC operation. For Line-Level Signal Switching. AVS8 Kit \$129 Asm \$179



8/16 Hobby Servo Controller. Futaba-J Compatible, Infrared Receiver Included with SV16 upgrade. Perfect for animatronic applications. SV8 Kit \$79 Asm \$99 SV16 Upgd Kit \$39 Asm \$59



Quad Relay Driver, includes 4 LED Status Lights. 12V Operation. With 5 or 10 Amp Relays. Optoisolated RS-232 Input. Call for info on our infrared 8-Relay version. R45 (5A) Kit \$69 Asm \$99 R410(10A) Kit \$79 Asm \$109

Includes Driver Software in QBASIC for PC users.

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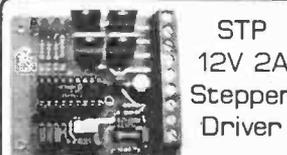


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8-Input Scanner. Send a single ASCII character to ask for logic status of the 8 inputs, board responds with numbers 0 to 255. Use to control other devices based on input detected. Perfect for detecting sensor status. B8C Kit \$39 Asm \$49

Infrared Transceiver for Remote RS-232 Communication with 16 IR Controllable Devices. IRTK Kit \$39 Asm \$49 RSB Serial Booster Gives your RS-232 Port the Power It Needs to Drive 16 NCD Devices. RSB Kit \$29 Asm \$34

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MODEL 100 \$279



- 12 BIT 100 KHZ A/D
- 4 ANALOG OUTPUTS
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- 24 DIGITAL I/O

MODEL 60 \$179



- 8 2-AMP RELAYS
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- 1 8-BIT ANALOG INPUT

MODEL 40 \$99



- RS-232 INTERFACE
- 28 LINES DIGITAL I/O
- 8 ANALOG INPUTS
- PWM OUTPUT
- OPTIONAL 12 BIT A/D

MODEL 70 \$239



- RS-232 INTERFACE
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- UP TO 60 BMP/SEC

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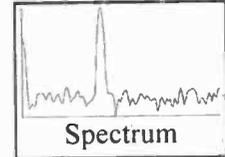
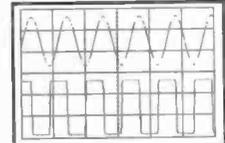
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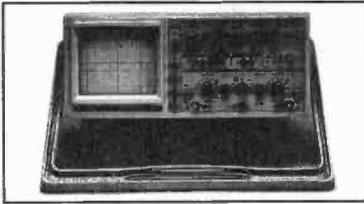
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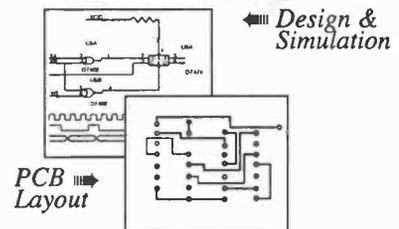
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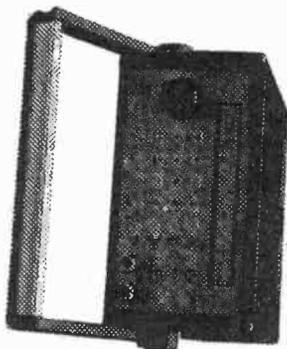
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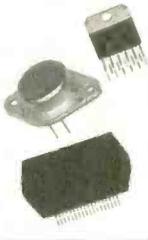
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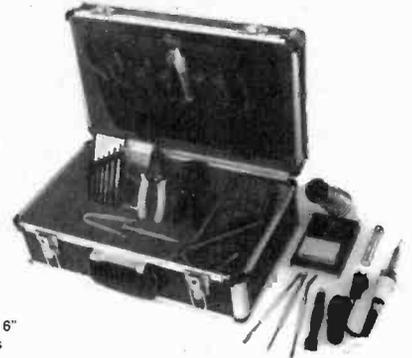
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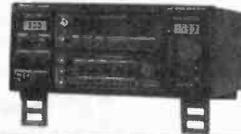
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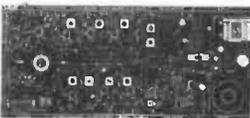
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ANALOG

Model	Bandwidth MHz	Sensitivity (max)	No. of Channels	Sweep Rate Max ns/div	Delayed Sweep	Video Sync	Component Tester	Beam Find	Time Base
S-1360	60	1mV/div	2	10ns/div	Yes	Yes	Yes	Yes	2
S-1345	40	1mV/div	2	10ns/div	Yes	Yes	Yes	Yes	2
S-1340	40	1mV/div	2	10ns/div	No	Yes	No	No	1
S-1330	25	1mV/div	2	10ns/div	Yes	Yes	Yes	Yes	2
S-1325	25	1mV/div	2	10ns/div	No	Yes	No	No	1

DIGITAL STORAGE

Model	Bandwidth MHz	Analog Sen (max)	No. of Channels	Sampling Rate	Memory Channel	Internally Backed Up	Pretrigger %	Output
DS-303	30	1mV/div	2	20MS/S	2K	Yes	0, 25, 50, 75	RS232
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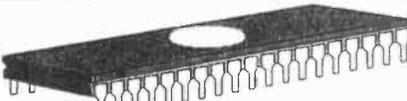
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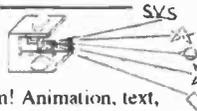
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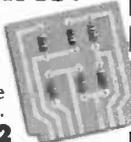
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March 1997, Popular Electronics

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TYPE or **PRINT** your classified ad copy **CLEARLY** (not in all capitals) using the form below. If you wish to place more than one ad, use a separate sheet for each additional one (a photo copy of this form will work as well). Place a category number in the space at the top of the order form (special categories are available). If you do not specify a category, we will place your ad under miscellaneous or whatever section we deem most appropriate.

We cannot bill for classified ads. **PAYMENT IN FULL MUST ACCOMPANY YOUR ORDER.** We do permit repeat ads or multiple ads in the same issue, but, in all cases, full payment must accompany your order.

WHAT WE DO

The first word and company name of each ad are set in bold caps at no extra charge. No special positioning, centering, dots, extra space, etc. can be accommodated.

RATES

Our classified ad rate is \$1.75 per word. Minimum charge is \$26.25 per ad per insertion (15 words). Any words that you want set in bold are each .40 extra. Indicate bold words by underlining. Words normally written in all caps and accepted abbreviations are not charged anything additional. State abbreviations must be post office 2-letter abbreviations. A phone number is one word.

If you use a **Box** number you must include your permanent address and phone number for our files. **ADS SUBMITTED WITHOUT THIS INFORMATION WILL NOT BE ACCEPTED.**

For firms or individuals offering Commercial products or Services. **Minimum 15 Words.** 5% discount for same ad in 6 issues within one year; 10% discount for same ad in 12 issues. **Sorry, no discounts on credit-card orders.** **Boldface** (not available as all caps), add .40 per word additional. **Entire ad in boldface**, add 20%. **Tint screen behind entire ad**, add 25%. **Tint screen plus all boldface ad**, add 45%. **Expanded type ad**, add \$2.25 per word.

General Information: A copy of your ad must be in our hands by the 13th of the fourth month preceding the date of issue (i.e. Sept issue copy must be received by May 13th). When normal closing date falls on Saturday, Sunday or Holiday, issue closes on preceding work day. Send for the classified brochure.

DEADLINES

Ads not received by our closing date will run in the next issue. For example, ads received by November 13 will appear in the March issue that is on sale January 17. **POPULAR ELECTRONICS** is published monthly. No cancellations permitted after the closing date. No copy changes can be made after we have typeset your ad. **NO REFUNDS**, advertising credit only. No phone orders.

CONTENT

All classified advertising in **POPULAR ELECTRONICS** is limited to electronics items only. All ads are subject to the publishers approval. **WE RESERVE THE RIGHT TO REJECT OR EDIT ALL ADS.**

AD RATES: \$1.75 per word, Minimum \$26.25

Send you ad payments to:

POPULAR ELECTRONICS 500 Bi-County Blvd, Farmingdale, NY 11735-3931

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100 - Antique Electronics	270 - Computer Equipment Wanted	450 - Ham Gear Wanted	630 - Repairs-Services
130 - Audio-Video Lasers	300 - Computer Hardware	480 - Miscellaneous Electronics For Sale	660 - Satellite Equipment
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190 - Cable TV	360 - Education	540 - Music & Accessories	710 - Telephone
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9 - \$26.25	10 - \$26.25	11 - \$26.25	12 - \$26.25	37 - \$64.75	38 - \$66.50	39 - \$68.25	40 - \$70.00
13 - \$26.25	14 - \$26.25	15 - \$26.25	16 - \$28.00	Total words _____		\$1.75 per word = \$ _____	
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21 - \$36.75	22 - \$38.50	23 - \$40.25	24 - \$42.00	Special Heading _____		\$20.00 = \$ _____	
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Total classified ad payment \$ _____ enclosed

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It's easy to cash in!

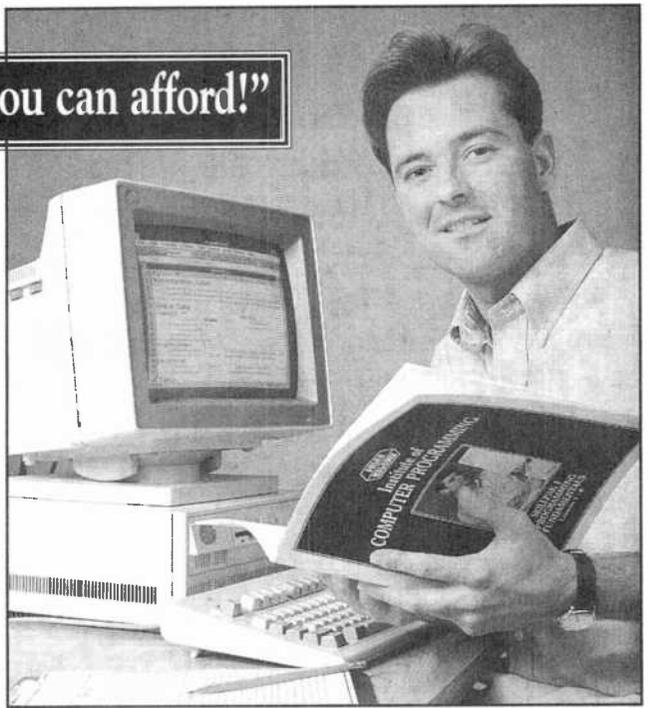
Look at some of the things professional computer programmers do. "Wrote a C program to clean up a WordPerfect file; edited the resulting file as data errors were found." This work would take a trained programmer less than five hours to complete, and they could make over \$200 for the work. That's money you could be making — and soon — with training from the Foley-Belsaw Institute of Computer Programming.

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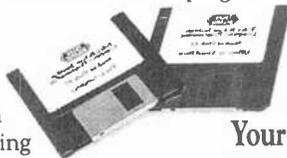
Other schools force you to buy a complete computer package as part of their training program. At Foley-Belsaw we understand that your needs as a programmer may not fit into a "one size fits all" approach. Why should you pay hundreds of dollars for a computer system that you may not need?

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Call or complete & return this coupon to: Foley-Belsaw Institute, 6301 Equitable Road, Kansas City, MO 64120

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March 1997, Popular Electronics

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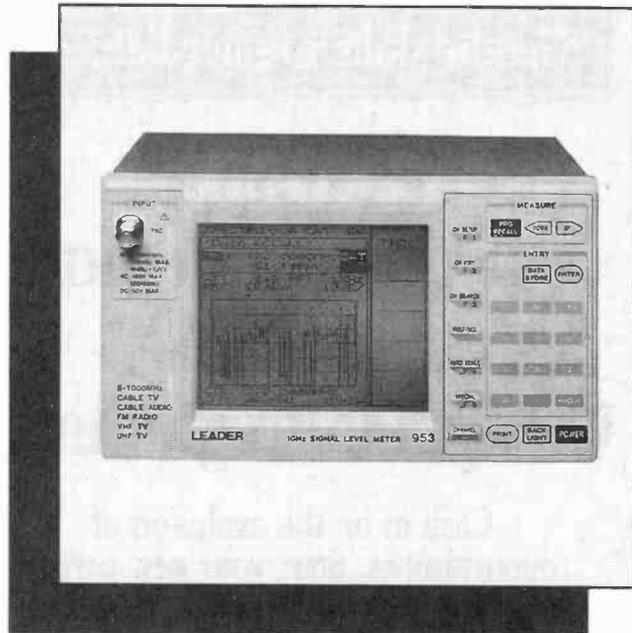
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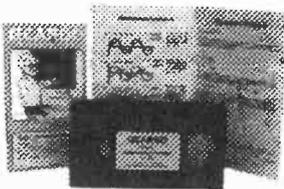
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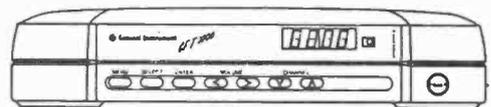
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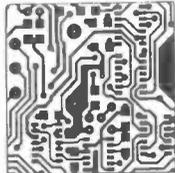
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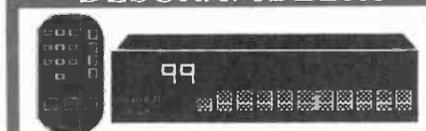
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March 1997, Popular Electronics

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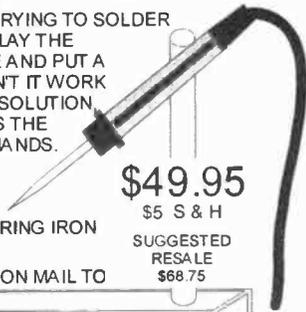
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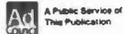
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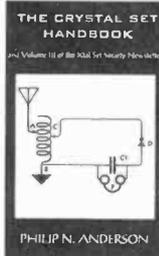
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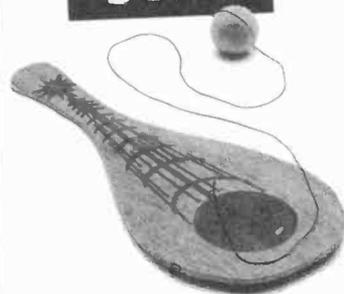
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CircuitMaker[®]

The Virtual Electronics Lab[™]

The screenshot displays the CircuitMaker software interface with several windows open. The main window shows a schematic diagram of a circuit with components like resistors (R1, R2, R3, R4, R5), capacitors (C1, C2), and op-amp comparators (U1, U2). A 'DC Analysis' window shows a graph of Voltage (V) vs. Time (s) with a red line indicating a ramp. A 'Transient Analysis' window shows a graph of Voltage (V) vs. Time (s) with a blue sine wave. An 'AC Analysis' window shows a graph of Voltage (V) vs. Frequency (Hz) on a log scale. On the right, a 'Count down to launch' window shows a rocket launch graphic. A red banner in the bottom left corner reads 'New For Windows 95/NT VERSION 4 Enhanced For Windows 3.1x'.

Professional Schematic Layout

CircuitMaker's schematic capabilities are unmatched and include many advanced lighting features not found in similar programs. These powerful features minimize the time and task associated with drawing a schematic and insure a professional looking final product. Printout and export options are numerous and results are of the highest quality. But that's what people have come to expect from CircuitMaker.

Unlimited, Indestructible Devices

CircuitMaker ships with over 1500 devices. That's more (at no additional cost) than any competing product. If you need a device that is not included, CircuitMaker provides industry standard SPICE import and a powerful macro capability. These destructible devices accurately emulate actual devices and enable the user to try out those "what if" scenarios with no risk and at no additional cost.

Accurate Simulation & Advanced Analysis

CircuitMaker features analog, digital and mixed-mode simulation. Obviously, simulation is of no value if the results are not accurate. CircuitMaker's simulation engine is based on Berkeley SPICE3, which is renowned for its accuracy. That's why we can factually state that CircuitMaker provides its user with the most accurate simulation available. Furthermore, CircuitMaker provides a wealth of analysis capabilities not found in other products in its class. No other product offers this much simulation muscle at such a reasonable price.

Printed Circuit Board Output

CircuitMaker's PCB output capability helps you complete your design cycle by generating a netlist that can be imported into any compatible PCB program. This is not a costly "add-on module"; it comes standard with every copy of CircuitMaker. MicroCode Engineering also offers TraxMaker, a professional level, PCB layout and autorouting program for just \$299. Used in conjunction with CircuitMaker, TraxMaker completes a powerful end-to-end circuit design system.

Advanced Schematic Capture
 Digital, Analog, and Mixed-Mode Simulation
 Full SPICE Compatibility
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 Retail Price

	YES							
CircuitMaker	YES	\$299						
Electronics Workbench Version 4	YES	NO	YES	NO	NO	NO	NO	\$299
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"CircuitMaker Shocks The Competition, With An Unbeatable Bottom-line"

Total Customer Satisfaction

At MicroCode Engineering we are committed to total customer satisfaction. When you purchase CircuitMaker you have the confidence of knowing that a trained staff of professionals is available to serve you after the sale. Our free unlimited customer service is second to none! Whether you have general or technical questions they will be answered promptly by a knowledgeable representative.

FREE Functional Demo

A free functional demo is available on the Internet at <http://www.microcode.com>, on CompuServe (GO MICROCODE) and on America Online by doing a file search for CircuitMaker.

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DB32 Antenna



CC30 Carry Case

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