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May 1996

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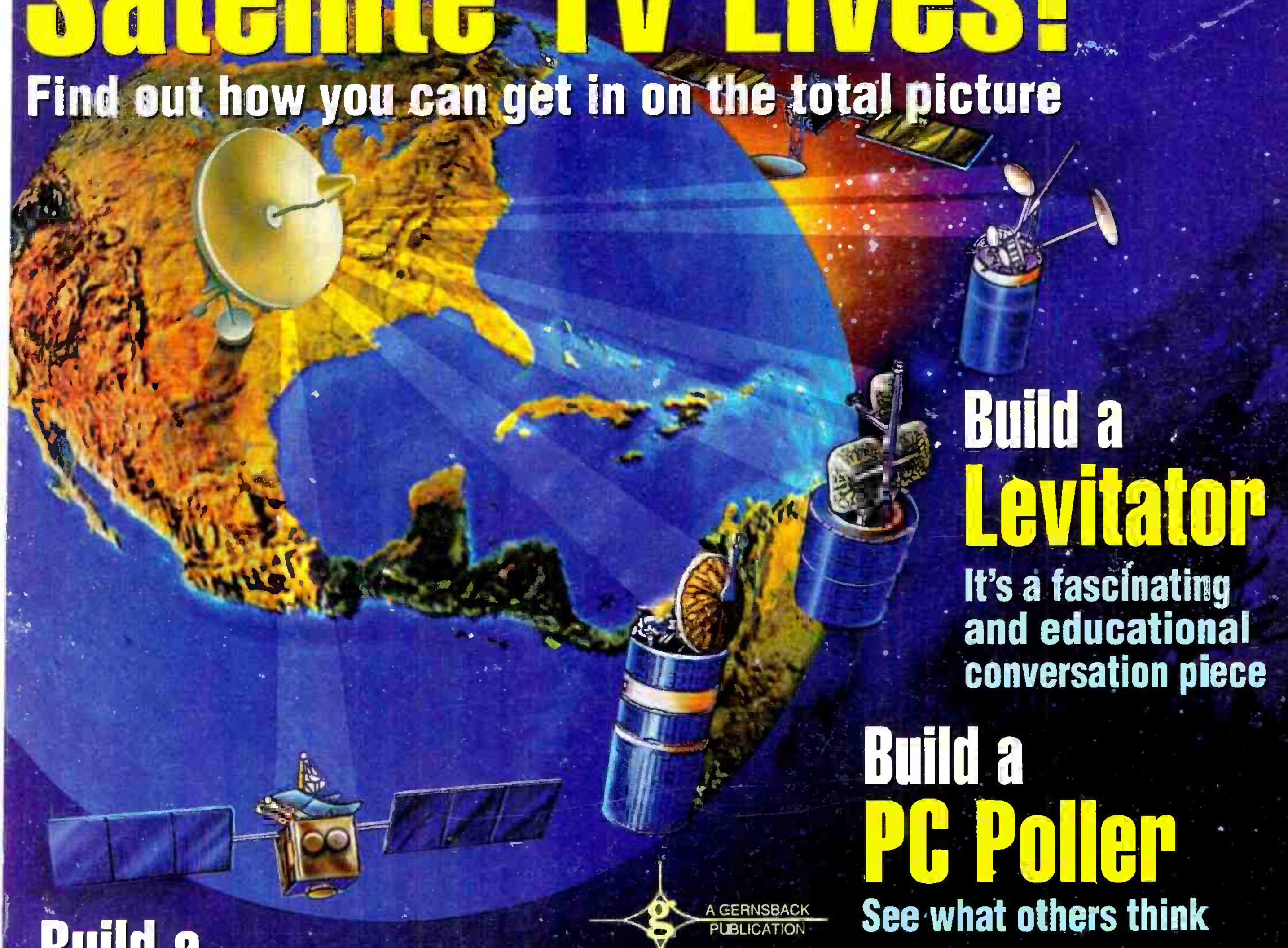

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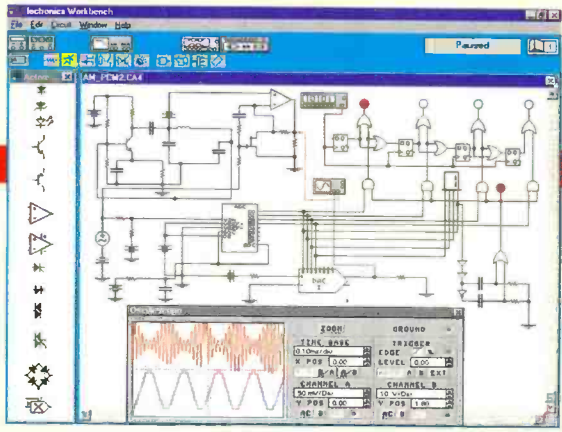

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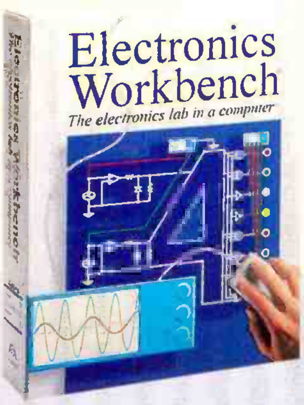

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MAY 1996
Vol. 13, No.5

A GERNSBACK PUBLICATION

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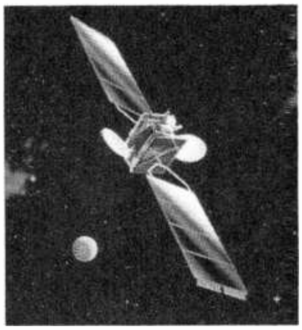

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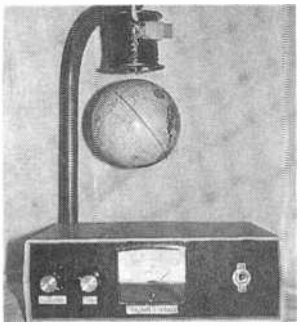

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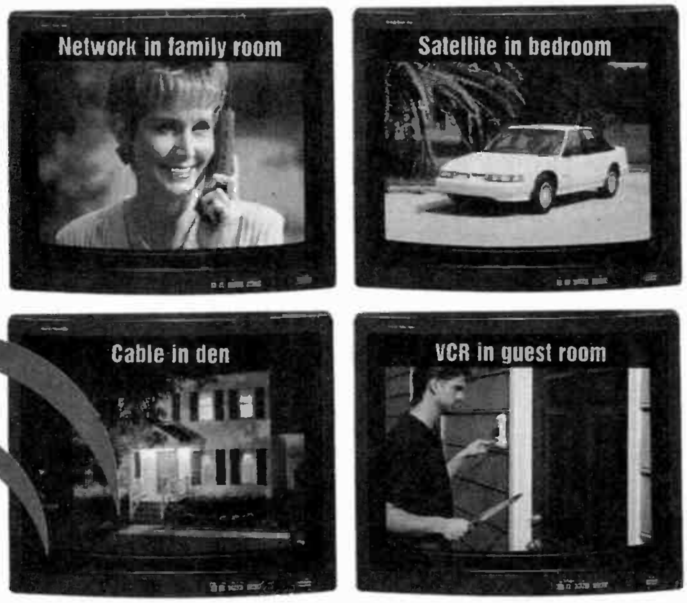
ABC AUDITED

TECHNOLOGY UPDATE

New breakthrough clones TV signals and sends them to any other TV in your home

Recoton's new development duplicates cable, TV, VCR and satellite signals and transmits them...without any wires!



by Charles Anton

Today, television choices are virtually unlimited. Between cable, satellite TV, videos and network programming, it's almost a full-time job trying to keep up with all the alternatives. And it promises to get more complicated in the future. Breakthroughs in fiber optic technology will bring over 500 channels into your home.

Home broadcasting breakthrough. The problem with all this technology is the expense required to maintain your system and keep it up-to-date. Now, a wireless video broadcasting system from Recoton gives you the power to utilize this technology without the hassle and expense of re-wiring your entire home.

Today, Recoton introduces the next generation in wireless broadcasting. The wireless video broadcaster transmits (re-broadcasts) cable, TV, VCR or satellite programs to any other TV in your home...wirelessly!

Wave of the future. Never drag your VCR from room to room again: Recoton's wireless video broadcasting system transmits video or TV signals to any other TV in your home.

Because the system is totally wireless, you won't have to worry about running miles of wires. Besides, who wants to install cable in every room of their home? With Recoton's wireless video broadcasting system, you won't have to. You can even watch one program on your main TV while someone else watches something different on another TV. It's just like having a personal broadcasting system in your home—and it's legal in every state.

Hi-tech home broadcast. Recently, the *Federal Communications Commission* allocated a band of radio frequencies specifically for wireless, in-home product applications. Recoton took advantage of the FCC ruling by creating and introducing wireless equipment that can transmit within the prescribed frequency over distances of up to 150 feet.

Wireless Video Breakthrough...

Cable *Broadcast cable channels, even premium channels, to other TVs in your home that are not wired for cable.*

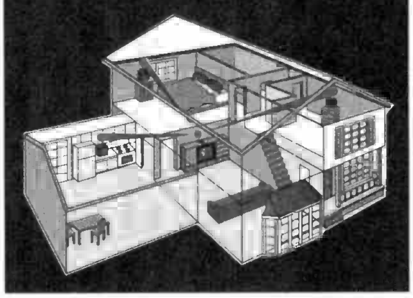
Videos *Transmit signals from one VCR to any room, even if someone is watching TV in the room that the VCR is in.*

Satellite programs *Watch satellite programs throughout your home without stringing miles of cable everywhere.*

Live video *View home videos as you film them or turn your camcorder into a security camera.*

Network programs *If the main TV is hooked up to an antenna, you can broadcast its clear signal to all the others.*

Recoton's video broadcasting system clones the accessories (cable, satellite, VCR, etc.) of one TV and broadcasts it to any other TV in your home...without wires!



One transmitter, unlimited receivers. One transmitter will operate an unlimited number of receivers. This means that a transmitter in the den can send signals to a TV in the living room, kitchen, bedroom and anywhere else you may have a TV. Recoton puts your favorite programs where you want them most.

Unlimited choices. Since the broadcasting system uses the latest in 900 MHz frequency signals, there is no time-consuming or complicated wiring. The receiver can be easily moved from one television to another.

The transmitter will also broadcast to multiple receivers, so you can watch the same program on multiple TVs simultaneously. The transmitter connects to the source TV; the receivers simply connect to the others.

Exclusive factory-direct offer. With this breakthrough in home video broadcasting technology, you can have the convenience of your own personal wireless broadcasting system for a fraction of the cost of owning your own TV station. For a limited time only, we are offering Recoton's wireless video broadcasting system (one transmitter and one receiver) for the low price of $99. You can order additional receivers for other TVs for just $59 each.

ADD A TV TOWER?

Buying your own TV tower would cost you about $3.5 million. The video broadcasting system is like buying your own TV station, but without the expense. For just $99, the Recoton system is like adding a cable box, VCR and satellite dish to every TV in your home.

Risk-free offer. The wireless video broadcasting system by Recoton is backed by Comtrad's exclusive risk-free home trial. Try it, and if you are not completely satisfied, simply return it within 30 days for a full "No Questions Asked" refund. It also comes with a 90-day manufacturer's limited warranty. Most orders are processed within 72 hours and shipped UPS.

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EDITORIAL

SIGNALS FROM THE SKY

With all of the attention direct-broadcast satellite TV has garnered over the past year or so, one might think that traditional, big-dish satellite TV is dead and gone. Nothing could be farther from the truth.

If you have the room, the proper site, and can deal with the esthetics—they're not called "BUDs" (Big, Ugly Dishes) for nothing!—big-dish satellite TV will give you everything that DBS (Direct-Broadcast Satellite) can give you, and much, much more.

For example, there is audio and video programming—including wild feeds (the feeds the networks use to distribute programming to their local affiliates) and back hauls (the feed from the site of a sporting or other event back to the cable or broadcast network for distribution)—that can be found nowhere else. And while the programming for most of the major cable channels is scrambled and can be viewed only by paying subscribers, there's also a lot of stuff in the clear—viewable by anyone for free. Contrast that with DBS, where all programming is by subscription only.

If you want to learn more about big-dish satellite TV, turn to this month's installment of Gizmo, which begins on page 19. There we examine the history of satellite TV, the state of the industry today, and look ahead to what the future might bring. In the next Gizmo (which will appear in the July 1996 issue of **Popular Electronics**), we'll get down to the nitty-gritty of setting up your own big-dish satellite TV system.

Also this month, Gizmo reports on the goings-on at the January Consumer Electronics Show where the hot news was all digital, including the introduction of the brand new Digital Video Disc (DVD). The DVD has generated lots and lots of excitement in just a very short time. To find out why, and to see what else happened at the show, turn to page 25.

Carl Laron
Editor

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LETTERS

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SUPER SURPLUS CORRECTIONS

It has come to our attention that there are a couple of errors in the Feb. 1996 article "Super Surplus Sources." First of all, EICO has informed us that they are no longer in the electronics business. Second John J. Meshna, Inc. is no longer in business at all. We apologize for any inconvenience these errors might have caused.—Editor

BACK TO THE FUTURE

Thank you for mentioning my company, Antique Audio, in the article, "Super Surplus Sources" (**Popular Electronics**, February 1996). However, you printed our old address. The new address is: Antique Audio, 253 Blanche, Plymouth, MI 48170. We can be reached by phone Mondays through Saturdays, 10 AM to 7 PM, at 313-455-4169. Visits are by appointment only.

We specialize in information and parts for tube radios, and list fresh stock electrolytic and Mylar capacitors, real wood knobs, and other items in our free flyer. Send a self-addressed, stamped envelope to receive a copy.

We are now offering a collection of *QST, Electronics Illustrated, ARRL Handbooks*, and *Popular Electronics* from the 1950s and 1960s for sale. The *Popular Electronics* issues in particular have entertained us for many, many hours with the great projects, "tweaking"-type improvements, and articles about various developments that predicted the "future" of electronics. The biggest shock, however, came in the May 1964 issue. Inside was a six-page article on *antique radios*!

M.O.
Plymouth, MI

SURPLUS SOURCE ADDITIONS

I just read "Super Surplus Sources" in the February issue of **Popular Electronics**, and was surprised to see the omission of a good surplus source (one with a full-page ad on page 84 of the same issue). That source is Alltronics (2300 Zanker Road, San Jose, CA 95131; Tel. 408-943-9773).

In the "Vacuum-Tube Data" section, the author says, "[they] are offered by just a few specialized dealers." It would help people looking for tubes to list some dealers.

The best tube sources that I have found are Antique Electronic Supply and Alltronics. Another source for many tubes is Keyboard Systems (3637 East 7800 South, Salt Lake City, UT 84121; Tel. 801-943-7888). They are a distributor of parts and service data for Lowrey Electronic Organs, and they also have tone-generator ICs for most makes of organs built in the 1970s and early 1980s. I am mentioning them because they also carry most of the tubes ever used in electronic music equipment, both organs and amplifiers, from antique to current production models (tube amplifiers are still being used because a number of guitarists prefer the sound of tubes). Nearly all the tubes used in music equipment were also used in other tube electronics. Keyboard Systems' tube list includes all the tubes used in "Build a Single-Ended Hi-Fi Amplifier" in the same issue of **Popular Electronics**.

B.S., CET
Hillsboro, MO

MODERN-DAY RADIO ROW

Karl T. Thurber Jr.'s article, "Remembering Radio Row" (**Popular Electronics**, January 1996) prompted me to write this letter.

Cleveland, Ohio is fortunate to have an old-fashioned "Radio Row" consisting of three different establishments catering to antique-radio and -television enthusiasts, all within a two-minute walk.

Within the three businesses can be found restored radios and televisions, parts, memorabilia, and repair services; catalogs are available. Members of Cleveland's Radio Row are: Bob's Repair (3554 West 105th Street, Cleveland, OH 44111; Tel. 216-251-4070), which specializes in antique radio tubes; Playthings of the Past (3552 West 105th Street, Cleveland, OH 44111; Tel. 216-251-3714), carrying antique radios, parts, and memorabilia; and Vintage TV & Radio Supply (3498 West 105th Street, Cleveland, OH 44111; Tel. 216-671-6712), with a selection of antique radios and TVs, parts, service, and memorabilia.

J.S.
Olmstead Twp., OH

PRICE CHECK

I would like to point out a slight correction to the DMX review, which appeared in the January 1996 issue. The price quoted for the receiver ($150) is too good to be true. Local agents in Los Angeles are quoting prices that are much higher. I am looking forward to DMX because I've tried the SCA modification route with poor results.

By the way, the DSS article was by far the best I've seen!

E.T.
North Hollywood, CA

You're right; we goofed. We printed prices quoted to us by DMX's former PR firm, and they were too good to be true. The correct price for the DMX receiver, including satellite dish is usually around $700.—Editor

HAVES & NEEDS

I am looking for 15-volt output tubes to restore one of my antique radios. They were made using blue glass. The numbers I need are Sonora #SO-1 or Arcturus #40. Thank you.

JOHN A. SWETT
8677 Usher Road
Olmstead Twp., OH 44138

Multimedia Watch

New Multimedia Software

By Marc Spiwak
Technical Editor
Windows Magazine

These past few months I've been preoccupied with making the transition to Windows 95. In the meantime, tons of new software titles have piled up, just waiting to be reviewed here. So this month I thought it was about time to get through a bunch of it. So let's get right to work.

TV AND MOVIE TITLES

The Day After Trinity is not only a great documentary movie, it's also a great CD-ROM title containing the entire 88-minute film and more from The Voyager Company. The movie chronicles the life of J. Robert Oppenheimer, from his early roots through his involvement with the development of the atomic bomb, and the history of the atomic age. The CD-ROM also features running commentary by the director of the film, Jon Else, declassified military and FBI documents, a photo gallery, and more. The Day After Trinity is $29.95 well spent, and it's also an entire movie that you can watch on your computer.

I've got several discs from a company called CD Titles, and many of them fall into the TV/movie category. Who can resist *The Three Stooges*, especially when a handful of uncut episodes are thrown onto a CD-ROM for viewing at home or at work—they certainly beat screen savers any day! CD Titles sells this disc, and all of its other titles, for the prices of $7.99 to $9.99.

CD Titles also packs (literally!) one of my favorite movies onto one of those inexpensive discs. *Night of the Living Dead* contains the entire 96-minute film, in AVI format. Now tell me, for under $10.00, who wouldn't want to own a copy of this cult classic film that will run on a PC? *Betty Boop* contains eight of Betty's feature episodes on one disc. *Charlie Chaplin Film Festival* includes a bunch of his zany episodes, as well. *Classic Cartoons* is packed with Mighty Mouse, Woody Woodpecker, and more. Another neat title, *TV Commercials of the 50s and 60s*, contains tons of vintage TV commercials, many of which would be very "politically incorrect" today. *Greatest Moments of the 20th Century* is an almanac of world-shaping events loaded with 60 minutes of full-motion video.

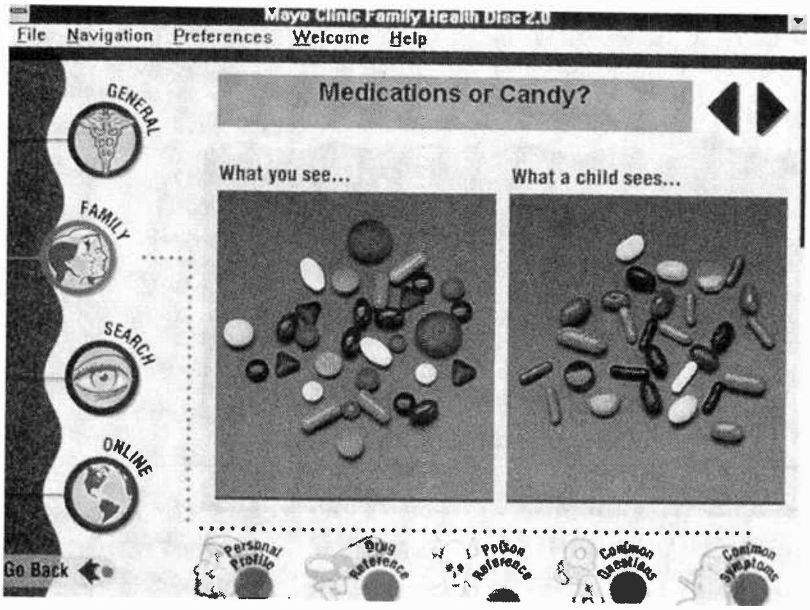
GOOD HEALTH

I've got so many health-related CD-ROMs in my possession that I might never have to visit a real doctor again. Actually, those discs can't replace real doctors, but they do cover various health topics in detail and can help cut down on unnecessary office visits, or let you know when you need to get to a doctor right away. *The Family Doctor, 4th Edition*, from Creative Multimedia is chock full of useful medical information. The disc covers drugs, side effects, first aid, symptom diagnosis, anatomy, and more; there's even a medical dictionary.

The Mayo Clinic Family Health 1996 Edition from IVI Publishing is another CD-ROM that's loaded with information that can help you and your family stay healthy and keep track of medical records. But there's more: The software includes an online link to the Internet, which you can tap for its vast wealth of health tips and information. A copy of Netscape Navigator is included on the disc.

Nine Month Miracle from A.D.A.M. Software uses advanced multimedia techniques to bring you inside a mother's body during the development cycle of a human child. You get to view the changes to both the mother and child as the baby develops. This title sells for around $39.95.

I've also got three titles from the Dr. Schueler's series from Pixel Perfect Software. *Dr. Schueler's Self Health* is the complete interactive personal-health manager. *Dr. Schueler Presents: The Corner Drugstore* is the ultimate drug and pharmacy product reference on CD-ROM. That tremendous database is actually a four-disc set with over five hours of video and information on drugs from A to Z. *Dr. Schueler's Home Medical Advisor Pro* is more of a doctor's eye view of med-

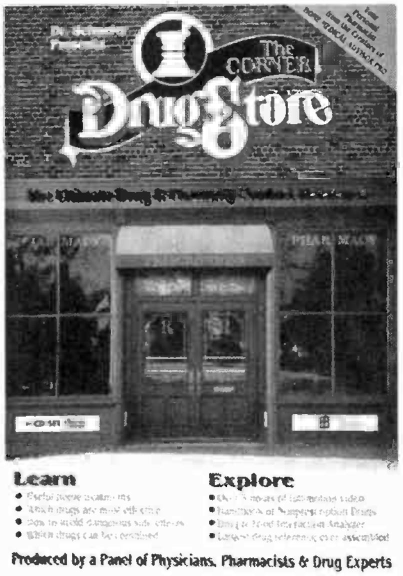


The Mayo Clinic Family Health 1996 Edition from IVI Publishing is loaded with information that can help you and your family stay healthy.

icine. One warning, however: That neat disc contains stuff that might make some people sick and some that's unsuitable for children.

OTHER STUFF

Software that's designed to run under Windows 95 runs much better than older versions not intended for it. That newer software can better take advantage of Windows 95's 32-bit operation. That's why Microsoft is busily at work releasing new versions of our favorite old software. *Encarta 96 Encyclopedia* and *Encarta 96 World Atlas* are the ultimate desktop reference pair, and *Oceans* lets you explore the deep in greater detail. *Bookshelf 95* is an excellent desktop companion for any type of work, and *Cinemania 96* is a fun way to pick out a movie for relaxing after work.



Dr. Schueler Presents: The Corner Drugstore is the ultimate drug and pharmacy reference guide; it comes on a 4-disc set.

For all you UFO enthusiasts out there, I've got two new discs on UFOs this month. The first one, *UFOs . . . The Real Story* from Unity Publishing, is a multimedia reference based on the 36 years of work of Stanton Friedman, a well-known nuclear physicist and UFO lecturer and author. The disc includes plenty of video and stills of UFO sightings. *Incident at Roswell* from OmniMedia details the event on July 4, 1947, when something crashed

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CIRCLE 72 ON FREE INFORMATION CARD

The Voyager Company
578 Broadway, Suite 406
New York, NY 10012
CIRCLE 73 ON FREE INFORMATION CARD

near Roswell Air Force base in New Mexico. Initial reports stated that a crashed "flying disc" containing twisted alien bodies was found. Later on, the initial statement was reversed and it was reported that is was a downed weather balloon. Well, this "spinning disc" will help you make your own decisions.

If you're into maps or just driving places, then you'll love the software from DeLorme, one of the best mapping-software publishers in the business. *MapExpert 2.0* is the latest version of what I think is the best map-printing and -customizing program around. The disc contains maps of the entire United States, with 12-million street segments and 1.1-million geographic and man-made features. This is the program you want for printing a map of your home town or a major road trip. It does sell for the hefty price of around $295, however.

Street Atlas USA 3.0 is the latest update to a program that's very similar to MapExpert—you basically get the same street maps of the entire country—but with trimmed down map-printing and -customizing features, and a trimmed-down price of $79. Even with the trimmed-down features, Street Atlas is an excellent program, and is ideal for the occasional user.

At a price of $79, *Phone Search USA* is the perfect complement to Street Atlas. Phone Search links over 80 million published residential and business telephone listings to the Street Atlas maps. *Map'n'Go* is more travel oriented, combining a comprehensive map database with routing and print capabilities, and more than 31,000 hotels, inns, campgrounds, restaurants, and other points of interest. Also included is a 128-page North America Road Atlas (the paper kind, in full color and a nice, extra-large size) that makes planning trips even easier. This one sells for only $39.

Three new titles from Books That Work include *3D Kitchen, Popular Mechanics Car Guide*, and *Garden Encyclopedia*. 3D Kitchen lets you design your own kitchen in fantastic, realistic-looking views. The Popular Mechanics Car Guide for 1996 is filled with the facts you need to know when buying that new car. Garden Encyclopedia helps you select the right plants for your garden.

I've got three new children's titles this month. *NFL Math* from Sanctuary Woods requires that kids exercise their math skills in order to make the plays in realistic looking NFL football games. Then there's *Lamb Chop Loves Music* and *Haunted House* from Philips Media. Lamb Chop Loves Music features Shari Lewis and her puppet Lamb Chop in a musical adventure. Haunted House brings Jan Pienkowski's pop-up books to life in a haunted multimedia adventure.

Also from Sanctuary Woods are *The Journeyman Project Turbo* and *The Journeyman Project 2 Buried in Time*. The Journeyman Project Turbo is a re-do of the original game but designed to run much faster and smoother. This game features some of the wildest animation I've ever seen. The Journeyman Project 2 Buried in Time is a slick sequel to the original.

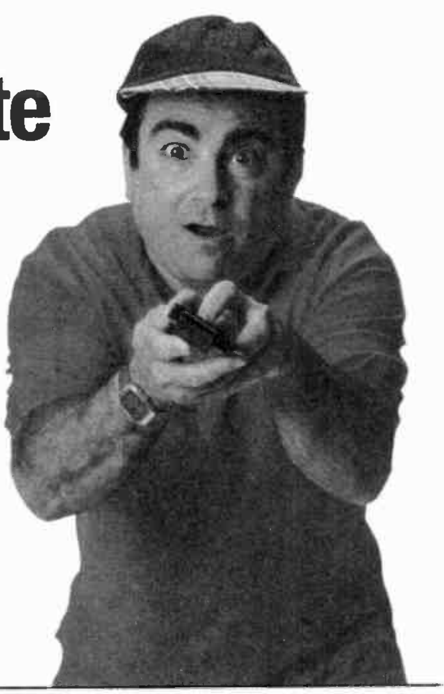
One more from Sanctuary Woods is *Ripley's Believe It or Not! The Riddle of Master Lu*. In this game you join Robert Ripley, famed explorer and collector of the bizarre, on a 1936 mission to dig up an archeological treasure and, of course, save the world.

The Martial Arts Explorer from Future Vision Multimedia is a neat collection of animation, video clips, interviews and more, which all bring the ancient art to life in a modern way. Also included is information on the art, philosophy, and history, of the Far East. This disc has a suggested retail price of $49.95.

Driving gamers will love the new *Al Unser, Jr. Arcade Racing* game from Mindscape. This game features 15 challenging tracks that really capture the feel of racing. A training mode lets you get a feel for the race car. Then you can race a friend via a network or race against 10 other skilled drivers controlled by the computer. ■

TECHNOLOGY UPDATE

Put the remote back into your remote control!



Amazing new device attaches to your existing remote control giving it the power to transmit anywhere, even through walls!

By Charles Anton

It's Thursday evening and you have dinner guests. The kids are watching TV but it's too loud. Without embarrassing yourself or the kids by yelling to turn it down, you pick up your remote with Leapfrog long range power and turn it down without a hassle.

Until now remote control has never been very "remote." Even with the best equipment you had to be right in front of your stereo, TV, VCR, etc. to make it work. Now you can operate your entire entertainment system from anywhere in your home with Leapfrog, the next generation in remote systems.

How "remote" is it? Imagine yourself at home enjoying a relaxing evening of movies on your VCR. You decide to stop the movie so you can get yourself a snack. You aim the remote and click, but nothing happens! You grow more and more irritated, and finally have to stand right in front of the VCR before you can get it to stop the movie. You find yourself wondering why they call it a "remote" in the first place.

Why all the hassle? Typical remotes use infrared technology. In order for the process to work, the remote must be in direct line-of-sight with the audio-visual equipment. The equipment must "see" the signal.

How does Leapfrog work?

Leapfrog converts your infrared remote signal to radio frequency. Radio frequencies enable the signals to pass through walls and other obstacles. It also allows signals to transmit up to 150 feet without staying in line-of-sight with your equipment. Leapfrog then re-transmits the signal to the receiver, which forwards it to your audio-visual equipment.

Leapfrog installs in minutes. The transmitter attaches to your current remote. Plug the receiver into any outlet and place it in line with your audio-visual equipment.

Leapfrog sends radio signals which pass through any non-metal obstacle, giving you complete control of your personal electronics system.

Radio revolution. The Leapfrog transmitter never needs to be perfectly "lined-up" with the TV, etc. Why? Because the transmitter doesn't rely on an infrared signal. You can even point it in the wrong direction and it still works. Leapfrog overcomes all the headaches of obsolete remote controls through the use of radio waves.

Radio waves work anywhere within a 150 foot range. The signals pass through walls, doors, ceilings and floors, letting you control your equipment from any room of your home. You cannot aim and miss.

Infrared to radio. The Leapfrog transmitter, which attaches to your existing remote control, sends radio signals to the Leapfrog receiver. This receiver then transmits the signal to your audio-visual equipment with infrared technology.

Versatile uses. This amazing new remote control modifier works with any infrared remote. Just imagine the convenience of controlling your VCR, TV, stereo, cable converter box, speakers in multiple rooms, or any other audio-visual system throughout your home.

Leapfrog is also ideal for use with universal remotes. Control it all with just one remote.

Talented remote. The Leapfrog is not another hand-held remote control. This powerful innovation actually modifies your current remote, thus enhancing its value. You can control your stereo, your VCR, your TV, etc. from anywhere. From across the room or from across the house.

You can even use Leapfrog from outside. This is a fantastic feature to have when you're out by the pool, on your patio, or in your garage.

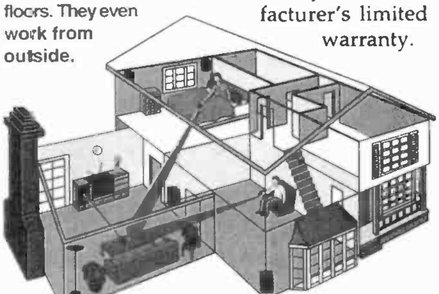
Factory direct. You would expect an innovative device like this to cost several hundred dollars. That might be the case if we sold only through exclusive high-end audio-visual dealers. But we bring the good news straight to you. You save money with factory direct prices.

Why Leapfrog beats infrared

- **Range.** You can control electronics from up to 150 feet away.
- **Aim.** You can't miss. Point your remote in the wrong direction and it'll still work.
- **Value.** It lets you get the most out of your audio-visual equipment by making use of it throughout your home.
- **Flexibility.** Because it sends signals through barriers, it lets you store your equipment behind cabinet doors.

Try it risk free. We are so confident that you will love Leapfrog that we've backed it up with our "No Questions Asked" 30 day money-back guarantee. If you are not completely satisfied for any reason, just return it for a full refund. Plus, it comes with a full one year manufacturer's limited warranty.

Leapfrog transmits signals in a range of up to 150 feet. Signals actually pass through walls, ceilings and floors. They even work from outside.



Leapfrog Remote Range Extender $79 $6 S&H

Please mention promotional code 192-PL-6654.

For fastest service call toll-free 24 hours a day

800-992-2966

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

COMTRAD INDUSTRIES

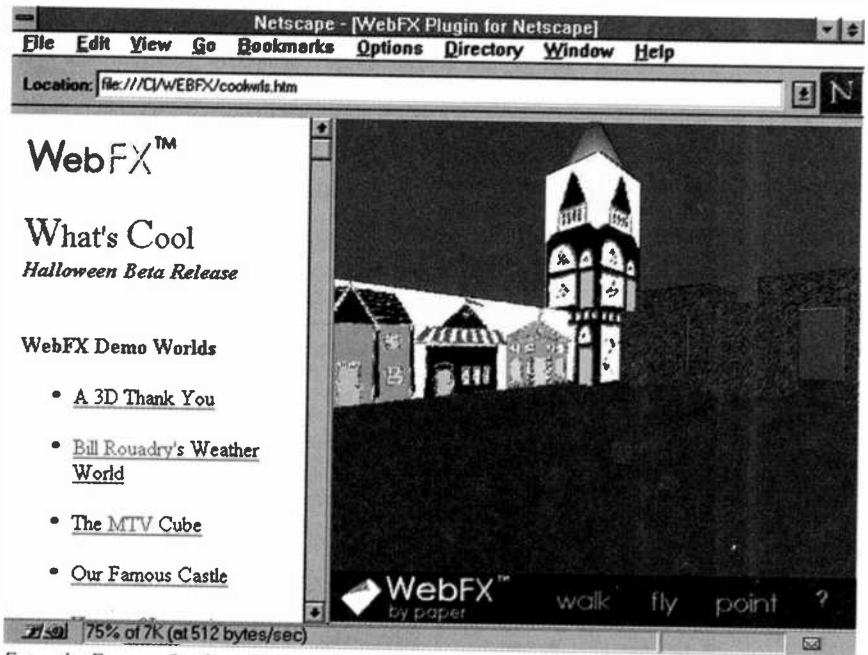
2820 Waterford Lake Drive Suite 106
Midlothian, Virginia 23113

NET WATCH

Virtual Reality on the Web

BY DAN KARAGIANNIS

Many PC users have experienced a subtle form of virtual reality in games like Doom or Hexen. Even without the depth of vision provided by VR headgear, the seemingly 3-D worlds in such computer games allow for a pleasant suspension of disbelief among many kids and adults. Put another way, users feel like they are entering another world, even if doing so doesn't result in anything more than a few hours of entertainment.



Enter the Famous Castle and get used to walking around in a virtual building. One day, the storefronts you see at sites like this will probably link you to real online retailers.

This month we'll take a look at how you can enter virtual worlds over the Internet that actually can be used to accomplish things—primarily, the acquiring of information.

VIRTUAL-REALITY MODELING LANGUAGE

Anyone who's Web-savvy has heard of hypertext markup language, or HTML. It's what makes Web pages look the way they do, through the use of codes that indicate such things as the positioning of text and graphics. A Web browser translates HTML and lets you see the results on your screen.

While some HTML sites are a lot more pleasing to look at than plain text, they are still somewhat two-dimensional and static. In other words, regardless of how graphic-intensive they are, sites on the Web still feel just like what they are—pages of material.

All that is about to change, thanks to Virtual-Reality Modeling Language or VRML. When accessed through a VRML browser or a standard Web browser with a VRML plug-in program, a VRML site really comes alive. Because the basic virtual site loads into your computer's RAM, there are no delays for downloads while you're actually exploring. Put otherwise, turning a corner in a virtual castle doesn't mean you have to wait for the data of what's around that corner to be received from a site.

What's also great about VRML is the relatively small size of the sites. Because the actual virtual engine is in your browser or plug-in, you only have to download map-like data of a particular site. An average download time of a site using a 28.8-kbps modem is less than 10 seconds (double that, obviously, for a 14.4 modem).

What does that mean for the future of the Web? Well, the possibilities are truly endless. Imagine being able to walk into a virtual library to find a book you want at a glance. Or perhaps you'd like to fly around a virtual Earth and select one region to zoom in on and get a current forecast or satellite view (that's actually a currently available site that we'll look at in a moment).

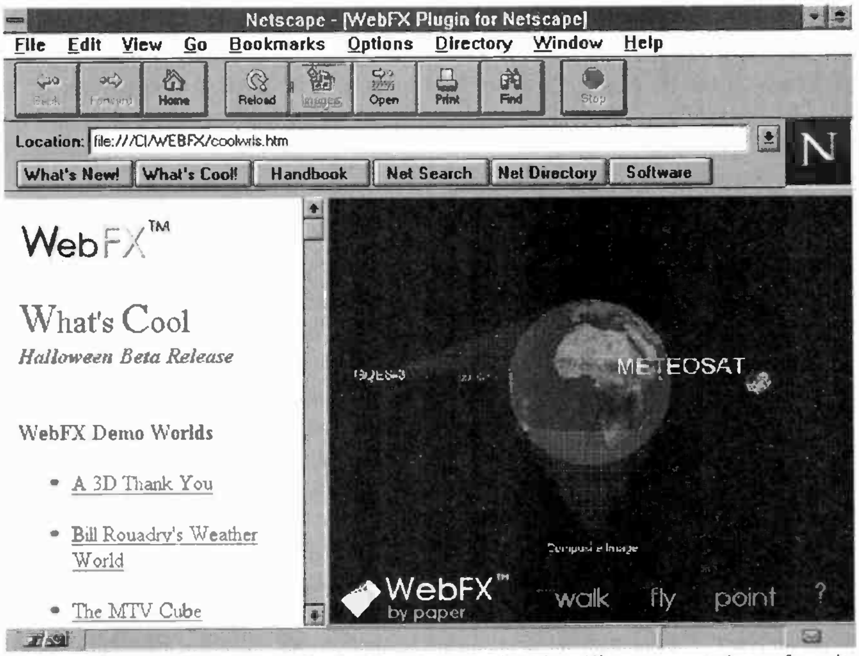
But enough hype. Let's look at how to actually enter the world of VRML.

PAPER PLUG-IN

If you have a SLIP or PPP connection to the Net, and are running Netscape, there is a great piece of plug-in software available that will let you view VRML sites right from the familiar environment of your browser. The program, called WebFX, is available from our first site of the month, Paper Software's home page.

The company makes a new version of their plug-in to match each release of Netscape (at the time of this writing, version 2.0 beta 4 is about to be released). So if you update Netscape, you will have to update WebFX as well. Another option is to use the WebFX Explorer standalone browser (see the site for more information).

Once you download the plug-in and unzip it, run the setup program from within Windows. Installation is basically automatic. You can then either run the plug-in, which automatically loads Netscape first, by itself, or click on the Cool Worlds icon that the software creates in the WebFX program group. I recommend that you do the latter so you'll have immediate access to sever-



Just click on one of the satellites orbiting this virtual earth and you'll get a current image from the actual satellite in space.

al great sites. Here are just some of them (The Net addresses of the following VRML sites are not listed in the "Hot Sites" box. That's to avoid confusion with standard URLs—to visit the sites, access them through the Cool Worlds link just described):

A 3D Thank You lets you move up to or around a floating thank-you note from Paper Software. This is a good introduction to the way perspective in a VRML site works. When you go real close to the note and turn to the right or left, the letters are seen as getting smaller in the distance.

Bill Rouadry's Weather World is a representation of the earth and various weather satellites. Fly up to the satellite covering the region of the earth you're interested in and double-click it. You'll get a current satellite photo of that region's weather from the real, corresponding satellite floating in space (incidentally, the names of the satellites are floating next to each virtual representation). Once you can keep track of where you are in "space" within this site, you've mastered how to move in a VRML site (more on movement in a moment).

The MTV Cube is a cube that plays the morphing scene from Michael Jackson's "Black or White" video on all six of its sides. Moving around the cube gives you a great demonstration of the video playback capabilities of a VRML browser. Due to the increasing pixelization that occurs as you move closer to the video cube, you'll find it feels as if you really are approaching a video display of some type.

Our Famous Castle lets you walk through the courtyard of a virtual castle. Sites like this will one day let you perhaps go shopping at online stores "located" within the buildings inside such a courtyard. For now, use the site to just get used to moving around in a virtual building.

The Ubiquitous X29 with a Sky is a virtual representation of a jet fighter, floating against a blue-sky background. This site also helps you get better control of what it's like to fly around in virtual space. Note what happens when you enter the fighter (or any virtual object).

There are also other sites to visit when you enter Cool Worlds. Space prevents us from going into them in detail, but you should definitely check out Intel Inside, which places you inside a computer chip, and Protein Man's Top Ten VRML sites, which lets you enter a virtual environment to select other virtual sites to visit (around the Holidays the site contained stockings on a virtual fireplace; each stocking linked you to a site).

When visiting any of the preceding sites, you might find it difficult getting used to moving around. Here are some pointers.

On the bottom of your VRML window, there will be the following clickable items: Walk, Fly, Point, and ?. Selecting Walk makes you move as if you were walking; you can go forward, back, left, or right. Fly lets you go up and down as well. Point lets you point to an area in a virtual site with the mouse; a click then brings you a little closer to it. Finally, selecting ? presents you with tips on using the software.

In future columns, I'll cover other VRML viewers as well as what's new in VRML sites. For now, we'll turn our attention back to a great HTML site.

SPORTSLINE USA

Although I'm not a sports fan, I can appreciate, by observing those around me, just how important it is for some to get the latest scores or sports news. If you feel that way, here's a site for you.

Sportsline USA is a comprehensive source for sports information, entertainment, and merchandising. Unlike pages we've looked at in the past, there is a modest charge to use some of Sportsline USA's features. When you visit the site, you will notice that some of the links there have little stars to the right of them. Those are the areas restricted to members only.

Just how modest is the membership fee? At the time of this writing it's only $4.95 a month. If you don't join, you'll still find plenty of headline stories and game results to keep you busy for a while. However, as is the case with a certain piece of green plastic, membership to Sportsline USA does have its privileges. Here are some reasons you might want to join:

> **HOT SITES**
>
> **Paper Software**
> http://www.paperinc.com
>
> **Sportsline USA**
> http://www.sportsline.com

Baseball LIVE! gives you the opportunity to "watch" a baseball game in progress on a "virtual diamond." Game information is continuously fed to Sportsline and programmed into Baseball LIVE!. The result is that the diamond on your screen will display pitcher, batter, and on-deck batter information. Each at-bat is detailed, and when a player gets a hit, a baserunner will appear on the appropriate base. Obviously, such a virtual display will never replace watching a game in progress, but provides a great way to check on the progress of a game while you should be doing some work . . . just don't let your boss catch you!

Another premium feature for members is Prime-Time Celebrity Chat. In that forum, you'll be able to chat in real time with legendary athletes Joe Namath and Mike Schmidt or popular NBC-broadcaster Bob Costas about game strategies, analysis, and sports in general. Each host will have his own weekly, hour-long session.

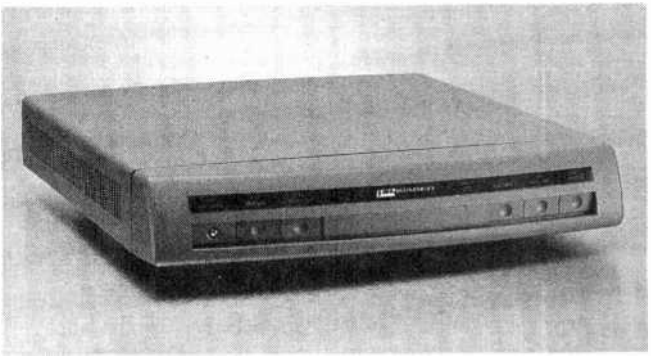
In addition to those features, there are also countless contests, trivia games, downloadable photos and audio clips, team schedules, Las Vegas game odds, and standings and statistics for teams. Put otherwise, there's way too much to cover adequately here. If you're a sports fan, get to the Sportsline USA site next chance you get.

That's it for now. Until next time, you can either e-mail me at peeditor@aol.com or snail-mail me at *Net Watch*, **Popular Electronics**, 500 Bi-County Blvd., Farmingdale, NY 11735. ■

NEW PRODUCTS

5-in-1 Uninterruptible Power Center

Designed specifically for use with personal computers and peripherals, *SL Waber's UPStart Uninterruptible Power Center* will automatically save and restore data and provide up to five minutes of operation during power outages. The UPStart combines dual 250-VA backup power outputs, advanced surge suppression, and solid-state modem protection with Electronic Bookmark Save-and-Restore (SRS) software. It supports both Windows-based and Macintosh computers.



The power center automatically warns the user of power failures via an RS-232 interface. At the same time, it engages its internal battery system to ensure that unsaved work is protected from loss. It is capable of supporting a Pentium microprocessor running up to 150 MHz with a 17-inch monitor. The UPStart also automatically tests the power load during startups to eliminate unnecessary failures caused by overloads.

The Electronic Bookmark SRS software saves data and files during extended power interruptions, storing all work in process on the hard disk in special multiple files. It then instructs the UPStart to shut down and cut battery power to the computer and monitor. When the power returns, it automatically reboots the system and restores files and data. The application is displayed as it appeared before the power failure.

The Electronic Bookmark SRS, which works with Windows 3.1 as well as Windows 95, features a Power Sleep function that can be used to quickly power down the system and eliminates the need for users to manually close and exit each application individually. At startup, that function automatically reboots the system and retrieves the previous session's work.

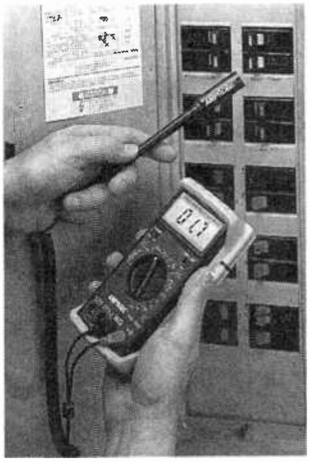
Three types of protective circuitry are at work in the UPStart: surge, modem, and noise. Sophisticated surge-protection circuitry protects computer systems from spikes caused by jolts of high-current electricity, including lightning. Modem and fax protection eliminates the "unguarded back door," which could allow dangerous power surges to enter the computer system through the modem. Internal filters shield the computer system from noise caused by EMI and RFI. LED indicators display the grounding and surge-protection status, and an electrostatic discharge plate allows for quick and safe transfer of any electrostatic charge to ground.

The UPStart 5-in-1 Uninterruptible Power Center has a suggested list price of less than $200. For more information, contact SL Waber, 520 Fellowship Road, Suite 306, Mount Laurel, NJ 08054; Tel. 609-866-8888; Fax: 609-866-1945.

CIRCLE 80 ON FREE INFORMATION CARD

IR PROBE

Amprobe's IR-100 IR-Probe is designed to compare the temperature of electronic equipment, or any target, to the surrounding (ambient) environment. The operating condition of electrical connections, overloaded neutrals due to harmonic currents, circuit breakers, power panels, motors and bearings, transformers, and ballasts in fluorescent lighting can be conveniently judged by the temperature rise above ambient. For example, improperly



tightened or spliced connections will scan hot when brought to normal load for 30 minutes or longer. A color-coded severity criteria card to guide you through your checks is included with the IR-Probe.

The IR-100 IR-Probe noncontact differential temperature scanner costs $99.85. For further information, contact Amprobe Instruments, 630 Merrick Road, P.O. Box 329, Lynbrook, NY 11563; Tel. 516-593-5600; Fax: 516-593-5682.

CIRCLE 81 ON FREE INFORMATION CARD

QUAD-SPEED CD-ROM DRIVES

Two new quad-speed CD-ROM drives from *Panasonic Communications & Systems* have two features that set them apart from the competition: a reliability rating that is up to 25% higher than many competitors and 24-hour/7-day technical support. The *LK-MC684BP* internal drive and the *LK-MC604S* external drive both support many CD formats, including audio CDs, Video for Windows, Photo CD Multisession, and, with the addition of an MPEG board, CD-i and Video CD. Most major operating systems and environments, including DOS, Windows 3.1, and OS/2 are supported, and the LK-MC684BP is also Macintosh compatible. The quad-speed

drives have 175-msec random seek and a data-transfer rate of 600-kB per second. Panasonic is the only company to offer a power-save feature on its drives, resulting in lower power consumption when the drive is inactive.

The LK-MC684BP features an enhanced IDE (Integrated Drive Electronics) interface with ATAPI (AT Attachment Packet Interface) support, enabling it to run on 80286, 80386, 80486, and Pentium ISA bus systems. It offers plug-and-play operation and includes an interface card, connection cables, and EZ installer software. It can be installed in any 5¼-inch slot, whether vertically or horizontally oriented, for greater configuration flexibility. Tabs on the disk tray hold a CD in place if the drive is mounted vertically.

The external stand-alone model *LK-MC604S* features an embedded SCSI interface to ensure plug compatibility with a wide range of systems, including PCs and Macs. The drive also supports most major SCSI interface boards.

The LK-MC684BP and the LK-MC604S have suggested retail prices of $299 and $499, respectively. For more information, contact Panasonic Communications & Systems Company, Two Panasonic Way, Secaucus, NJ 07094; Tel. 800-742-8086 or 201-348-7000.

CIRCLE 82 ON FREE INFORMATION CARD

TRUE-RMS DIGITAL MULTIMETER

Extech's Number 380289 true-RMS digital multimeter displays total harmonic distortion as a percent of total RMS value (AC volts or current) at 50/60 Hz. True-RMS measurements are made on AC voltage and current ranges.

The DMM's measuring capabilities include voltage, current, capacitance, frequency, and temperature, plus continuity beeper and diode test. AC voltage is measured with an accuracy of 0.75%, and DC voltage with 0.3% accuracy. Rapid sampling occurs four times per second. Min/max and average readings are displayed, and the auto-hold function freezes the reading when stable. The digital multimeter can display up to 3999 count and has a 41-segment bar-graph and full function indication. The user can select auto or manual ranging, record/offset/relative modes, and go/no-go programming of reference test points. Safety features include shutter protection for current terminals and 600-volt input protection on ohm ranges.

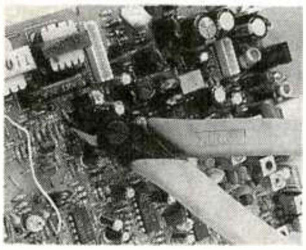
The digital multimeter comes with test leads, a 9-volt battery, a rubber holster, and a type-K temperature probe. An optional RS-232 interface and software are available.

The 380289 true-RMS DMM costs $199. For further information, contact Extech Instruments, 335 Bear Hill Road, Waltham, MA 02154; Tel. 617-890-7440; Fax: 617-890-7864.

CIRCLE 83 ON FREE INFORMATION CARD

TAPERED-HEAD FLUSH CUTTERS

The *Xuron 9200 Series Micro-Shear* tapered-head flush cutters are designed to reach into densely populated PC boards for cleanly cutting component



leads. The cutters provide improved access over standard oval heads for getting into position to cut wire on crowded boards. Manufactured from precision-ground, heat-treated alloyed steel, they are capable of cutting soft wire from less than 1 mil up to Number 14 AWG (American wire gauge). Patented Micro-Shear bypass technology produces a clean, square cut with less effort than compression-type cutters. The 9200 Series feature comfortably cushioned rubber hand grips in two handle lengths. Static-control grips are optional.

The 9200 Series Micro-Shear flush cutters have a list price of $19.75 each. For additional information, contact Xuron Corporation, 60 Industrial Park Road, Saco, ME 04072; Tel. 207-283-1401; Fax: 207-283-0594.

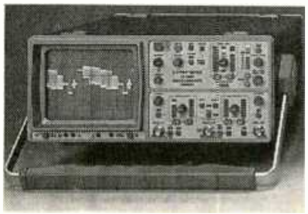
CIRCLE 84 ON FREE INFORMATION CARD

35-MHz ANALOG OSCILLOSCOPE

The *HM304* from *Hameg Instruments* is a 35-MHz, dual-channel, microprocessor-controlled analog oscilloscope with 1-mV/div vertical sensitivity. It features automatic signal control, which presents a set display to the user, who only has to adjust focus and intensity. Manual mode is still available, if required.

Standard features include an RS-232 serial interface, which allows for remote control via a PC or other serial controller, and a memory base that can store and select up to six different user-defined test setups. The peak-to-peak trigger circuitry is sensitive enough to lock onto and trigger signals beyond 100 MHz. Alternate trigger capability allows two asynchronous signals to be observed. A high-resolution timebase allows signal expansion in the "delay" and "automatic trigger after delay" modes by up to 1000 times.

The HM304 is also equipped with a component tester, dual-frequency probe calibration, and active video sync circuitry. A switching power supply automatically accepts line voltages between 90- and 260-volts AC. Weighing in at just 12 pounds, the scope is well suited for field applications, while its serial op-



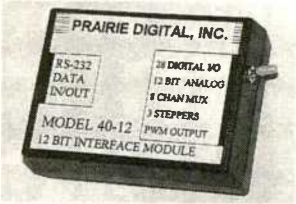
eration and stored setups make it an efficient automatic test station.

The HM304 analog oscilloscope costs $880. For further information, contact Hameg Instruments, 266 East Meadow Avenue, East Meadow, NY 11554; Tel. 800-247-1241; Fax: 516-794-1855.

CIRCLE 85 ON FREE INFORMATION CARD

DATA-ACQUISITION AND -CONTROL MODULE

Prairie Digital's Model 40-12 is a general-purpose measurement and control module for use with all computers. It can be connected to any RS-232 device, including stand-alone operation via modem connection. It features both analog and digital input, pulse-width modulation (which can be used for analog output), and a stepper-motor controller mode. It can be used to control relays, lights, and stepper motors; can measure temperature, pressure, light levels, and humidity; and is well-suited for robotics, alarm systems, and servo control loops. The unit can be combined with a palmtop for portable data logging, or connected to a modem for remote control.

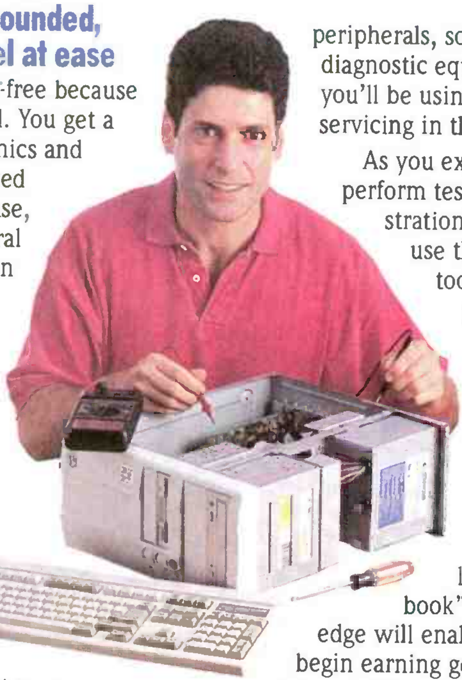


The Model 40-12 is not based on a PIC microcontroller, but on a full-blown, powerful, masked microcontroller IC tied to a 12-bit A/D converter and input multiplexer. It offers serial port communication, 28 individually programmable input/outputs, two IRQ lines, and four channels for reading relative resistance or capacitance.

The Model 40-12 data-acquisition and -control module costs $139. For more information, contact Prairie Digital, Inc., 846 Seventeenth Street, Prairie du Sac, WI 53578; Tel. 608-643-8599; Fax: 608-643-6754. ■

CIRCLE 86 ON FREE INFORMATION CARD

NRI makes it easy to start a new career as a computer service technician



Training so well-rounded, even beginners feel at ease

Training with NRI is stress-free because you're never overwhelmed. You get a solid foundation in electronics and computers through bite-sized lessons that cover every base, from upgrading to peripheral repair, from virus protection to fixing RAM problems. Constantly updated, these lessons will serve as valuable references throughout your new career.

Another resource available to you is NRI's team of instructors and technical professionals. By reviewing your projects, they make sure that you can apply theory to real-world demands. What's more, they're available to answer your questions throughout your training and career.

Learn by doing, the NRI way

Only NRI can ensure your success because only NRI gives you hands-on experience with the kind of computer, peripherals, software, and diagnostic equipment you'll be using and servicing in the real world.

As you explore circuitry, perform tests and demonstrations, and learn to use the Ultra-X tools, multimedia peripherals, and Windows 95 included in your course, you quickly gain a competitive edge over all those who learned "by the book" only. This edge will enable you to begin earning good money as a computer service professional *even before you complete your training program!*

Send for your free catalog on any one of NRI's training programs, including Microcomputer Servicing. All come with great materials, lifetime instructor support, and NRI's innovative TeleGrading system. Find out more today!

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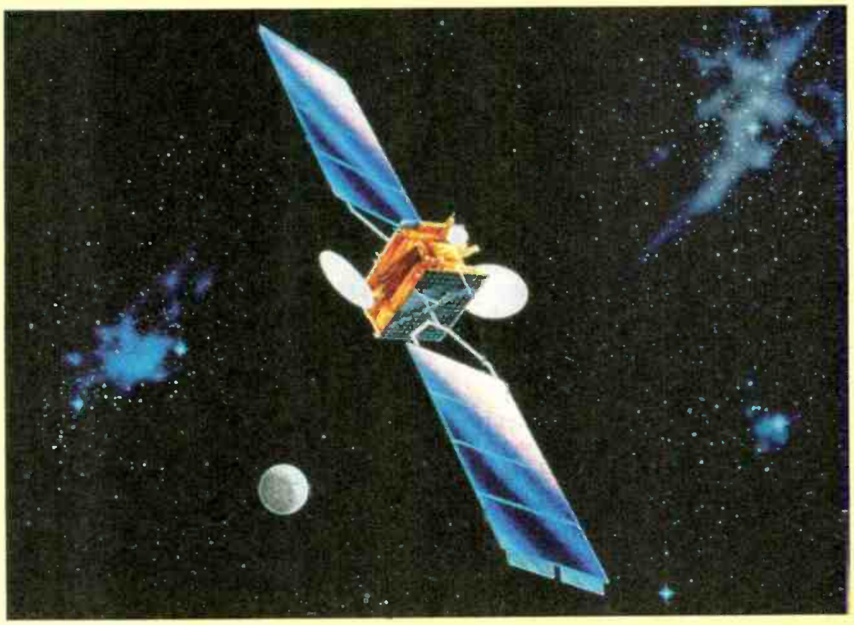

There are so many options for watching TV today that it's difficult to think back to the time when people were lucky to receive as many as seven different channels of programming. Now, of course, you can name a category—news, home shopping, movies, children's programming, sports—and there seems to be at least that many channels devoted to it. All you need is the right video delivery system and you can have it all.

The new digital, small-dish satellite systems have sure captured the lion's share of media coverage in the past year. And if all you are interested in is watching standard cable-TV fare—Lifetime, Nickelodeon, MTV, HBO, The Movie Channel, the Cartoon Network, and the like—then a small-dish system is probably the way to go.

But, for our money, the Cadillac of home video delivery is the big-dish C-band system. Big-dish systems are considerably more difficult to install than the little digital dishes, but the C-band systems offer a variety of programs not available elsewhere. A properly installed system will give you the highest-quality picture available, better than any of the little-dish direct-broadcast satellite systems. Even better, big-dish satellite TV gives you access to audio and video programming that you just can't get any other way.

This month, we'll detail some of the programming available on big-dish satellite and explain how TV delivery by satellite works. In the July issue, we'll look at how to assemble a home satellite system and review some actual hardware. First, though, we'll start with a look back at the early days of satellite TV, and we'll see where the industry is today and where it is heading.

A LOOK BACK

Back in the 1950s, as television surged in popularity, everyone wanted to be a part of the action. Unfortunately, people who lived too far from a large city, or who lived in the "shadow" of mountains that blocked TV signals, were unable to join in the fun. Entrepreneurs jumped to the rescue, however, mounting a single antenna high on a mountaintop and sharing the antenna with local residents via cables running to each home. Those community-antenna television (CATV) systems started the cable-TV industry.

Today's cable-TV industry operates along similar lines, except that most of the stations that it distributes to homes are received via satellite. (Most cable companies receive local broadcasts via rather standard off-air antennas, beam them by microwave to the cable head end, and mix it in with the satellite-received signals before they are fed out to subscribers.)

Cable TV as we know it today began in September 1975, when Home Box Office became the first in the television industry to use satellites for the regular transmission of programming. The first presentation was the Ali/Frazier "Thrilla in Manila" heavyweight bout. Most of HBO's early programming was sports-related.

Another milestone was reached in 1975 when a small UHF TV station in Atlanta beamed its signal to a satellite for distribution, and in doing so became the first "superstation." WTBS is now enjoyed by millions.

In those early days, all of the TV signals delivered by satellite were unscrambled or "in the clear." The programmers were not concerned about the security of their signals, concluding that the enormous expense of the necessary receiving equipment—along with the technical knowledge required to set up a receiving station—would make it all but impossible for their signals to be intercepted.

Well, they were almost right. It wasn't easy, but in the fall of 1976, Bob Cooper, Jr. became the first person in North America to operate a home satellite system. His 20-foot dish was able to receive signals from the three satellites that were in orbit at the time.

No one had expected that such home dishes would be a viable way of receiving television broadcasts. But many factors, including improvements in low-noise amplifier technology, allowed for smaller dishes, and a new industry was born.

That, of course, was the last thing that the programming industry wanted. The programmers fought hard to make home satellite reception illegal—but the young TVRO industry fought back.

One important victory was the elimination of two FCC rules that would have made it difficult for the TVRO industry to grow. The first rule required a license for satellite receiving dishes. The second rule required that a dish be no *smaller* than 9 meters (about 27 feet) in diameter.

The programmers insinuated that intercepting their transmissions was illegal, or at least improper—one reason that early satellite viewers didn't have the best of reputations. The TVRO industry, for its part, insisted that the airwaves belonged to everyone, and viewers had the right to watch any signals they could receive. The fights between the programming and TVRO industries continued back and forth. In 1984, legislation was enacted to make the home reception of satellite programming specifically legal. The fight didn't stop there. In 1986, another law upheld the right of broadcasters to encrypt or scramble their signals—an act that almost killed the satellite industry.

On January 15, 1986, HBO became the first programmer to scramble its signals full-time. The encryption technology was developed by HBO, and sold to M/A-Com. That move was instrumental in getting the other programmers to go with the same encryption technology—something they wouldn't do if HBO was the sole player for decoder authorization.

M/A-Com's VideoCipher II encryption technology became the *de facto* industry standard. M/A-Com is now the VideoCipher division of General Instrument. VideoCipher II Plus is the current industry standard for encryption of C-band programming.

Even though a delivery system was in place, the programmers still didn't seem all too interested in selling to the TVRO market. They made their money by selling to cable companies, and perhaps they didn't want to antagonize the companies that were already feeling threatened by TVRO. It seemed as if everyone wished that the TVRO industry would just go away. When programmers decided to sell to the backyard market, they charged satellite viewers far more than what cable viewers were paying.

AlphaStar promises to deliver digital direct-to-home TV to dishes between two and three feet in diameter. The service should be starting up by the time you read this.

Even though there was still plenty of free programming available, scrambling irked many dish owners. They didn't like the idea of paying for something that they previously got for free. Scrambling, however, spawned a whole new industry: signal piracy.

SIGNAL SCRAMBLING AND PIRACY

C-band satellite encryption is a combination of two different scrambling techniques. The video is scrambled with signal inversion and sync suppression. Such video scrambling is rather unsophisticated, and rather easy for pirates to beat. To combat illegal descrambling, another element was added to VideoCipher—the audio signal is digitized, encrypted, and then inserted where the video sync pulses are normally located.

The video pirates were a determined bunch, however, and VideoCipher was soon "cracked." The hackers never defeated the Data Encryption Standard (DES) that was the heart of the audio scrambling. Instead, they found security holes and "back doors" to exploit.

Just months after VideoCipher II was introduced, hackers responded with a chip that fooled it into recognizing all scrambled channels as being authorized for viewing. The Three Musketeers chip ("all for one and one for all") was used so extensively that it is virtually certain that there were more illegal than legitimate descramblers in use.

Another technique that hackers used was to clone a legitimate descrambler (called the "mother") that has been authorized to receive every scrambled station, and make up to 100 "daughter" receivers. Of course, once an illegal daughter was found and disabled, all of its sisters were also disabled. That's because VideoCipher is an addressable system—each receiver is authorized when it receives its address in the VideoCipher data stream. All VideoCipher-encoded channels carry the data stream, and receivers must periodically see its address in the stream or it will lose authorization.

The latest step in the descrambling wars is the introduction of VideoCipher II Plus Renewable Security (VC RS). The VC RS module has a slot into which a TvPass card (a kind of smart card) can be inserted. Easily installed by the consumer, each card contains an upgrade of the encryption security code, making it easier (and for General Instrument, cheaper) to stay one step ahead of the program pirates.

Whether for technical or economic reasons, the system has, so far, proven invulnerable to hackers, and it has been unnecessary for General Instrument to produce any TvPass cards. However, at the end of last year, rumors were circulating that a potential break was in the works. We hope not—it would certainly mean the end of C-band as we know it, because it would push programmers to digital encryption much sooner than they would otherwise move.

ENTER DBS

During the time that the debate over the legality of receiving programming from existing C-band satellite issues was raging, new services were being envisioned at

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higher frequencies and at higher power. The new frequencies in the Ku region (11.7–12.7 GHz) were broken into two distinct bands by international agreement. In the Americas, the first band, 11.7–12.2 GHz, was set aside for fixed satellite service (FSS). The second band, 12.2–12.7 GHz was the broadcast satellite service (BSS) band, intended for direct broadcast satellites (DBS). The FSS band was intended to be used for point-to-point communications, while the BSS band was intended specifically for broadcasts to consumers.

Satellite services operating at Ku-band frequencies have several potential advantages over similar services delivered at C-band. First—and perhaps most important for mainstream acceptance—is that Ku-band dishes can be smaller because the gain of the dish is higher at higher frequencies, and because Ku-band satellites can be significantly more powerful than their C-band counterparts.

Today, C-band satellites typically operate at a power of between 8.5 and 16 watts, while Ku-FSS satellites typically operate at a power of between 20 and 50 watts. The satellites that deliver DSS programming are operating at 120 watts.

Why are C-band satellites so weak? The earliest satellites, as well as some older satellites still in operation, are low-powered for two reasons. First, the technology for high-powered microwave transmitters was not sufficiently advanced back when those satellites were launched. Second, satellites aren't the only inhabitants of the C band. They must share the spectrum with ground-based telephone microwave transmissions. Therefore, C-band satellites are limited in power to avoid interfering with telephone transmissions. Interference from such microwave links, known as *terrestrial interference* can often cause degradation of picture quality of home satellite receiving systems.

The smaller Ku-band dishes aren't just less conspicuous. They are easier to install and, because they have less wind-load problems, they can often be roof-mounted—an important consideration in densely packed urban and suburban environments. Small dishes are easier to manufacture and ship, and they can be made closer to a true parabolic shape than larger dishes. Because they are usually manufactured in one-piece designs, they maintain their shape better than C-band dishes, which are often assembled from eight or more "petals."

Although suitable receiving dishes can be made smaller as the satellite transponder power increases, there is a limit to how small they can be made. That limit is determined by the "field of view" or beamwidth of the dish. Smaller dishes have wider beamwidths. If a dish is made too small, it will "see" two or more satellites at a time, each of which will interfere with the other. Therein lies the major difference between the C, Ku-FSS, and Ku-BSS bands. Satellites in the C- and Ku-FSS bands are spaced every two degrees, where Ku-BSS satellites have an orbital-slot spacing of nine degrees. Even with equivalent power levels, that allows smaller dishes to be used.

The early attempts at direct-broadcast satellites were dismal business failures. In

DESCRAMBLING THE SATELLITE SIGNALS

Not all satellite video signals are scrambled. Some programmers don't encrypt their signals. When new services are launched, they usually remain in the clear for at least a little while, perhaps to whet the appetites of potential subscribers. For example, the Sci-Fi channel was in the clear for about a year before it was scrambled. Some remain in the clear. The Learning Channel has been in the clear since before 1979. BET (Black Entertainment Television) is also available for all satellite-dish owners to enjoy whether or not they own a descrambler. Some stations will remain in the clear for as long as they are around—the shopping channels and religious channels, for example, want to reach as many viewers as they possibly can. Of course, there is plenty of free programming available on a catch-as-catch-can basis.

However, if your tastes in TV run toward the mainstream cable services such as USA Network, Nickelodeon, MTV, HBO, and Showtime, you'll need a VideoCipher descrambler in your satellite receiver.

Most satellite viewers have a love/hate relationship with VideoCipher and General Instrument, its manufacturer. On one hand, VideoCipher saved the industry by providing a way for programmers to charge viewers. Many in the industry feel, however, that VideoCipher is now hurting the industry because of its expense.

A VideoCipher descrambler now costs about $300—about half the price of a complete entry-level DSS system. Prices were as high as $450 last year because of module shortages. Because of the high fixed cost of the descrambler, C-band satellite cannot compete with DBS on equipment costs. Fortunately, however, because of the less-expensive programming costs when compared to DSS, C-band systems end up costing the same after a few years.

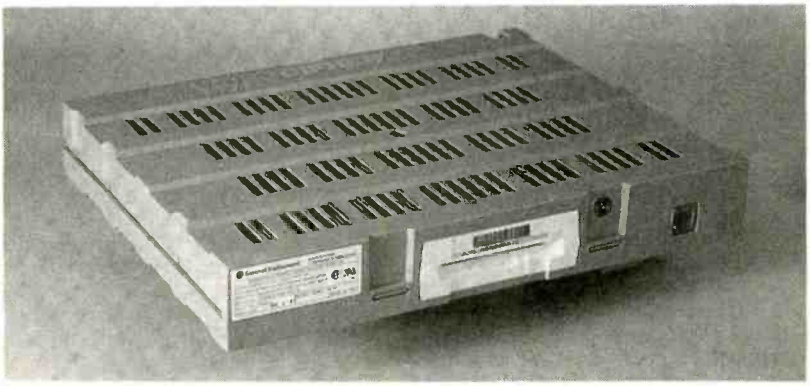
Virtually all satellite receivers are manufactured to accommodate the insertion of a VideoCipher module. Typically, a cover on the rear panel can be removed, allowing the module to be inserted. A card edge on the module mates with a socket in the receiver.

The rear of the module has a smart-card slot and a modular telephone jack. The smart-card slot allows a TvPass card to be inserted to upgrade the security if the VideoCipher II system is broken by hackers. (That's why current descramblers are called VideoCipher Renewable Security or VC RS modules.)

The module's modular jack allows it to be connected to a phone line. A built-in modem allows pay-per-view movies to be purchased just by pushing a button on the remote control.

VideoCipher allows for program information to be transmitted along with the program. Push the VIEW button on the remote control, and the name of the programmer and program will pop up in a black on-screen box. Push NEXT, and information about the next program will appear—if the programmer chooses to provide the information. Some programmers just can't be bothered. Push VIEW when watching Lifetime, for example, and the only information you'll get is "You're watching Lifetime TV."

VideoCipher also allows a rating ceiling to be set so that you can, for example, lock out any movies with an R or higher rating unless a password is entered. Many receivers also have parental lock features that require a password for access to specific channels. ■



The VideoCipher module: Most consumer satellite receivers are designed to take advantage of it.

Sony is the second manufacturer to get on the DSS bandwagon. Hughes Network Systems follows in the first quarter of 1996, with Toshiba and Uniden to join later this year.

maintained by the Primestar distributor. Primestar subscribers do not have to buy any equipment, but they must have the system professionally installed at a cost that typically varies between $100 and $200. Any required equipment upgrades will be handled at no charge to customers.

Primestar beams its programming up to its satellite from several transmission locations in Colorado and New Jersey. The signal reaches the satellite, is boosted in power, and then sent down to subscribers' reception dishes on Earth, where it is channeled to a decoding box inside the subscriber's house, and then to the television set.

When Primestar began operation in 1990, it was seen by many industry observers as simply a plan by the cable companies to derail "true" DBS. Early on, Primestar was no bargain, offering just a handful of channels to a small number of rural subscribers. But Primestar has been nothing if not aggressive. Primestar closed out 1995 with over one million subscribers, representing about 45 percent of the DBS market.

Although the three-foot Primestar dish is small when compared with C-band dishes, it is significantly larger than those required for high-power DBS services. In many markets, that's a significant liability.

Primestar had planned to shift its service from its current medium-power satellite in the FSS band to a high-power service in the BSS band. Tempo, a sub-

the 1990s, however, DBS seems to be succeeding as a business. Two systems, Primestar and DSS, are currently in operation. At press time, two more, AlphaStar and EchoStar, were gearing up to enter the market. In all cases, the key element that has made this success possible is digital compression or data reduction.

PRIMESTAR

Primestar Partners, a DBS provider since 1990, became the first digital DBS provider in April 1994, beating DSS by a matter of weeks. Primestar is a partnership of six multiple cable system operators in the U.S. and G.E. American Communications. The six cable companies are Comcast Cable, Continental Cable Vision, Cox Cable Communications, Newhouse Broadcasting, Tele-Communications Inc., and Time Warner Cable. G.E. American Communications owns the satellite (GE American K1, 85 degrees West longitude) used by Primestar.

A complete hands-on look at Primestar appeared in the July 1995 *Gizmo*. Here's a brief recap along with the latest update.

Primestar delivers about 95 channels of audio and video programming to dishes roughly three feet in diameter. Subscribers lease a dish and a decoder box that are

THE "C" IN C-BAND STANDS FOR CHOICE

No other video-delivery system offers the outstanding choice available to C-band and Ku-band satellite-dish owners. Whether it's pay TV channels, free stuff, or niche programming you're after, you'll find more of it on C-band than anywhere else. With few exceptions, if you can get it anywhere, you'll get it on C-band.

You'll find at least 25 sports services, 11 shopping channels, 11 adult channels, 8 religious channels, ethnic channels, and more. You'll also find programming not available anywhere else. There's plenty of back hauls, where sports programming is beamed back from the event to the network for distribution. There are also tons of "wild feeds," programming that is being distributed by the networks for taping.

Let's assume that you're a soap-opera fanatic and want to watch both ABC's *All My Children* and NBC's *Days of Our Lives*. Well, they are on opposite each other, and unless you have two VCRs, you'll have to miss one. Right? No! Just set your VCR to tape the *AMC* feed at 2 AM each weekday!. You can't wait until Monday night to find out what happens on Chicago Hope? Well, tape it on Sunday at 6 AM!

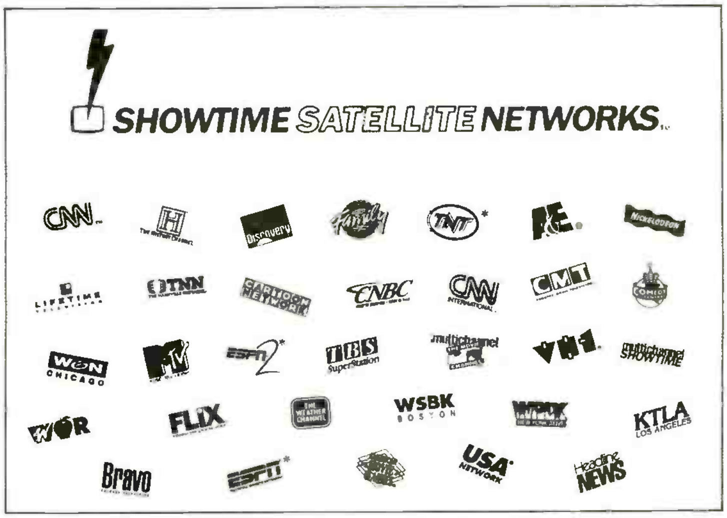
If you are a DSS owner, you might be frustrated that you just can't watch *Star Trek Voyager*. Well, on C-band, you can watch the wild feed distributed by UPN on Sunday—without subscribing to anything.

The FOX network has most of its programming in the clear, and also offers two FX channels (east and west) in the clear. Of course there's also the NASA channel, a must for any Space Shuttle junkies.

Although you'll find electronic news gathering on C-band, Ku is where most of ENG is moving to. You never know what you'll find, and best of all, you'll see the report uncut, unedited. You'll also find plenty of sports up on Ku.

That is only a small sample of what's out there. You want audio? There are plenty of audio subcarriers, making satellite radio full of variety. Whether you want to listen to KLON in Long Beach, California for their excellent jazz programming, or to WFMT in Chicago for classical music, or WCBS, all-news radio in New York, you'll enjoy the excellent quality that satellite can deliver. We can't overemphasize the variety of audio programming on Satellite. We'll give more specifics next time. ■

A PLETHORA OF PROGRAMMING



One of the advantages of C-band is that programming is more reasonably priced than any other delivery medium. Why? It's simple—there's competition!

If you want to subscribe to cable TV, you're stuck with whoever has the franchise in your town. If you want to buy a little DSS dish, you have to buy from DirecTv, USSB, or both—each of which offers different channels, and not as many pricing options as you might like. Primestar is yet another way to go, but there's only one Primestar to buy programming from.

In the C-band industry, things are different. Programming is distributed by as many as 30 packagers, all of whom are in fierce competition with each other. You can buy programming in packages, but you can also order individual services *a la carte*.

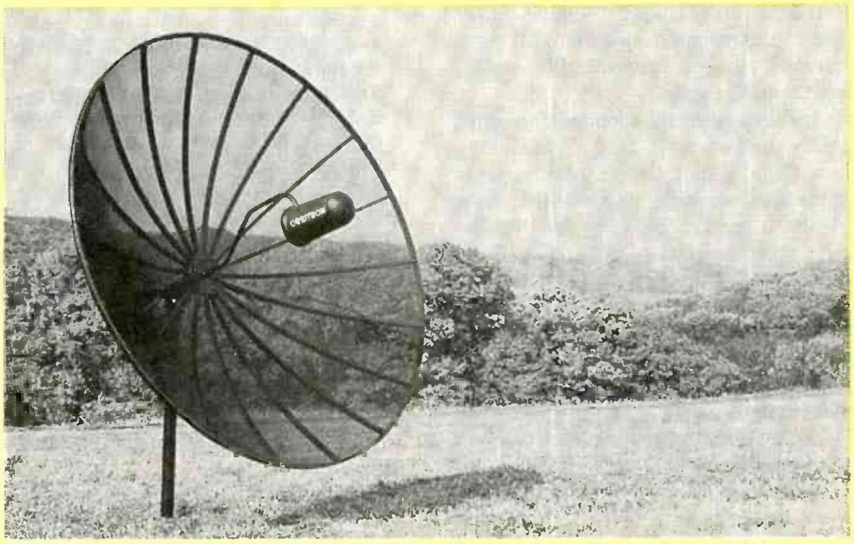
For our installation, we went with a package that contains a mix of the basic cable services plus the premium channels Showtime, The Movie Channel, and Flix. This *Ultraview* package has a total of 46 channels including, in no particular order, Bravo, ESPN, ESPN2, American Movie Classics, Nickelodeon, Discover, A&E, Comedy Central, MTV, VH-1, The Weather Channel, CNN, CNN Headline News, CNNI, and the Sci-Fi Channel.

In addition, Ultraview provides Lifetime; The Family Channel; The Nashville Network; USA Network; CMT: Country Music Television; PrimeTime 24 (network affiliates NBC—WNBC, New York; CBS—WRAL, Raleigh; ABC—WABC, New York); FOX—WFLD, Chicago; and Superstations WTBS (Atlanta), WSBK (Boston), WGN (Chicago), WWOR (New York), and KTLA (Los Angeles).

And that's not all. Remember, with satellite TV you have access to multiplexed and multiple feeds. For package subscribers, that means that you can see Showtime, The Movie Channel, MTV, Nickelodeon, and the Family Channel, Discovery, Channel, USA Network, Comedy Central on more than one channel—the East and West feeds. The total cost of the package is about $326 per year.

We never considered ourselves to be big television watchers. But since we've installed our satellite system and subscribed to the Ultraview package, it's hard *not* to find something that we want to watch at any time of the day or night.

There are a number of drawbacks to all that programming—besides missed deadlines, staying home a lot, and fighting over what to watch. Seriously, we've already noticed that we're spending less time reading books and listening to the radio than we did before satellite TV. Not quite so serious is the flap over "flipping." It used to take a few seconds to flip through all the stations on the dial—you could do it several times during one commercial break, driving other viewers crazy. Now, however, it's possible to spend the entire night flipping from channel to channel without ever really *watching* anything! ■



C-band viewers usually find it hard to hide their love of satellite TV. Not all dishes need to be as large as the Orbitron's 12-foot SX12 shown here. With the newest higher-powered C-band satellites, six-foot dishes can be used with success in many parts of the country.

sidiary of TeleCommunications Inc., or TCI (a 15% owner of Primestar), had reached an agreement to buy 27 channels at the 110-degree orbital slot from Advanced Communications Corp, one of the original DBS licensees.

However, in April 1995, the FCC dealt a major blow to those plans when it stripped Advanced Communications Corp. of its high-power DBS orbital slot. The FCC claimed that Advanced had not shown "due diligence," and was not even close to launching a service.

Primestar appealed the unprecedented action, but as we were going to press, an auction for the slot was scheduled for late January. Primestar will likely enter a bid, even though it is still appealing the FCC decision. Other likely bidders are MCI and, perhaps, AT&T.

Meanwhile, the Ku-band satellite that Primestar currently uses is due to run out of fuel later this year. Primestar has contracted for space aboard another GE Americon satellite, however. The changeover should be seamless to subscribers.

DSS

The DSS digital satellite system became the first high-power DBS service in June of 1994. Within the first year, Thomson Consumer Electronics, the first DSS hardware supplier, had shipped over a million units from its factories under its RCA brand

CLARKE'S VISION

Although we all take communications satellites for granted today, nobody even thought about their possibility until about a half century ago. Then, in 1945, Arthur C. Clarke, the noted science-fiction author, proposed that geosynchronous satellites could be used for global communications in a paper published in the British magazine *Wireless World*.

While contemplating the possible uses of Germany's V-2 rocket technology after World War II, Clarke wrote a letter to *Wireless World*, theorizing that "an 'artificial satellite' at the correct distance from the earth would make one revolution every 24 hours, *i.e.*, it would remain stationary above the same spot and would be within optical range of nearly half the earth's surface." He elaborated on the concept again later that year in an article in the same magazine.

At the time, Clarke imagined that the satellites would be manned, and suggested that three satellites could blanket the earth with programming and communications.

In his book, *How the World Was One: Beyond the Global Village*, Clarke explains why he never attempted to patent the idea. "The answer is simple—lack of imagination. Not for a moment did I dream, in those final months of the war, that the first crude comsat would be orbiting within 13 years, and that commercial operations would start within 20."

The first communication satellites were not geosynchronous—the launch vehicles were not powerful enough to push their payloads into such high orbits. Instead, ground-based tracking systems were used to keep the satellites in view. It wasn't until the early 1960s that a satellite first made it to geosynchronous orbit. In tribute to Clarke, the equatorial orbit 22,300 miles up—where all geosynchronous communication satellites are parked—is called the Clarke Belt. ■

name. At the end of 1995, more than 1.3 million receivers had been authorized to receive programming.

The main players in DSS are Thomson Consumer Electronics, Hughes Space and Communications Company, DirecTV, and USSB.

Thomson not only built the first receivers, but also developed the digital compression hardware on which DSS depends. Hughes built and launched three satellites that are currently providing programming. DirecTv, Inc., a unit of GM Hughes Electronics, is one program distributor. United States Satellite Broadcasting, or USSB, a subsidiary of Hubbard Broadcasting, Inc., is the second program distributor.

Thomson had the exclusive right to manufacture DSS receivers until the first million were sold. Sony became the second licensee. Three more companies—Hughes Network Systems, Inc. (HNS), Uniden America Corp., and Toshiba America Products, Inc.—will join the lineup this year. HNS was expected to ship product in January, with the other two waiting until the second half of the year.

ALPHASTAR

AlphaStar Digital Television is the U.S.-based subsidiary of Tee-Comm Electronics, Inc., which is based in Canada. At press time, AlphaStar was planning to launch its service by the end of the first quarter from AT&T's Telstar 402R, a medium-power (60-watt) Ku-band FSS satellite, which should allow the use of two- to three-foot dishes. AlphaStar has purchased 13 transponders on the satellite for its service.

The 13 transponders that AlphaStar has secured on the new satellite will allow the company to broadcast "more than 100 video, audio, and information services using digital compression," according to AlphaStar statements. That capacity is expected to be expanded to well over 200 services in 1997 with an additional 24 transponders secured on AT&T's planned Telstar 5 satellite. Those new transponders will be powered at 100 watts. That additional transponder space and power will allow AlphaStar not only to increase the amount of services that it delivers, but also to reduce the size of the dishes that are required to receive the signals.

AlphaStar announced programming deals with Digital Music Express (DMX) to provide 30 channels of digital music. The two companies, however, will transmit their services independently from the Telstar 402R satellite.

AlphaStar recently purchased its uplink center, located in Oxford, Connecticut, from GE Spacenet. One of the advantages of the site, according to AlphaStar, is the ability to see the European satellites located over the Atlantic Ocean so that European programming can be distributed.

Receivers for the new system will be manufactured at the start by Tee-Comm and Samsung, with others sure to follow. AlphaStar plans to rely heavily on direct marketing, and has lined up Amway and O-Rourke Brothers as distributors. It will also sell through satellite TVRO dealers.

We will review AlphaStar's service in an upcoming issue.

ECHOSTAR

EchoStar's Digital Sky Highway (DISH) Network is another new DBS system that is scheduled for launch early in 1996. EchoStar is headed by Charlie Ergen, a figure well known to the C-band TVRO world, as the head of Echosphere Corp, a manufacturer of satellite equipment. EchoStar will market through its current TVRO dealer base before moving to traditional consumer-electronics retailers.

EchoStar-1, built by Lockheed Martin Corp. was launched late December by China Great Wall Industries Corp., from Xichang, China. The satellite successfully reached its 119-degree orbital slot about two weeks later.

When service does begin, EchoStar plans to deliver about 70 channels of programming, expanding to about 130 chan-

(Continued on page 30)

SELECTED SATELLITE TERMS

Actuator—A dish mover. A motorized arm that moves a satellite dish into position under the control of a receiver.
C band—A band of microwave frequencies from 3.7 to 4.2 GHz. Many satellites *downlink* their signals at these frequencies.
Clarke Belt—The orbital belt above the equator at a height of about 22,300 miles.
DBS—Direct-broadcast satellite. Satellites that downlink their signals in the Ku band primarily for home reception.
Dish—Common term for a parabolic microwave antenna.
DSS—Digital Satellite System. The first high-power DBS service developed primarily by Thomson Consumer Electronics, GM Hughes Electronics, DirecTV, and USSB.
DTH—Direct-to-home. Encompasses any satellite-delivered signal, whether C-band or Ku-band, that is available to dish owners.
GHz—A frequency of 1000 MHz.
Feedhorn—A device mounted at the focal point of a parabolic dish to collect microwave signals.
IRD—Integrated receiver/descrambler. A satellite receiver that contains a built-in VideoCipher decoder module.
Ku band—A band of microwave frequencies between 11 and 13 GHz.
LNB—Low-noise block downconverter. A microwave amplifier that converts a block of frequencies to a lower frequency. LNBs for satellite TV typically convert C- and Ku-band signals to a frequency band of 950–1450 MHz for input to the receiver.
Polar Mount—A common mount for satellite dishes. One axis is aligned with the true north pole so that the satellites in the Clarke Belt can be scanned with the movement of only one axis.
Polarotor—A small motor mounted on-dish that rotates the microwave probe to receive signals of either horizontal or vertical polarity.
TVRO—Indicates a satellite system that can receive, but not transmit signals.
Video Compression—The reduction of the number of bits needed to describe a video image. ■

Report from Las Vegas

THE 1996 WINTER CONSUMER ELECTRONICS SHOW

While the Blizzard of '96 blanketed the east coast with several feet of snow, paralyzing everything in its path, it was business as usual at the 1996 Winter Consumer Electronics Show in sunny Las Vegas. Sure, there were a few minor differences from previous shows. For instance, the computer exhibits were moved to larger quarters at the Sands Convention Center. The show had a "new" sponsor—the Consumer Electronics Manufacturers Association. CEMA, which replaces the EIA's Consumer Electronics Group, is no longer a group within the Electronic Industries, but "an entity unto itself, carrying a higher degree of respect and of responsibility," in the words of CEMA president Gary Shapiro. Finally, there was some noticeable apprehension on the part of east-coast attendees who rightly suspected that they would not fly home as scheduled.

The show went on with all the hoopla we've come to expect from CES. This year, perhaps more than most, there was a unified theme underlying the noise and bustle of the show floor. And once again there was a lot of excitement over a hot new technology. But this time, it was accompanied by real products being shown, or at least several working prototypes.

This year, the show's theme was digital technology, and its buzzword was DVD, or Digital Video Disc. In his opening-session remarks, Thomson Consumer Electronics executive vice president of marketing and sales, Joe Clayton, put it bluntly: "The digital future is now, with products such as CD-ROM, CD-based video games, digital satellite system, and more. If you aren't ready for it, the opportunity may pass you by." Envisioning the 1996 holiday season, he continued, "The shelves will be stocked with the digital future ... digital camcorders, D-VHS, DSS, and what I believe will become the pinnacle of all digital products, DVD."

Just what is this hot new product that the average consumer has never even heard of? And why will he want to buy it? Read on and we'll tell you!

A firm believer in the digital future, Thomson Electronics' Joe Clayton displays a prototype RCA DVD player, debuting at a store near you by Labor Day.

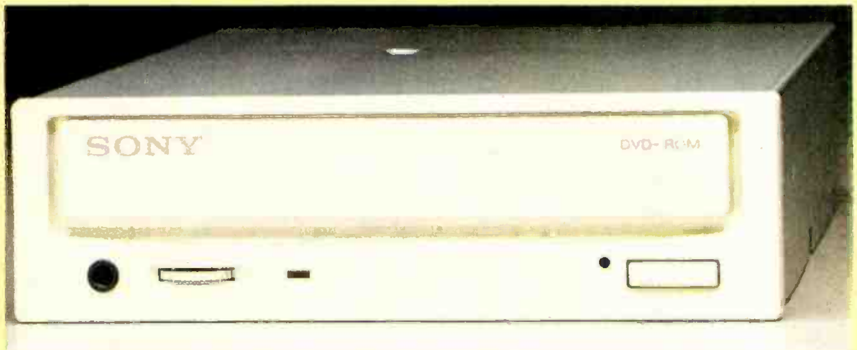
DIGITAL VIDEO DISC, UP CLOSE

The name is deceiving, for the disc delivers much more than just video. In fact, its many proponents had been batting around "digital versatile disc" as an alternative. Instead, they settled on DVD as a generic term, with computer applications dubbed DVD-ROM.

DVDs have several features in common with standard audio CDs: Size, durability, and fast random access are the most obvious. Equally important are the facts that, with some modification, existing CD-production facilities can be used to manufacture DVD software, and that DVD players are backward compatible; that is, they will be able to play today's music CDs.

Appearances aside, there are some major differences between CDs and DVDs. The DVD format allows for both single-sided, single-layer discs and single-sided, dual-layer discs. Single-layer DVDs hold seven times the data of CDs—4.7 gigabytes per layer, compared to 680 megabytes for CD. For high-capacity applications, dual-sided discs will offer 9.4 gigabytes on a single layer, and 17 gigabytes on two layers. (The dual-sided discs will be for video applications only.) The discs are encoded with MPEG-2 video compression and Dolby AC-3 digital surround sound.

What does all that mean to the consumer? A single-sided DVD disc can hold up to two hours and 13 minutes of video, with playback quality superior to that of laserdiscs and sound a step up from Dolby Pro Logic. The discs are familiar looking and,



DVD has computer as well as entertainment applications. This is Sony's DVD-ROM drive prototype.

well, compact, and there's no need to flip them over half way through the film. DVD-ROM provides the higher storage capacity needed for computer applications ranging from databases to multimedia to videogames. The format is backward-compatible with CD-ROMs as well as audio CDs. And for both entertainment and computing purposes, future versions of DVD promise to be recordable.

DVD's greater capacity also translates to increased flexibility and interactivity. DVD movie discs will offer a choice of viewing options, including standard 4:3 aspect-ratio, letterboxed, or 16:9 widescreen modes. Movie and multimedia producers can add extra features such as sound tracks in as many as eight different languages, and subtitles in up to 32 different languages, without reducing the two-hour, 13-minute capacity. Discs can also hold movies in different versions—a director's cut and R- and PG-rated versions of the same film, perhaps. Producers envision that discs could be created with multiple story lines that would allow the viewer to interactively determine the outcome of the plot.

Is the DVD player going to replace the VCR? Probably not anytime soon. Not everyone is as optimistically enthusiastic as Clayton, who expects RCA-brand DVD players to be in stores, with a $499 price tag, by Labor Day, and predicts potential first-year sales for all DVD brands to reach between 2-million and 2.4-million units.

Several variables will directly affect the success of DVD. From the consumer's point of view, deciding factors will be price and software availability. As long as the lowest suggested retail price for a DVD movie player is double the going price of a four-head, hi-fi VCR—particularly before the ability to record is added—DVD will remain a toy for the early adopters. Of course, with growing acceptance comes lower prices, with lower prices come more buyers, and as the cycle continues, sales should take off.

Public acceptance will require a wide selection of software available at reasonable prices. The participation of major Hollywood studios in the development of the product would indicate that they're ready to put their film libraries on DVD. It is expected that by the time the first DVD players hit the market, about 400 titles should be available, priced at around $20 each.

Perhaps the most important factor on DVD's side is industry unity—and not just one industry. The format has the support of several major consumer-electronics manufacturers, computer and software companies, and motion-picture studios. Its specifications have met the approval of the computer industry's Technical Working Group and the motion-picture industry's Studio Advisory Committee. And the consumer-electronics giants have put aside their differences to present consumers with a united front. The only argument seems to be who gets the most credit for developing the format!

THE ROCKY ROAD TO DVD

There were a lot of differences to work through. Although everyone agreed that a digital, CD-sized, high-capacity, optical storage disc was a great idea, two distinct, and presumably incompatible, formats were proposed.

On one side, Sony and Philips were pushing Multimedia CD (MMCD), a single-sided, five-inch, high-density CD that could store 135 minutes of MPEG-2 quality video plus multiple tracks of compressed digital audio and subtitles. The disc could hold 3.7 gigabytes of data, more than five times that on a conventional CD or CD-ROM. MMCD could be developed as a dual-layer format, which would double the capacity.

The opposing faction, led by Toshiba and Time Warner, was putting all its considerable weight behind Super Density (SD) double-sided discs, manufactured by bonding two 0.6-mm platters together, that could store 4.8 gigabytes on each side—more than enough for a full-length movie with Dolby AC-3 digital sound track, three language channels, and four subtitle channels.

For some time, SD appeared to be a sure winner. It had garnered the support of MCA, MGM/UA, and Turner Home Entertainment on the software side, and Matsushita, Thomson, Pioneer, Hitachi, JVC, and Nippon Columbia on the hardware side. Meanwhile, Sony/Philips actively tried to woo major computer manufacturers to their camp, expecting them to strongly prefer their one-sided disc.

Proposed DVD-disc packaging samples.

To everyone's surprise, the computer industry, led by IBM, put its collective feet down. Refusing to back either MMCD or SD, it called instead for a single standard for both computer and video applications. Computer manufacturers (including, but not limited to, IBM, Microsoft, Apple, Compaq, and Hewlett-Packard) issued a joint statement saying that the interests of all concerned—"consumers, software and content providers, and hardware manufacturers"—would best be served by combining "the strongest technical features" of both systems into one format.

The group also outlined nine objectives that the new video/multimedia format should meet: 1) A single interchange standard for entertainment and computer applications; 2) backward compatibility with existing CDs; 3) forward compatibility with future recordable CDs; 4) a single file system for all uses and combinations of uses; 5) costs comparable with existing CD-ROM drives and discs; 6) no caddy; 7) reliable storage and retrieval with average uncorrectable errors no greater than that of existing CDs; 8) the capability to accommodate future capacity increases with technology for multiple data layers or blue lasers; and 9) high performance for both sequential (movies) and nonsequential (random-access data) files.

The movie industry had its own digital-video wish list, issued back in the summer of '94: 1) The ability to accommodate a full-length feature film, about 135 minutes on a single disc; 2) picture quality superior to that of laserdisc; 3) audio compatibility with matrixed surround and other high-quality presentation systems; 4) the ability to accommodate three to five languages on one disc; 5) some kind of copy-protection system; 6) multiple aspect ratios; 7) multiple versions of the same program on one disc with a parental-lockout feature to restrict access to adult versions.

Disproving the old adage "you can't please all of the people all of the time," the two opposing camps decided to do just that. Sony/Philips and Toshiba/Time-Warner set aside their differences, and their egos, and began collaboration on a single DVD standard to meet all of the criteria requested by the computer and motion-picture industries. (For a look at the final specifications, see Table 1.)

That cooperation led to the timely introduction of the new format, and could play a major role in its eventual success. It also represents a major milestone—the merger of the computer, consumer-electronic, and movie industries—that is expected to be the start of a trend.

Such a merger can go a long way toward boosting a product's viability in the marketplace. First, a united front reduces consumer confusion—they aren't being asked to choose between competing formats.

TABLE 1—DVD MAIN SPECIFICATIONS

Physical Characteristics

Disc Diameter:	120mm (5 inches)
Disc Thickness:	1.2mm (0.6mm thick disc × 2)
Memory Capacity:	4.7 gigabytes/single side
Track Pitch:	0.74 micrometer
Wave Length of Laser Diode:	650 nanometer/635 nanometer
Numerical Aperture (NA):	0.6
Error Correction:	RS-PC (Reed Solomon Product Code)
Signal Modification:	8–16

Specifications For Audio/Video Application

Data Transfer Rate:	Variable speed data transfer at an average rate of 4.69 megabits/second for image and sound
Image Compression:	MPEG-2 digital image compression
Audio:	Dolby AC-3 (5.2 channels), LPCM for NTSC (A maximum of eight audio channels and 32 subtitle channels can be stored.)
Running Time (movies):	133 minutes per side (at an average data rate of 4.69 megabits/second for image and sound, including three audio channels and four subtitle channels.)
File Management Structure:	Micro UDF and ISO-9660

Specifications For Computer Application

File Management Structure:	Micro UDF and/or ISO-9660

DVD Disc Types And Capacities

Single-Sided Discs:

DVD-5	4.7GB
DVD-9	8.5GB

Double-Sided Discs:

DVD-10	9.4 GB
DVD-18	17 GB

Only one new technology is being presented, and its backers plan to present it in a big way. A huge advertising campaign is planned, along with extensive training for retail sales personnel.

DVD GETS REAL

Several manufacturers, including Philips, Onkyo, LG Electronics (Goldstar), Panasonic, Toshiba, Sony, Thomson, and Pioneer, displayed DVD player prototypes at WCES 96. Let's take a look at a few.

Toshiba unveiled plans for two players: the $699 SD-3006 and the $599 SD-1006. The SD-3006 includes component (RGB) video outputs. With its "color-difference" output, the signal can be routed directly to line-scanning converters (doublers, quadruplers, etc.) and high-end video displays. Its fluorescent display indicates functions and options, and its universal remote can also operate a TV, VCR, and cable box. Both models offer advanced special effects; a variety of repeat modes; S-video, composite video, and analog stereo audio outputs; parental control function; aspect-ratio selection; and subtitle and dialog language selection. They will be available this fall.

For videophiles who already own a library of laserdiscs, Pioneer showed a unique DVD/LD/CD combi-player as well as a DVD player. "Pioneer's leadership in championing the laser videodisc format is widely acknowledged," said Pioneer Electronics USA vice president of new technology and strategic planning Mike Fidler. "The hard-won technical experience, industry respect, and consumer awareness that this has earned our company will prove invaluable in introducing DVD hardware and software, a field we expect to be highly competitive from the very beginning."

Sony's "total system approach to establishing the DVD market" includes plans to market DVD players later this year, with DVD-ROM drives to follow shortly thereafter, and a Sony MPEG-2 encoding facility will open next year in Culver City,

Toshiba's top-of-the-line SD-3006 DVD player will offer composite video output.

Pioneer's prototype DVD/CD/LD/CDV player covers all the digital bases.

Sony's DVD player prototype.

California. The company is already producing DVD discs at a pilot plant in Japan, and full U.S. production will begin this fall. In addition, Sony-owned Columbia/Tri-Star Home Video has targeted 150 motion pictures for release on DVD, with the first 50 available during the product launch phase.

Thomson plans to round out its DVD lineup by introducing ProScan and GE brand units fast on the heels of the $499 RCA-brand DVD-player that it expects to market by summer's end. Thomson announced at WCES an interesting "cross-sourcing" agreement, under which Matsushita will manufacture DVD players for Thomson's brands, and Thomson will manufacture Panasonic-brand digital satellite systems (DSS) for Matsushita. Thomson also announced that its DVD advertising budget would rival the highly successful DSS ad campaign.

DSS TAKES OFF

Besides DVD, DSS was causing the biggest stir at WCES 96. Following its splashy debut last year—by far the most successful consumer-electronic product introduction of all times, with about a million units sold in the first 12 months—manufacturers and dealers alike are jumping on the DSS bandwagon.

Joining hardware providers Thomson and Sony, Uniden—for years a strong player in the TVRO market—has two DSS systems ready for mid-year marketing. The $599 USD-100 and the $749 step-up model USD-200 both feature the StarSight on-screen channel guide with one-touch VCR programming. The USD-200 also features dual LNB inputs and an 80-event VCR timer.

(For more up-to-the-minute news on DSS, see the companion story in this month's *Gizmo*.)

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Fax: 703-907-7601

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Elmwood Park, NJ 07407
Tel. 201-794-3900
Fax: 201-523-3601

LG Electronics U.S.A., Inc. (Goldstar)
1000 Sylvan Avenue
Englewood Cliffs, NJ 07632
Tel. 201-816-2000
Fax: 201-816-2170

Motorola, Inc.
1303 East Algonquin Road
Schaumburg, IL 60196
Tel. 708-576-5000
Fax: 708-576-7653

Panasonic Company
One Panasonic Way
Secaucus, NJ 07094
Tel. 201-392-4675
Fax: 201-392-4242

Philips Consumer Electronics Company
One Philips Drive
Knoxville, TN 37914-1810
Tel. 423-521-4316

Pioneer Electronics Inc.
2265 East 220th Street
Long Beach, CA 90810
Tel. 301-952-2286

Sharp Electronics Corp.
Sharp Plaza
Mahwah, NJ 07430-2135
Tel. 201-529-8200
Fax: 201-529-8919
Internet: http://www:sharp-usa.com

Sony Electronics Inc.
Sony Drive
Park Ridge, NJ 07656
Tel. 1-800-222-SONY
Internet: http://www.sony.com

Thomson Consumer Electronics
10330 North Meridian Street
Indianapolis, IN 46290-1024
Tel. 317-587-4450
Fax: 317-587-6708

Toshiba America Consumer Products, Inc.
82 Totowa Road
Wayne, NJ 07470
Tel. 201-628-8000
Fax: 201-628-0672
Internet: http://www.toshiba.com

DIGITAL VIDEO CAMCORDERS

Another exciting new digital format being exhibited at the Consumer Electronics Show is the DV—digital video—camcorder. DV camcorders record high-resolution (500 horizontal lines) pictures and CD-quality sound onto tiny digital tapes. Like DVD, DV specifications have been formalized into a worldwide standard, with the backing of 55 leading consumer-electronics companies. The 60-minute DV cassette measures 66×48×12.2 mm, or half the size of an 8mm cassette, and holds a ¼-inch metal-deposition tape. The camcorder features two rotating heads and a helical recording system that divides signals for recording a single frame into 10 tracks for NTSC or 12 tracks for PAL systems. Digital data compression is used to cut the huge amount of data recorded into an amount that the tape can hold.

Digital camcorders have several advantages over their analog counterparts in addition to improved picture and sound quality. They can be used as still-video cameras, and can be connected to color video printers. Two-channel audio allows users to add narration or background music on the second track. And the technology offers the ability to create multiple generations of digital-to-digital dubs with virtually no image deterioration.

Unfortunately, that capability is creating a stumbling block on the road to consumer DV VCRs. Those are not likely to be seen until some agreement on digital software copyright issues can be reached. Until then, DV users must duplicate their digital recordings on their analog VCRs.

Sharp's VL-DH-5000 Digital ViewCam features its own five-inch color LCD screen. That's the largest LCD screen on any camcorder to date, and the first on a DV camcorder. The pivoting screen provides easy viewing of the subject during recording, and a convenient way to play back tapes. The digital ViewCam, which features the same three-CCD optical system used in professional video cameras, will carry a hefty price tag of $4595 at its May introduction.

Sony displayed two currently available DV camcorders at the show. The DCR-VX1000 incorporates three-CCD imaging with 410,000 pixels per CCD, and offers a DV interface for digital-to-digital editing or dubbing (when connected to another Sony DV camcorder). Its suggested retail price is $4199. The DCR-VX700 has one 410,000-pixel CCD and a $2999 price tag.

Another three-CCD entry is the Panasonic PV-DV1000, with 270,000 pixels per CCD. It has a suggested retail price of $4199 and is already on the market.

JVC and Thomson both exhibited single-CCD units that will be available this spring. JVC calls its $2995 GR-DV1 "the

DSS, exhibited at Sony's WCES booth, as well as several others, was a traffic-stopper at the show.

60-minute DV cassettes (right) for use in DV camcorders are about half the size of 8mm tapes. The larger, 120-minute tapes (left) are for use in DV decks, when available.

Sharp's latest ViewCam is the VL-D5000 DV camcorder with a 5-inch color LCD monitor.

The pocket-sized RCA CC900D digital camcorder is slated for introduction in spring 1996.

world's smallest camcorder." The pocket-sized camcorder has some neat editing features, including the ability to zoom in on scenes that have already been shot. The RCA CC-900B, which will cost $2999, also sports special editing features, including the ability to change the color picture to black-and-white during playback.

As suggested from those prices, DV camcorders will not be flying off the shelves at your local electronics emporium. For the moment, they are being billed as "prosumer" items, aimed at professional-videographer consumers who moonlight as wedding videographers or in other ways make money using a camcorder. In that small but enthusiastic market, sales already have been strong.

To find its way into the mainstream consumer market, those prices will have to drop dramatically. Getting DV-compatible VCRs on the shelves would help too.

WRAPPING UP

Digital devices aside, WCES held few surprises, although several interesting products were exhibited. Motorola showed a pager-sized gadget that provides users with sports scores and even play-by-play reports on a tiny LCD screen. Sony announced its first 35-inch Trinitron, and new $199 price tag on its MiniDisc player. Goldstar displayed audio minisystems designed not for the bookshelf but for wall mounting.

Keep an eye on these pages in coming months for hands-on reviews of some of these products, as well as all the latest in consumer electronics. ■

SATELLITE TV

(Continued from page 24)

nels when its second satellite is launched. EchoStar's uplink center is in Cheyenne, Wyoming.

Keep reading *Gizmo* for a review of EchoStar's service when it's available.

THE FUTURE

The DBS industry is still in its infancy, but it is already sending programming to more than two-million homes. The number of DBS subscribers will surely pass VideoCipher subscribers early this year.

There are roughly 2.4-million paying VideoCipher subscribers—a market that programmers aren't ready to give up quite yet. There are also perhaps as many as two-million TVRO viewers who do not own a descrambler and watch just what's in the clear.

The major players, including Showtime and HBO are committed to delivering signals to customers via C-band satellites at least until the end of the century. But more and more program providers are seeking ways to reduce costs.

FOR MORE INFORMATION

Alphastar Digital Television
2 Greenwich Plaza
Suite 100
Greenwich, CT 06830
Tel. 203-622-7636

DirecTv
P.O. Box 92424
Los Angeles, CA 90009

Echostar Communications Corp.
90 Inverness Circle East
Englewood, CO 80112
Tel. 303-799-8222

General Instrument
6262 Lusk Boulevard
San Diego, CA 92121
Tel. 619-455-1500

Primestar Partners
3 Bala Plaza West
Suite 700
Bala Cynwyd, PA 19004
Tel. 610-617-5300

Showtime Satellite Networks
1633 Broadway
New York, NY 10019
Tel. 800-422-9006

Sony
One Sony Drive
Park Ridge, NJ 07656
Tel. 800-222-SONY

Thomson Consumer Electronics
600 North Sherman Drive
Indianapolis, IN 46201
Tel. 317-267-6613

Toshiba
1010 Johnson Drive
Buffalo Grove, IL 60089-6900

USSB
3415 University Avenue
St. Paul, MN 55114
Tel. 612-645-4500

Digital compression will, without a doubt, come to C-band program distribution, allowing many more signals to be crammed onto the satellites. What that means to dish owners is still far from certain, however.

General Instrument's DigiCipher technology so far seems to be leading the race to become the digital standard. GI is promising that it will have a hybrid analog/digital receiver ready before the end of the year. But our guess is that digital C-band has little chance of success in the C-band market.

So enjoy it while you can. C-band satellite is a great entertainment value and it delivers unrivaled variety. It's more than just cable in the sky. ■

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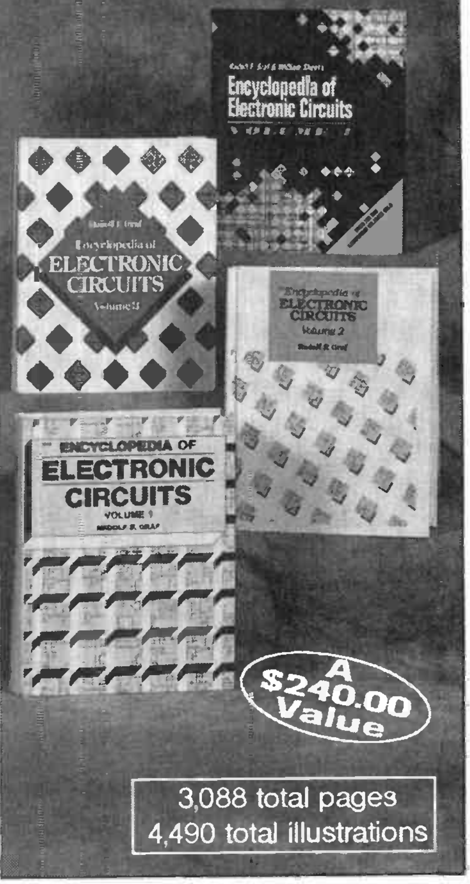

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DX Listening

Goodbye to the Happy Station

BY DON JENSEN

At 67, it was the oldest show on shortwave. In fact, Radio Netherlands' weekly *Happy Station* program was probably the longest running English-language program in the history of radio broadcasting!

But the show was showing its age, and by the time The Happy Station aired for the last time last fall, perhaps it really was time to retire the venerable SW show. Even so, no doubt, many long-time SWLs suffered real nostalgia pangs at its departure from the worldband-radio scene.

Astonishingly, during more than six decades, Radio Netherlands' Happy Station had only three regular on-the-air hosts: Eddy Startz, Tom Meyer, and Peter Myers. "Over the years," writes Richard Cuff, "Easy Listening" columnist for the North American SW Association's *Journal*, "the format had certainly changed. From Eddy Startz's gimmicks like 'A Nice Cuppa Tea,' Souza marches, and animal-farm sounds; to Tom Meyer's Easter Egg Hunt, some of the world's first telephone call-in shows, and the Birthday Book; to Pete Myers' emphasis on audience participation in the show itself, the program's character has clearly evolved. In comparing the most recent effort to the original, it was clear that time and tastes had changed to the point where Radio Netherlands was making a program to fit a name and not to serve the majority of the audience."

The Happy Station broadcast dates to 1928, and the experimental transmission of station PCJJ, operated by the Philips Laboratories in Eindhoven, Holland. PCJJ's 25 kilowatt transmitter—a mere 1/20th as powerful as some of today's SW giants—was big stuff in those early days. But reached, as was intended, half way round the world to deliver a shortwave signal to the Dutch East Indies—today's Indonesia.

In 1928, Eddy Startz, a young announcer, began the weekly program, introducing the friendly show with an invitation to his listeners to join him, for the next hour, for "a nice cuppa tea." Startz also invited millions of listeners worldwide, over the subsequent decades, to "Keep in touch with the Dutch" through his programming. The multi-lingual announcer also offered segments of programming to non-English-speakers in his audience.

With the exception of the W.W. II years, when the Nazi occupation of Holland forced the PCJ (as the shortwave station was called in those days) program off the air, Startz went on, and on, Sunday after Sunday. Finally, when Eddy retired from broadcasting in 1970, he was replaced as Happy Station host by then 32-year-old Thomas Hendrik Meijer, who had been born in Holland, but with his family, escaped the wartime occupation to the West Indies, where he grew up.

Here's the broadcasting center of Radio Netherlands that, together with its predecessor shortwave outlets, presented the Happy Station program for more than six decades.

The one-time pharmacy student decided his real interests lay in other directions, to music and the theater. In 1965 he joined the staff of Radio Netherlands, changing the Dutch "ij" spelling to "y," becoming Tom Meyer. Five years later, upon Startz' retirement, Meyer succeeded him at the Happy Station microphone. Like his predecessor, Meyer was multilingual, speaking English, German, French, Spanish, and some Italian, as well as Dutch.

Meyer also avoided controversy, long an important element in a program that promoted a happy outlook. He stressed that his broadcast goal was "Harmony. Harmony in person-to-person relationships . . . the starting point for greater harmony in world matters."

The Happy Station program's subtitle was "Your Sunday family show of smiles across the miles," a bit of something for everyone, easy-going chitchat and music, from jazz to country and western. The format seemed to work, as during the Meyer years, Radio Netherlands, citing a shortwave survey, said the average number of listeners to a typical Sunday show was about 200 million, worldwide.

After 22 years, Meyer announced in 1992 that he was leaving the program to take up writing and dramatic interests. "Meyer is out, Myers is in," a DX Listening reader wrote me at the time. And so it was: Pete Myers, himself a longtime Radio Netherlands announcer, took over the Happy Station and brought it into the 1990s, with a greater participation from his still-significant worldwide audience. And for three years, Myers continued as host of this tremendously long-running SW program.

The program aired for the last time, Sunday, Sept. 17, on Radio Netherlands, which stressed that its strong commitment to SW entertainment broadcasting continues.

The Happy Station is gone, but not forgotten.

IN THE MAIL

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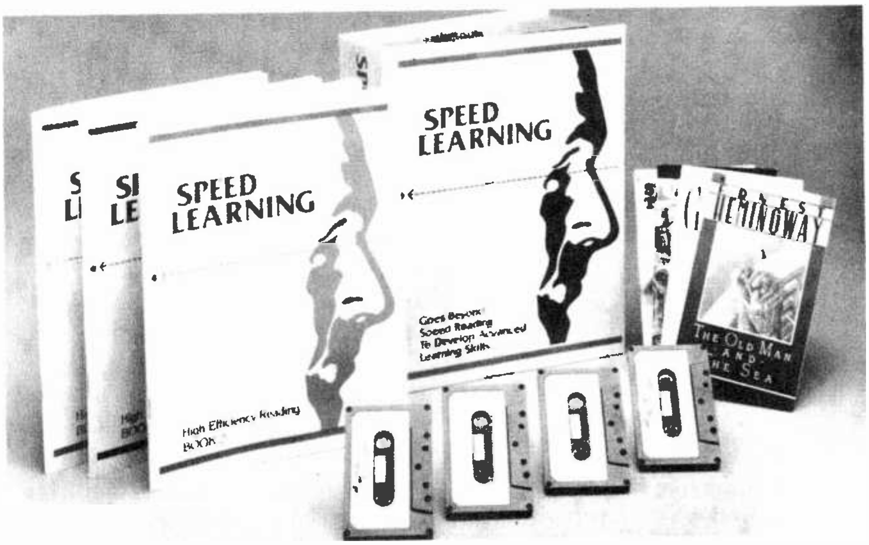

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As I would like to regularly include photos of DX Listeners enjoying their favorite hobby, I have a special request: Have someone snap a clear, sharp photo of you at your SW receiver listening to your favorite stations. And be sure to let us see your face—not just the back of your head!

First in the mailbox is a letter from Mike Azarian, who says he's a fourth-generation Armenian-American who does not speak or understand the native language of his late great-grandparents, but would like to know more about their homeland, which long was a part of the former USSR. "How can I tune in Armenia on shortwave?" he asks.

The Voice of Armenia, broadcasting from the capital of Yerevan, does have some English programming, Mike. As this is written, it has been reported in English on 9,965 kHz at around 2145 UTC. Earlier, at 2100 UTC, look for multi-lingual station identifications. Listeners also suggest trying the 0930 to 1000 UTC English transmission on 15,275 kHz. *Passport To World Band Radio* schedule listings also show that 11,290 and 11,945 kHz might be worth trying, at around 0100 to 0130 UTC, during the summer months ahead.

"I'm something of a radio history nut," writes Alfred Browne, New York City. "A friend, knowing that fact, recently sent me an interesting clipping about one of the world's real shortwave pioneers, Hugo Gernsback. Since **Popular Electronics** is published by Gernsback Publications Inc., I thought DX Listening readers might find it interesting too.

"Hugo Gernsback," Alfred continues, "was born in Luxembourg in 1884, and came here to New York City at the age of 20. He invented the dry-cell battery and produced the first home radio receiver in 1906. He also sold electrical parts to radio experimenters through his Modern Electric's mail-order company.

"A promoter of radio experimentation, he founded the Wireless Association of America in 1909, and soon claimed to have 10,000 radio enthusiasts as members. He recommended to the U.S. government that it allocate the supposedly worthless shortwave frequencies to radio amateurs, which Congress did.

"He issued the first logbook of radio amateurs in 1910, and published other radio and electronics magazines over the years."

Thanks, Alfred! Yes, today's **Popular Electronics** does have historical links to this amazing radio pioneer. Incidentally, Hugo Gernsback was a prolific inventor, creating the first walkie talkie in 1919 and experimenting with television in 1928. He is generally credited with popularizing science-fiction writing and to honor his contributions in this field, science fiction's annual literary award is dubbed the "Hugo."

Gernsback died in 1967.

DOWN THE DIAL

Here are some SW listening targets to try for. As a reminder, schedules are given in Universal Coordinated Time (UTC), the international time standard which is equivalent to Eastern Daylight Time plus 4 hours, CDT+5, MDT+6 and PDT+7.

COSTA RICA—6,150 kHz. Adventist World Radio's Central-American outlet, *TIAWR*, is heard with English religious programming at 2345 UTC. It also operates on parallel frequencies of 7,375 and 9,725 kHz.

HUNGARY—7,250 kHz. *Radio Budapest* was logged on this frequency, and on 5,935 and 9,835 kHz, at 2112 UTC with a "DX Quiz" program.

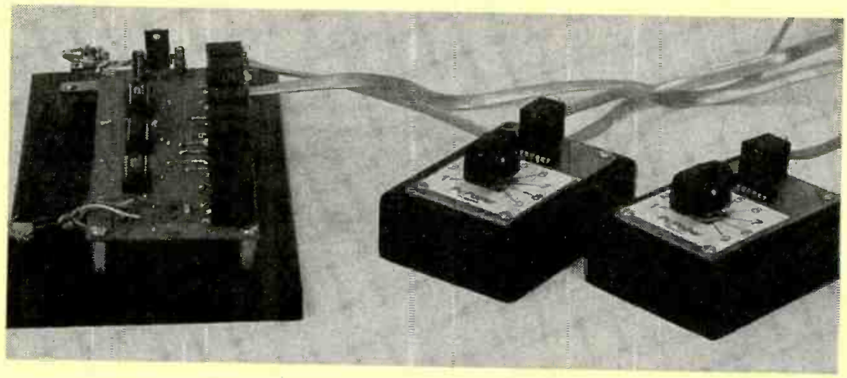
MOLDOVA—11,750 kHz. *Radio Dneister International* has an English-language transmission signing on at 2030 UTC. Moldova was formerly known as Moldavia when it was part of the former Soviet Union.

SPAIN—9,690 kHz. Beijing's *China Radio International,* heard on this frequency at 0300 UTC in English, is actually being relayed by shortwave transmitters in southern Europe.

VENEZUELA—9,660 kHz. *Radio Rumbos* in Caracas is heard here at various times during the evening hours with Spanish-language programming and "Rumbos" identifications. ■

CREDITS: William McGuire, MD; Ken McHarg, Ecuador; Bob Montgomery, PA; Denis Pasquale, PA; Sheryl Paszkiewicz, WI; North American SW Association, 45 Wildflower Road, Levittown, PA 19057

BY JAMES J. BARBARELLO



BUILD THE PC POLLER

Use it and your PC to poll the responses from several switches at once.

Anyone who watches audience-participation shows like *America's Funniest Home Videos* knows that there are instances where group responses need to be captured and analyzed. For example, there has to be some way for the audience to vote on which video is really the funniest.

Also, off the air, ad agencies routinely bring in groups of consumers to view potential commercials. During such screenings, each consumer continuously indicates his or her interest by adjusting a control that ranges from "bored" to "wow!" Such a system can also be useful in a classroom setting, where students can listen to a series of multiple-choice questions and provide their responses.

But no matter what application such a polling system is used for, it works in the following way: It immediately monitors the status (open or closed) of several switches, captures the responses, and logs them into a computer, where various analyses can be performed. When looked at that way, it becomes clear that a poller could even be useful in security or manufacturing operations.

The *PC Poller* described in this article is just such a versatile device. It allows you to poll the status of up to 36 keypad stations. Each keypad station can have up to nine switches, totaling 324 possible switches, which are all polled and sensed through any PC's parallel port. From there, the received data is interpreted using a simple QBasic program, which could be easily adaptable to almost any application.

Of course, you can't get up to 324 on-off indications through a 25-pin parallel port simultaneously. You can, however, sequentially scan the status of each individual switch very rapidly with a PC. So rapidly, in fact, that the scan can take less than one second on a fast computer. Let's see how.

Circuit Description. The schematic for the Poller control-board circuit is shown in Fig. 1. As shown in that diagram, the circuit will act as the first controller board. If you would like to connect more boards (remember, you can connect up to three more for a total of four), the subsequent circuits will be the same as the first except for the following changes:

For starters, the power-supply components, J10, C1, C2, and IC4 are only needed in the first board. Subsequent boards take their power from the first board.

Second, resistor R1 is only needed in the first board. In the other control circuits, the connection established by the resistor is not needed at all.

Finally, the DB-25 plug (PL1) that connects the Poller to a PC is only needed on the first board. The subsequent boards share the connections indicated in Fig. 1.

Now, back to how the circuit works. Jack J10 is connected to an 8- to 13-volt DC source. Two filter capacitors, C1 and C2, and a 7805 regulator, IC4, provide the circuit with a regulated 5-volt supply.

At the heart of the circuit is a 4017 decade counter, IC1. That chip has ten outputs, 0 through 9 (only 1–9 are actually electrically connected to the circuit). On each positive transition of the clock Input (CLK) at pin 14, the current output (we'll call it "n") goes low, and the next output (n + 1) goes high. That occurs only if the clock-enable (EN) input, pin 13, is low. If the EN input is high, the CLK input has no effect. Finally, a high at reset-pin 15 resets the count.

Each of IC1's outputs, 1–9, is inverted by a section of a 4049 hex inverter. Because nine inverters are needed, two 4049s, IC2 and IC3, are used.

To understand how the inputs are detected by the controller board, let's take a look at the keypad circuit, which is shown in Fig. 2. That circuit contains a single 4017, IC1, which also has its 0 output unconnected. The remaining nine outputs are each connected to one terminal of rotary-switch S1. The pole of the switch is connected through diode D1 to a common point in jack J1, a six-contact modular jack. The same type of jack is used for J1–J9 on the control board.

For the circuits to work together, they need to be controlled by a PC, which is connected by PL1 of Fig. 1. We'll look at the software that controls the Poller later, but for now, we'll just stick to circuit functions. Initially, a master reset signal from pin 1 of PL1 resets all the 4017s in both the control and keypad boards to the 0 output. Because IC1 of the control board has its 0 output high, all other outputs are low. Those low outputs are inverted to highs by IC2 and IC3, which disables the 4017s on all the keypad boards (a high EN disables the 4017).

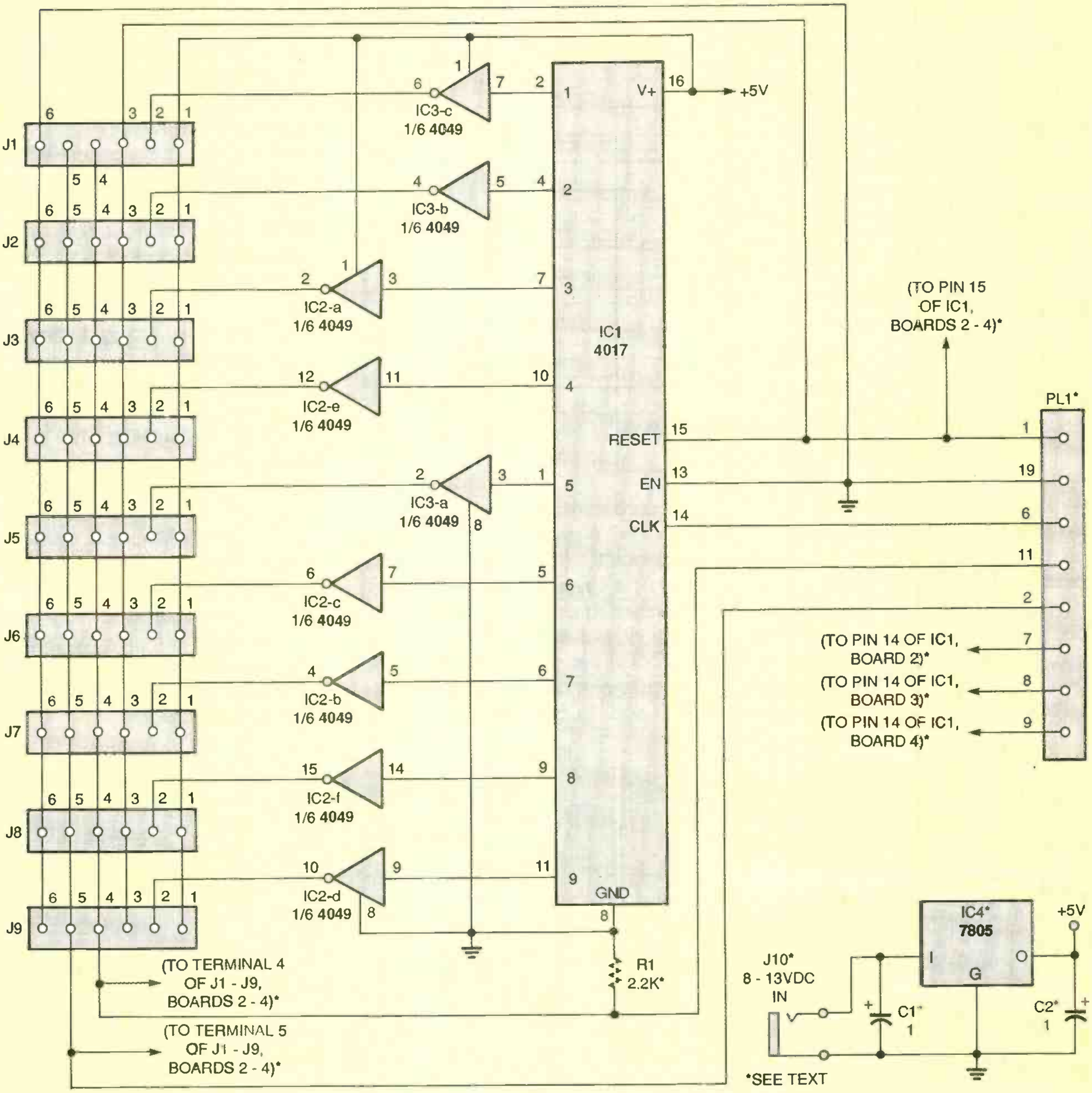


Fig. 1. This is the schematic for the PC Poller controller board. Although you can have up to four of these circuit boards working together, power-supply-components J10, C1, C2, and IC4; resistor R1; and plug PL1 are only needed in the first board.

Next, a control CLK signal clocks IC1 of the control board, bringing the 0 output low and the 1 output high. That is inverted in IC3-c, thereby enabling IC1 on the first keypad board. Then a keypad CLK signal begins clocking IC1 on the first keypad board (any other keypad-board 4017s are disabled, and therefore do not respond to the keypad clock).

Notice that in Fig. 2, the numbers on each setting of the rotary switch match the output numbers of IC1. Therefore, as IC1 of the keypad is clocked through outputs 1 through 9 by the CLK signal, the switch will pass the appropriate high level output through D1 to J1. In other words, if "3" is selected, the high level from output 3 will be passed on to the jack, and to the control board.

Back on the first control board (Fig. 1), resistor R1 acts as part of an OR gate (the diode on the keypad is the other part) to pass along the high level, while isolating the low levels from all other keypads. The software keeps track of which switch on which keypad board has been closed each time the software sees a high output.

Once the first keypad board has been clocked through all nine outputs, it is clocked one more time to bring the 0 output high again, completing the cycle and ensuring that none of the outputs connected to the keypads are high. Then IC1 on the control board is clocked, bringing its 1 output low and 2 output high. That disables the first keypad board and enables the second. The complete sequence is thus repeated for all nine keypad boards controlled by the first control board. As with the keypad boards, the control board is clocked

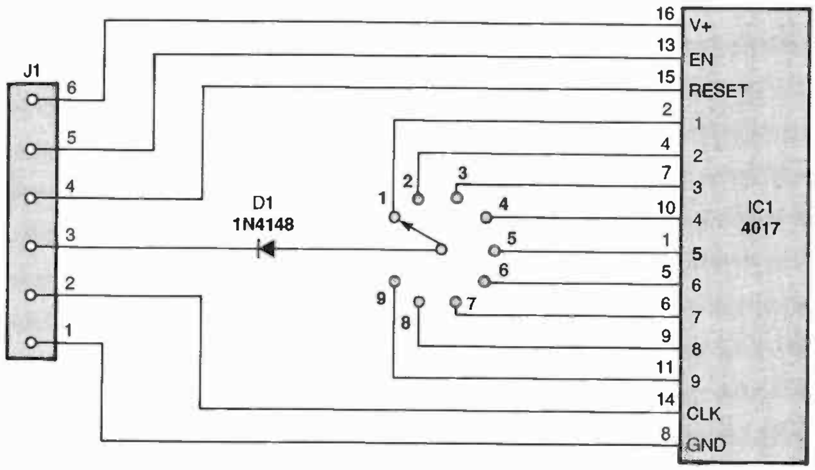


Fig. 2. Here's the schematic for the keypad board. Modular-jack J1 connects the circuit to the controller board.

one final time to bring its 0 output high (ensuring that all nine enable signals are high, disabling all keypad boards).

Each of the four control boards has common connections for the master reset, output, and master keypad CLK signals. The control CLK signal is unique to each control board, so each control board can be clocked separately (see pins 7, 8, and 9 of PL1). That allows each control board (and its associated nine keypad boards), in turn, to be activated as just described.

The power and ground connections, and the master reset, master keypad clock, and output signals are all bused to the keypad boards through the modular jacks. In addition, each keypad receives its individual enable signal through its jack connection. Likewise, the power and ground connections, and the master reset and output signals, are bused to each of the three additional control boards. And as we already mentioned, each control board is wired with an individual clock signal on one of pins 7–9 of PL1.

The Software. Listing 1 shows the QBasic software that is used to run the PC Poller. It can also be downloaded from the Gernsback BBS (516-293-2283). Considering what it has to do, the software is relatively compact due to the use of nested FOR-NEXT loops. Here's how the program works:

Line 5 dimensions the keypad (k) array to accept the status of the 36 possible keypads. Lines 6 and 7 enable the address space containing the parallel port (decimal address 888), and define the three port addresses AD0 through AD2, which will be used in the program.

LISTING 1

```
1  REM:  Pc Person Poller Demonstration
   Software
2  REM:  POLLER.BAS
3  REM:  V950605
4  REM:
5  CLS : CLEAR : DIM k(36)
6  DEF SEG = 64
7  ad0 = 888: ad1 = ad0 + 1: ad2 = ad1 + 1
8  VIEW PRINT 1 TO 1: COLOR 0, 6: CLS :
   VIEW PRINT
9  VIEW PRINT 2 TO 25: COLOR 7, 0: CLS :
   VIEW PRINT
10  COLOR 0, 6: LOCATE 1, 30: PRINT " Pc
    PERSON POLLER "; : COLOR 7, 0
11  LOCATE 3, 20: PRINT "Press ANY key to
    repeat scan, ESC to end."
12  LOCATE 5, 32: PRINT "K E Y P A D S"
13  LOCATE 7, 4
14  FOR i = 1 TO 36
15  IF LEN(STR$(i)) > 2 THEN
16  PRINT MID$(STR$(i), 2, 1); " ";
17  ELSE
18  PRINT "0 ";
19  END IF
20  NEXT i
21  LOCATE 8, 4
22  FOR i = 1 TO 36: PRINT RIGHT$(STR$(i),
    1);     " "; : NEXT i
23  LOCATE 9, 4
24  FOR i = 1 TO 36: PRINT "- "; : NEXT i
25  grandloop:
26  REM:  Pulse Reset Pin Hi/Lo
27  OUT ad2, 0: OUT ad2, 1
28  FOR i = 1 TO 4
29  FOR j = 1 TO 9
30  OUT ad0, INP(ad0) OR 2 ^ (3 + i)
31  FOR k = 1 TO 9
32  OUT ad0, INP(ad0) OR 1
33  IF (INP(ad1) AND 128) = 0 THEN
34  k(j + (i - 1) * 9) = k
35  END IF
36  OUT ad0, INP(ad0) AND 254
37  NEXT k
38  OUT ad0, INP(ad0) OR 1
39  OUT ad0, INP(ad0) AND 254
40  OUT ad0, INP(ad0) AND (255 - 2 ^ (3 + i))
41  NEXT j
42  OUT ad0, INP(ad0) OR 2 ^ (3 + i)
43  OUT ad0, INP(ad0) AND (255 - 2 ^ (3 + i))
44  NEXT i
45  LOCATE 10, 4
46  FOR i = 1 TO 36
47  IF k(i) > 0 THEN
48  PRINT USING "# "; k(i);
49  ELSE
50  PRINT "  ";
51  END IF
52  NEXT i
53  again:
54  a$ = INKEY$: IF a$ = "" THEN GOTO again
55  IF ASC(a$) <> 27 THEN
56  FOR i = 1 TO 36: k(i) = 0: NEXT i
57  GOTO grandloop
58  END IF
59  END
```

Lines 8 through 24 format the screen. The actual operation begins at line 25 (GRANDLOOP). Line 27 performs a master reset, pulsing pin 1 of the parallel port high and then low again. The actual polling and data capture is done in lines 28 through 44. Three nested FOR-NEXT loops are used to address each control board (i), each keypad for the given control board (j), and each switch on a given keypad (k).

The master reset signal is output from pin 1 of the parallel port (AD2, or 890 decimal). That output is provided to parallel port pin 11 (AD1, or 889 decimal). The keypad clock and control clocks are output respectively from parallel-port pins 2, 6, 7, 8, and 9 (all located at AD0, or 888 decimal). Pin 6 of the parallel port is the clock for the first control board, while parallel-port pins 7, 8, and 9 are the clocks for control boards 2, 3, and 4. In order to understand how the OUT commands are being used in this application, we need to review the bit patterns for address AD0.

Address AD0 contains eight binary bits, with the least significant bit (2^0, or 1) at pin 2, the next bit (2^1, or 2) at pin 3, and so on with the most significant bit (2^7, or 128) at pin 9. That is graphically represented in Table 1.

To clock the keyboards, we need to make bit 0 high and then low, without disturbing bits 4 through 7 (the control board clocks). Similarly, to clock a particular control board, we need to make its bit (4, 5, 6, or 7) high and then low, without disturbing bit 0. Referring to line 30, we first get the current status of AD0 (INP(AD0)) and then OR it with $2^{(3+i)}$. Note that i corresponds to the control board number, so an i = 1 is the first control board, and so on. So, we will OR the current status of AD0 with bit 4 (2^4) for control board one, bit 5 (2^5) for control board two, and so on. That has the effect of leaving all other bits undisturbed, but making the selected bit a 1.

Line 40 does the opposite. It ANDs the current status of AD0 with $255-2^{(3+i)}$. That has the effect of keeping all other bits undisturbed, but making the selected bit a zero. So, the FOR-NEXT i loop allows us to calculate the proper bit to be toggled.

The actual clocking is done within the FOR-NEXT j loop (note that lines 30 and 40 are actually part of the j loop, although their calculations rely on the value of the i loop). That clocking determines which keypad will be selected for a given control board. Once the keypad has been selected, the FOR-NEXT k loop takes over. Line 32 ORs the current status of AD0 with a 1, bringing the master keypad CLK line (pin 2) high. Line 33 then checks to see if the output line (pin 11) is high. If it is, line 34 is executed, storing the number of the activated keypad switch. If pin 11 is low, no storage takes place. Line 36 then brings pin 2 low again, completing the master keypad CLK cycle.

When the FOR-NEXT k loop has been completed, all 9 positions have been checked. Lines 38 and 39 clock the keypad once more to bring its 4017 to the "0" output. When all nine keypads of a given control board have been scanned (the FOR-NEXT j loop), lines 42 and 43 clock the control board's 4017 once more to bring it to the "0" output. That sequence is repeated four times in the FOR-NEXT i loop, once for each control board.

Lines 45 through 52 display the results stored in the 36 k-array elements. If no keyclosures were detected, a blank is displayed (line 50). Otherwise, the switch number is displayed (line 48). Finally, lines 53 through 57 wait for any key press before repeating the scanning process. While complicated-looking, the process takes only a second or so on a 486DX-33MHz PC.

Construction. While any project-building method, even point-to-point wiring, can be used to build the Poller, the sheer volume of interconnections makes using printed-circuit boards almost a necessity. Figures 3 and 4 show the solder and component templates for a double-sided control board. The template for the keypad PC board is

TABLE 1

Bit	Pin Number	Decimal Value
7	9	128
6	8	64
5	7	32
4	6	16
3	5	8
2	4	4
1	3	2
0	2	1

PARTS LIST FOR THE PC POLLER CONTROLLER BOARD (Fig. 1)

SEMICONDUCTORS

IC1—4017 CMOS decade counter, integrated circuit
IC2, IC3—4049 hex inverter, integrated circuit
IC4—7805 5-volt regulator, integrated circuit (first board only)

ADDITIONAL PARTS AND MATERIALS

R1—2200-ohm, ¼-watt, 5% resistor (first board only)
C1, C2—1-µF, 16-WVDC, electrolytic capacitor (first board only)
J1–J9—RJ11 6-contact modular jack
J10—Power jack (should match AC adapter that is used; first board only)
PL1—DB-25 plug (first board only)
Printed-circuit materials, suitable enclosure, nine-conductor cable, 8- to 13-volt DC source, wire, solder, hardware, etc.

PARTS LIST FOR THE PC-POLLER KEYPAD BOARD (Fig. 2)

IC1—4017 CMOS decade counter, integrated circuit
D1—1N4148 silicon diode
J1—RJ11 6-contact modular jack
S1—12-position rotary switch (only 9 positions used)
Printed-circuit materials, suitable enclosure, 6-conductor cable with RJ-11 6-contact modular plugs on each end, knob for rotary switch, wire, solder, hardware, etc.

Note: The following are available from James J. Barbarello (817 Tennent Road, Manalapan, NJ 07726; Tel. 908-536-5499): RJ11 modular jack (RJ11J)—$1.00; RJ11 cable with RJ11 plug terminations on both ends (RJ11C)—$0.25 per foot (specify length); enhanced software (both source and executable code) on 3.5-inch disk (PCP-S)—$12.00. U.S. Funds only please. All prices include shipping and handling. Write or call for price and availability on Control and Keypad PC Boards, and complete kits. The author will cheerfully respond to any questions accompanied by a self-addressed, stamped envelope. Phone calls will be accepted between 6:00 P.M. and 8:00 P.M. EST Monday through Friday.

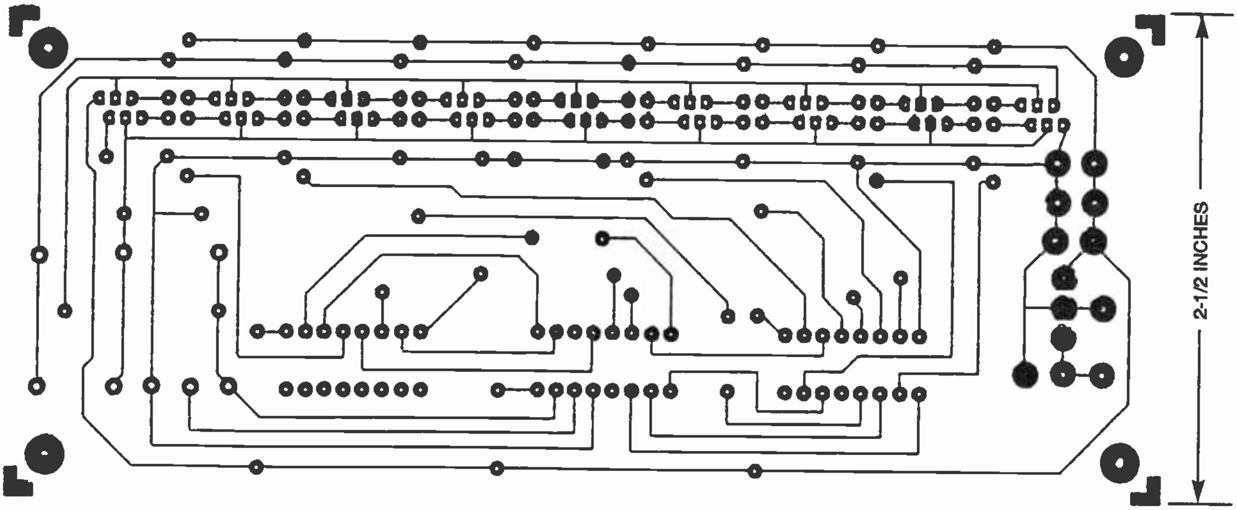


Fig. 3. The solder side of the controller board is shown here full size.

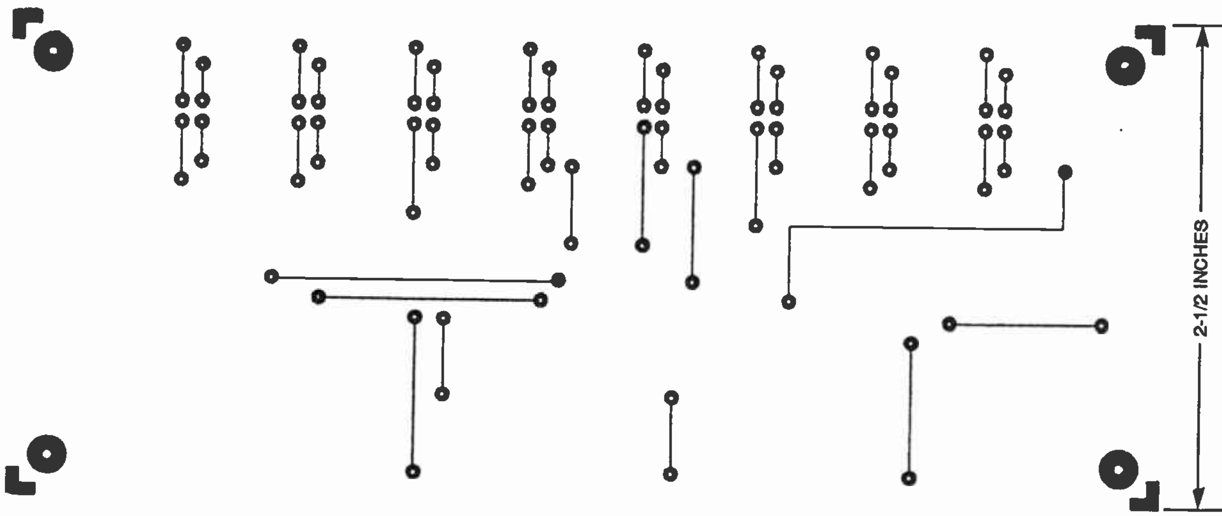


Fig. 4. This is the component side of the controller board.

shown in Fig. 5. You can either make your own boards or contact the author about the availability of etched and drilled boards (see the Parts List).

Etch or obtain the appropriate number of control boards. If you are using the double-sided PC board, the parts-placement diagram shown in Fig. 6 should make building the project easier.

Let's take a look at how to build the first control board. Begin by installing all the feedthroughs that are marked with an "X." Use little bits of wire, pass them through the holes, and solder them on both sides.

Next, mount 16-pin sockets for the three ICs. Go on to install resistor R1, and power-supply components J10, C1, C2, and IC4 (note that J10 is an off-board component).

For the first control board you will also need to make a 9-conductor cable with a DB-25 plug (PL1) on one end. As shown in Fig. 6, attach the nine wires to pins 1, 2, 6, 7, 8, 9, 11, and 19 of PL1. Then, attach the wires from pins 1, 2, 6, 11, and 19 to the appropriate pads, as shown in Fig. 6.

Continuing on the first board, mount RJ11 jacks J1–J9. Remember, those are six-contact jacks, not the more common four-contact versions used for standard telephone interconnection. The RJ11 modular jacks each have two snap-in posts protruding past their bottom surfaces. Snip off those posts flush with the jack bottoms before mounting the jacks. Position the jacks as close to the PC board surface as possible, and solder them into place.

If you're only using one control board, you only have to insert the ICs into their sockets to complete assembly. To add other control boards you

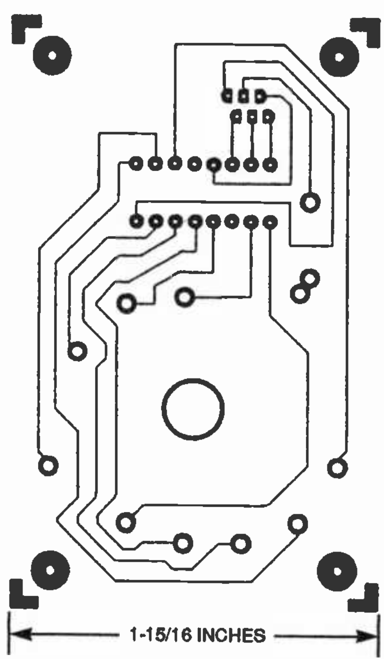


Fig. 5. Here's the foil pattern of the keypad board.

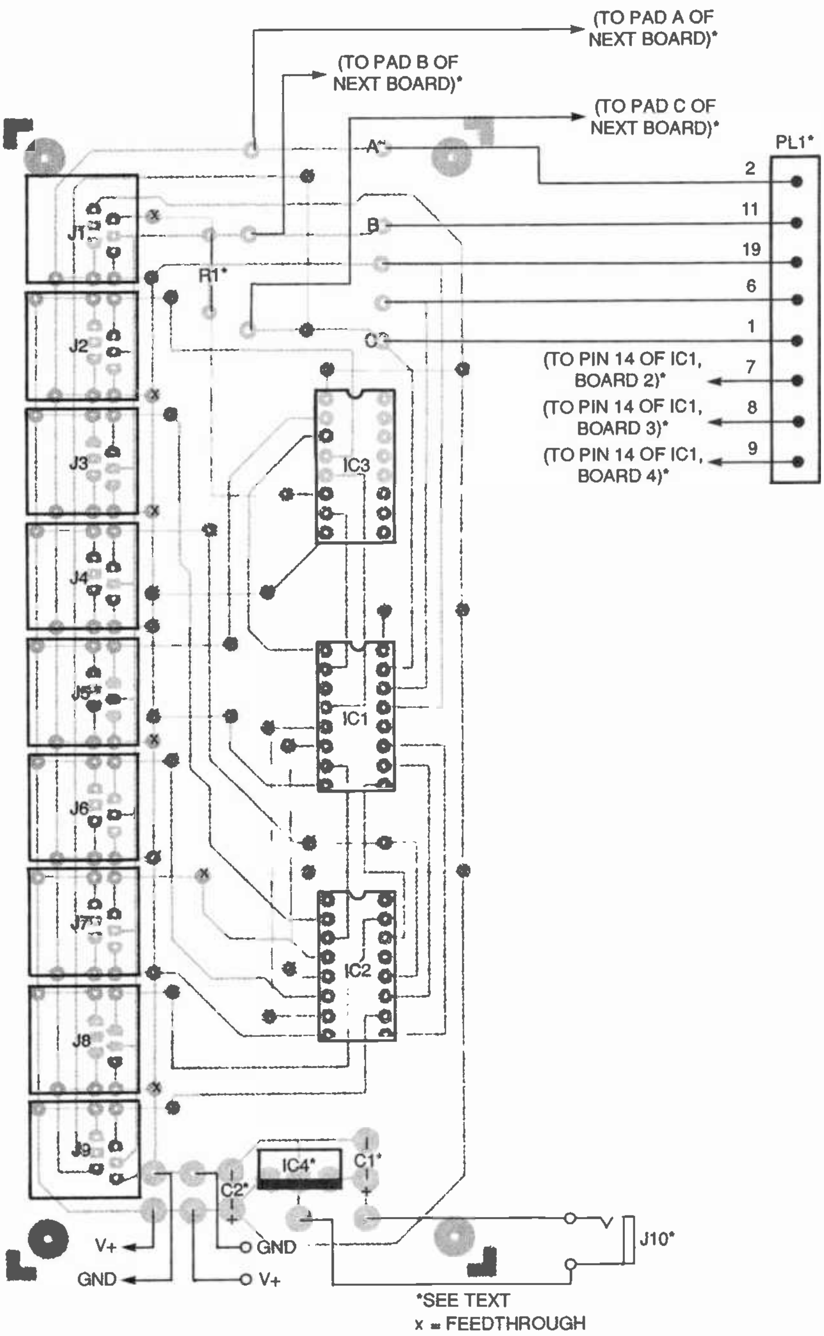


Fig. 6. Use this parts-placement diagram as a guide when building the controller board. If you're using more than one board, you will need to attach them using the various connection points indicated. Also note the points marked with an X; those are feedthroughs that need to be soldered on both sides (use little bits of wire).

will need to build each of them a little differently than the first one, and add some interconnections. Here's how to do all of that:

First, begin assembling each of the additional boards by installing the feedthroughs. Then, solder the IC sockets to the board. Mount the jacks next, being sure to cut the posts on them as you did earlier. Then insert the ICs and you're ready to interconnect the boards.

First of all, as you'll note in Fig. 6, the connections to pins 7–9 of the DB-25 plug each go to one of the additional boards. Connect those wires to the pads on the other boards where pin 6 would connect on the first board (because only one DB-25 plug is used, the pads on the other boards are free). That will establish a connection to pin 14 of each IC1 on each board.

As you'll also find in Fig. 6, three of the other pads that go to the DB-25 on the first board are labeled "A," "B," and "C." The pads located to the left of them are marked "To pad A of next board" and so on. On the first board, run wires from the latter pads to pads A, B, and C on the second board. Then, do the same from the second board to the third board, effectively daisy-chaining the boards together.

You will also have to make similar connections between boards for power. Note there are two V+ and GND connection pairs on each board. That enables you to connect the boards together to share the regulated 5 volts produced by IC4 of the first board. Use wires to attach one pair of V+ and GND connections to a pair on the second board. Then use wires to connect the free pair on the second board to the third board, etc. Following that technique means that the first and last board will each have an unused pair of power connections.

To complete all the boards, mount them in suitable enclosures. The author's prototype was mounted on a block of wood. If you're using more than one controller board, you might want to mount them in a row on a long piece of plywood to keep their interconnections from being strained by too much physical movement.

With the control board(s) completed, proceed to make the keypad boards. If you're using the PC-board pattern shown in Fig. 5, then assembly of each keypad will be simple. Just use the parts-placement diagram shown in Fig. 7.

Each of the author's prototype keypads uses 9 positions of a 12-position rotary switch. To make it easy to see which number the switch is set to, you might want to copy the full-size decal shown in Fig. 8 and apply it to the component side of the keypad PC board. Then begin assembly by installing a 16-pin socket for IC1.

Cut the posts on the RJ11 and mount it. Solder diode D1 to the board next. Then, from the component side of the board, pass the shaft of S1 through the large hole in the PC board. Secure the shaft with its hex nut. Next, use short wires to make the electrical connections to the switch on the solder side of the board. To complete each keypad circuit, add a knob to the switch and insert the IC.

When you're finished with the board, mount it in a suitable case. You will then have to fabricate an appropriate length (up to 25-feet long) six-contact cable for each keypad board. Attach an RJ11 plug to both ends of each cable.

Once all the control and keypad boards are complete, connect them together using the RJ11 cables. Then, connect a power source (supplying 8- to 13-volts DC) to power-jack J10 on the first control board.

Checkout. You can use the Poller with the software described earlier, or with advanced software available from the source in the Parts List. Once the software is in entered or loaded into your computer, connect PL1 to the PC's parallel port.

When you run the program, you will see a screen display that indicates which keypads are connected. The positions of the rotary switches will also be displayed. If you press any key, you can initiate another scan (or you can press the Esc key to end the program).

If, when you run the program, you do not get any indication for any connected keypad (even after resetting each rotary switch to various positions), check the parallel-port address of your PC. In some instances, the address might be different from the standard 888 decimal (378 Hex). Check your PC manuals for the actual parallel-port address, and substitute it for the 888 decimal in line 7 of the program. For instance, if your manual states your printer port is located at 3A0 Hex, change the first equality in line 7 to "ad0 = &H3A0" (without the quotes, of course).

Reconnect a keypad to each available jack on the control board, press Enter on the PC keyboard, and note the proper indication on the screen. If an individual keypad does not register a position, you might have installed the control knob so that it's pointing to the wrong position. Turn the knob and press Enter on the PC keyboard until you get an indication on the screen. Then adjust the position of the control knob to correspond with the screen indication. Likewise, if the keypad indicates a position, but it is inconsistent with the control knob, adjust the knob position to correspond with the screen indication.

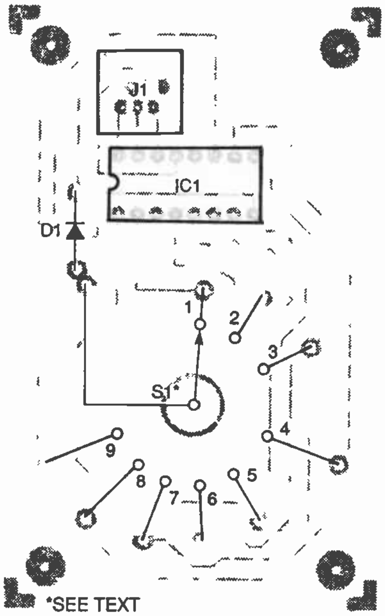


Fig. 7. As you could guess from this parts-placement diagram, the low parts count of the keypad board makes assembling it easy. Mount the rotary switch on the solder side using short wires, and put its shaft through the board to the component side.

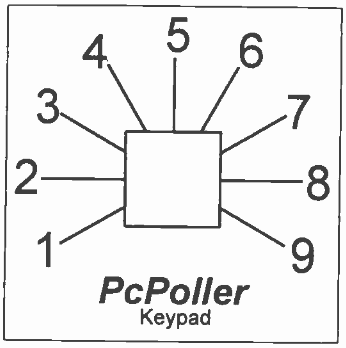


Fig. 8. If you use the keypad PC board and switch specified in the Parts List, you might want to add this actual-size decal to the component side of each of your keypads.

Program Modifications. You can expand the simple demonstration program to perform various analyses and storage tasks on the captured data. For instance, when using the system in a classroom environment, you could add a function that provides a bargraph of the responses after each scan (question) to view the response distribution. You could also compare the data for each student (keypad) against a set of desired responses. Then the software could calculate the percentage of desired responses obtained (*i.e.* a grade).

Another application could be in an ad agency. Viewers could give responses each second they are watching an event. Afterwards, the software could plot the individual responses on an x-y graph, with the x-axis being time, and the y-axis being a response from, say, 1 to 9. The data could then be easily correlated to events during the screening, and comparison of responses between individuals.

While the preceding are but two examples, they demonstrate the wide range of tasks the PC Poller can provide with some additional software programming. Those familiar with QBasic should feel free to experiment with the Poller software to customize it to their own applications.

A Security Application. If you'd like to use the Poller in a security application, you will need to modify the program to store multiple switch closures (which could represent open doors and windows, etc.). As it is now, Listing 1 is structured to store the highest numbered keypad switch closure during the scan. Here's how to change it to register multiple closures:

The major modification is to re-dimension the k array and change how the information is stored during the FOR-NEXT k loop. Make the following change to line 5, which dimensions the k array for all 324 possible switch activations:

```
5 CLS : CLEAR : DIM k(324)
```

Remember that there are three FOR-NEXT loops (i, j, and k) with i identifying the control board, j identifying the keypad attached to that control board, and k identifying the individual switch position on that keypad. So, any individual switch position can be represented by the formula:

$$((i - 1) \times 81) + ((j - 1) \times 9) + k$$

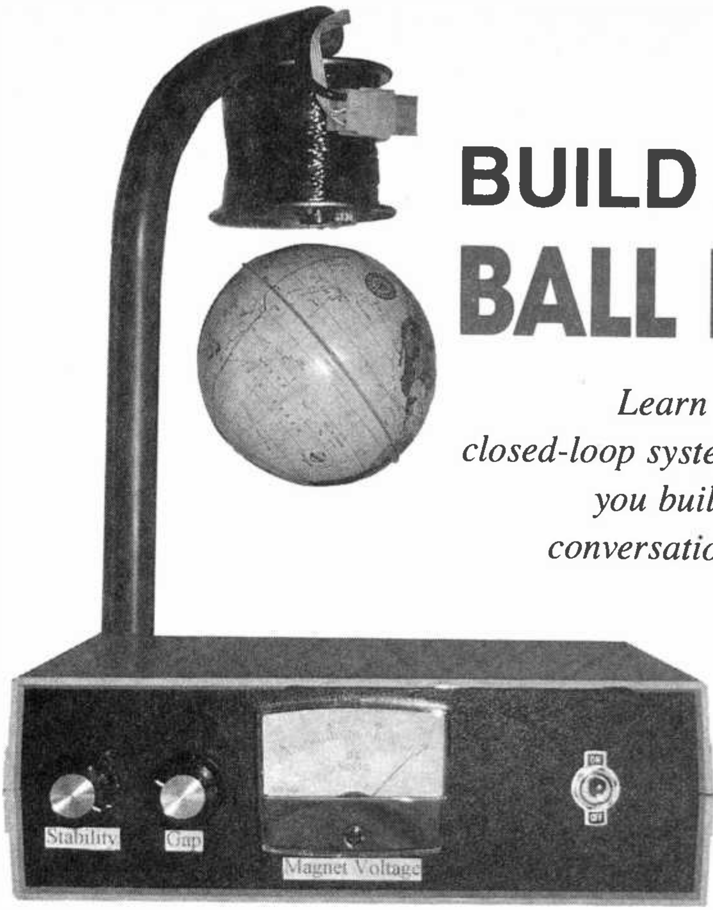
For instance, the fourth switch position on the first keypad connected to the first control board (i = 1, j = 1, k = 4) is

$$((1 - 1) \times 81) + ((1 - 1) \times 9) + 4 = 4$$

Similarly, the eighth switch position on the ninth keypad connected to the fourth control board (i = 4, j = 9, k = 8) is

$$((4 - 1) \times 81) + ((9 - 1) \times 9) + 8 = 323$$

(Continued on page 78)



BUILD A MAGNETIC BALL LEVITATOR

Learn all about closed-loop systems while you build a great conversation piece.

BY JAMES CICON

Your approach takes you closer to the planet. A red star shines in the distance. As you watch the Earth floating in space, you think that you can almost see it turning on its axis. With a mind of its own, your finger reaches out to flick the sphere into motion.

With a shock, the infinite depths of the universe collapse down to the confines of your work room as you snap back to reality. The red star is actually the LED on a nearby power supply. Maybe you were daydreaming, but the globe of the earth still floats on top of your workbench. What a conversation piece!

What kind of device are we talking about here? What could make a mini earth float in mid air? The *Magnetic Ball Levitator* described in this article, that's what. It's an educational project that will teach you all about closed-loop control systems as you build it. Forget complicated math or diagrams—we'll deal with the systems in a hands-on kind of way.

You might have read articles or even books on closed-loop controllers in the past, but if you're like most, you've found that those theory-only discussions do little more than frustrate the reader. To learn about concepts like instability and feedback, you're best off actually experiencing them at work. So read on.

Some other great reasons to build the Levitator are that it is cheap to build and does not contain any hard-to-find parts. You probably already have on hand most of the parts that you need to build it. And even if you don't, you should be able to get a trimmed-down unit up and running for between $10 and $20. To do that you would need to skip the fancy case, eliminate the magnet voltage meter, and run the Levitator with a benchtop power supply.

Control-System Basics. Control systems are all around us, and even within us. Our blood sugar level is regulated by an internal control system, as is our body temperature. Examples of external control systems include an airplane's autopilot, and even temperature-control circuits of some soldering irons.

While control systems come in many forms, they are all made up of smaller building blocks with functions that are common between all systems. For example, most control systems have a "plant" that has some output to be controlled. An actuator is used to control the output of the plant.

A common control system is the heating system in your home. The plant is the room, the output is the room temperature, and the actuator is the furnace. Many control systems also have an output sensor that determines how well the operation of the plant is maintained, compared to some reference or command input. In our room example the output sensor is the thermostat, and the reference is the setting of the thermostat.

The signal from the output sensor is used to turn on the actuator to affect the plant's output if some error exists between the plant's output and the reference. That is called feedback—an output signal is fed back, via a sensor of some sort, to the actuator to change the output. A control system with feedback is also called a closed-loop control system. In our example, the wire going from your thermostat to your heater is half of the loop. The heated air that comes out of the basement through ventilation ducts and back to the thermostat is the other half of the closed loop.

As mentioned earlier, an error signal is used to turn on the actuator. It is important to understand that the actuator is only activated if the error signal is not zero. For example, say that your thermostat is set at 68° F and your home's temperature is also 68°, but outside it is 35° and windy. Is your heater on? No, there is no error between the room temperature and the thermostat setting, so the furnace is off.

Open or Closed Systems? Let's stick to the example of home heating to do a little comparison between open- and closed-loop systems. The simplest type of heater (see Fig. 1) has a power-level switch (usually with off, low, medium, and high settings) and a heating element. An electrical signal flows from the power control to the heater, and the heated air flows from

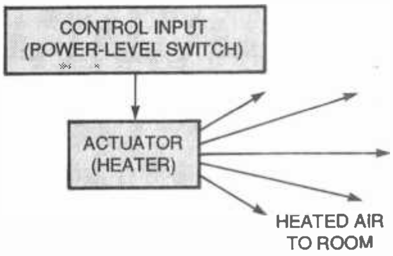


Fig. 1. Here's an example of a simple, open-loop control system. No signal comes back telling the system how well the room is being heated.

the heater to the room. No signal comes back telling the system how well the room is being heated. For that reason, it is called an open-loop control system because the signals in the system only flow in one direction.

The disadvantage of an open-loop system is that you constantly have to adjust the power control to maintain a comfortable temperature in the room. On cool days the power should be on low, on really cold days it should be on high. The necessary setting will vary from the morning to the evening. However, if you install an output sensor, you can determine when the room's temperature is too high or too low and adjust the power to the heater accordingly. Such a closed-loop system is shown in Fig. 2.

The output sensor and error detector shown in Fig. 2 are housed in the thermostat that is used to regulate the heater's output. That thermostat fills the roles of the sensor, error detector, and control input in the system. In many such thermostats, a lever sticking out of the thermostat moves over a temperature scale, while its axis is attached to the center of a spiraled bimetallic strip. The other end of the bimetallic strip is attached to a mercury-level switch.

When the switch is level, the mercury in it lies in the center of the switch and doesn't close any of the switch's contacts. When the switch tips in one direction a heater contact is closed; when it tips in the other direction a cooling contact is closed. If the room temperature heats up, the metal strip rotates in the cooling direction, tips the mercury switch accordingly, and turns off the heater. When the room cools down, the metal strip rotates in the other direction, tilting the mercury switch, and turns the heater on. The lever can turn the coil initially to one side or the other, causing the coil to have to turn further back or further forward to keep the switch level. Thus the room's temperature will have to be hotter or colder to level out the mercury switch.

That type of control system is sometimes called a "bang-bang" controller because the actuator is either fully on or fully off (that results in a rattle or "bang" of a furnace). It works well as long as you do not need very precise control, say an accuracy of ± a few degrees, but can have problems if used for more accurate control. That's because the slightest disturbance to the thermostat will cause it to turn the heater on or off, as the case might be.

To avoid such instability, you need to design hysterisis into the controller. In other words, when the room gets hot, the heater shouldn't turn off until the temperature is a few degrees hotter than the thermostat setting. Likewise, when the room is cool, the heater shouldn't turn back on until the room is a few degrees cooler than the setting on the thermostat. That keeps random disturbances, like drafts caused by opening a door, from affecting the system.

So, as you can see, there are cases where a much better system than a bang-bang controller is needed. That is where Proportional-Integral-Derivative (PID) controllers come into the picture.

Basics of PID. Figure 3 shows a block diagram of a closed-loop heating system that contains a PID controller. Notice that a PID controller contains all of the basic building blocks contained in an open-loop controller and also the components contained in a bang-bang controller. However, another block called a compensator is added. The compensator itself contains three new "blocks" of amplifiers labeled P (Proportional), I (Integral), and D (Derivative), and an adder to combine the three outputs.

The P block is an op-amp that you would use to boost the gain of an audio signal; the I and D blocks are also amplifiers. In a PID controller, the P block is probably the most important part. The I and D parts are there to fix up problems that can occur in particularly unstable systems. Therefore,

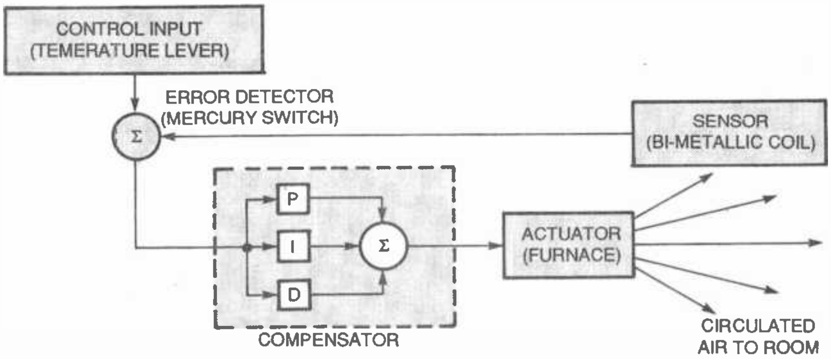


Fig. 3. This closed-loop heating system contains a PID controller. When a PID controller operates, the sensor measures the error in the plant's output and adjusts the actuator to activate proportionally to the error. That results in a smooth response.

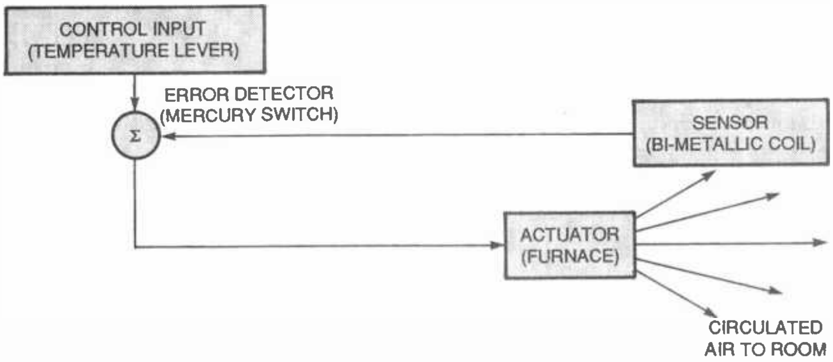


Fig. 2. With the addition of an error detector and an output sensor, a control system becomes a closed-loop type. The system shown here can determine when the room's temperature is too high or too low and adjust the power to the heater accordingly.

in many situations you can eliminate the I or D part (or even both) and the PID controller will work fine.

When a PID controller operates, the sensor measures the error in the plant's output and adjusts the actuator to activate proportionally to the error. That will achieve a smooth response and prevent a system from operating just like a bang-bang controller.

To see how all the basics we looked at can be applied, and to deal with how the I and D parts of a PID controller work, let's now move on to the Levitator itself.

Circuit Description. The schematic for the Levitator is shown in Fig. 4. Transformer T1 steps down the voltage from an AC outlet to 25-volts AC, which is then full-wave rectified by BR1. Capacitor C3 provides filtering. An unregulated 30-volts DC is provided from C3 for the high current draw that the actuator section of the circuit requires (more on that section in a moment). An LM7812 regulator, IC1, provides a regulated 12-volts DC for use by the rest of the circuit. Switch S1 is the power switch.

The output sensor of the circuit works as follows: An infrared LED, LED1, shines IR light onto the top of the globe that will be levitated. That IR light reflects off of the top of the globe back up to Q2, an IR phototransistor. Both LED1 and Q2 are mounted on the bottom of electromagnet L1, so the closer the globe is to the bottom of the magnet, the more light is reflected, and the more current flows through Q2. In other words, the amount of current that flows in Q2 is proportional to the amount of light shining on its base. Resistor R4 sets the brightness of LED1.

The reference or control input is set by potentiometer R6 and resistor R8; that fixed resistor sets a minimum resistance value for the reference circuit. If R8 was not present and the wiper of R6 were turned to its lowest setting, a short circuit would exist from the emitter of Q2 to ground (which could damage Q2). Current from Q2 is directed through R6. That current is proportional to the gap between the magnet and the globe under it. You can set the desired gap distance by adjusting R6.

One section of an LM324 quad op-amp, IC2-a, is used as an error-detector. If R6 is set high, a given gap will result in a higher error voltage being generated by the error detector than if R6 were set low.

The compensator of the circuit consists of IC2-b, R1, R2, C4, R3, and R5. That compensator actually has two inputs, which both have the error signal from IC2-a applied equally to them. One input is through R2, the stability-adjustment potentiometer; the input coming in via R2 is the proportional (P) input to the compensator. The other input comes in through C4. That input is the derivative (D) input for the compensator. The compensator does not have an integral (I) input. Resistor R1 is a feedback resistor for IC2-b, and R3 and R5 bias the op-amp to operate on a single 12-volt supply.

The magnet assembly is made up of coil L1 and thermal-fuse F1. Because F1 is supposed to stop current flow when the magnet overheats, the fuse should be wired as part of coil L1 (more on that later). Both the magnet assembly and its supporting circuitry (C1, D1, M1, Q1, and R7) make up the actuator. The input to the actuator is the error signal from the gate of Q1, an IRF510 MOSFET transistor, and the output is the magnetic field from the magnet assembly.

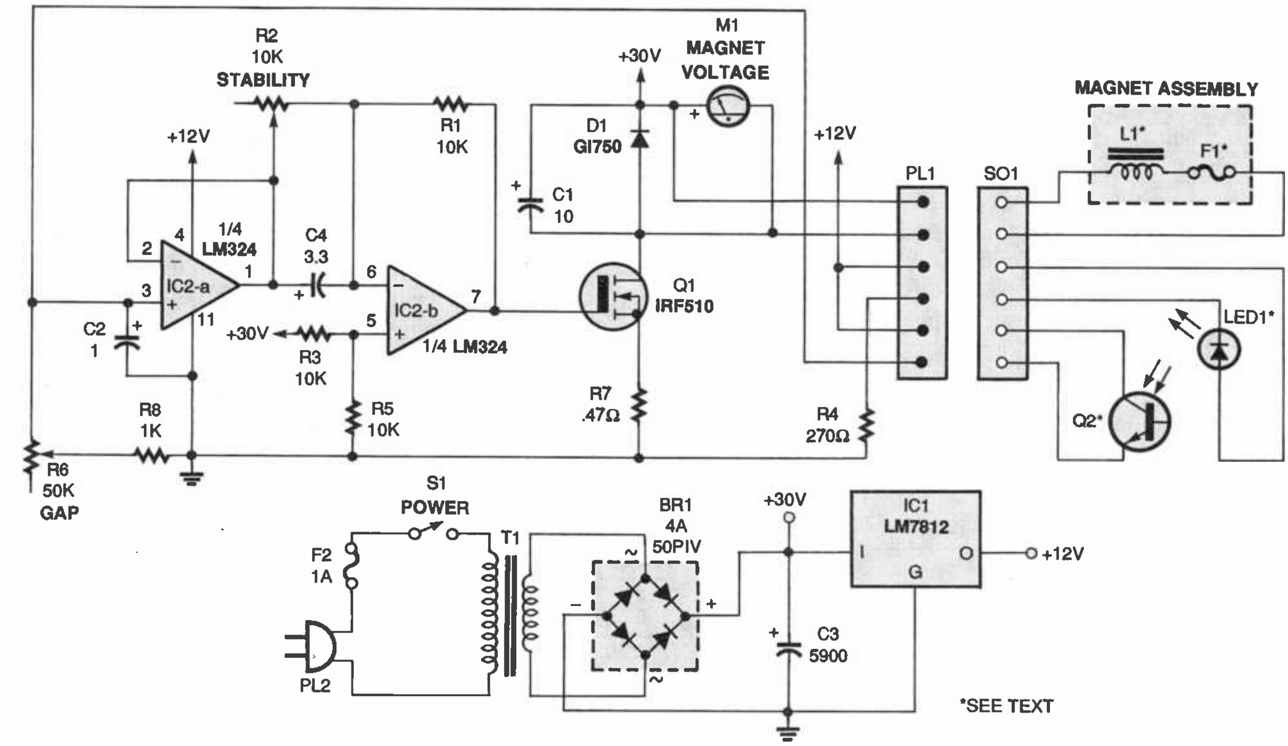


Fig. 4. Here's the schematic for the Magnetic Ball Levitator. The magnet assembly is made up of coil L1 and thermal-fuse F1; note that although those two components are shown in series next to each other, the fuse is actually wound in series as part of coil L1.

Capacitor C1 filters "noise," and diode D1 protects Q1 from large voltage spikes that can occur across the magnet assembly when the unit is turned off quickly. Meter M1 provides an indication of how much voltage is present in the magnet.

The magnet assembly, transistor Q1, and resistor R7 are configured as a power amplifier with a gain of about 20. Transistor Q1 is configured as a common-source amplifier, meaning that the input signal is applied to its gate, and the output signal is taken off of its drain. The impedance of the drain circuit is the magnet resistance, or about 10 ohms, and the impedance of the source circuit is equal to the value of R7, 0.47 ohms.

To see how all the circuit components work together, look at Fig. 5, a block diagram of the Magnetic Ball Levitator. That's essentially the same type of diagram that was used in the earlier discussion of closed-loop systems.

Let's begin with the unit turned on and the ball suspended beneath the magnet a little closer than it should be. When the ball moves too close, more current flows in Q2, and the voltage across R6 increases. The error signal out of IC2-a then goes positive and couples to IC2-b through R2. Op-amp IC2-b amplifies and inverts the signal applying it to the gate of Q1. That negative signal is inverted and amplified, causing voltage on the drain of Q1 to go positive. As a result, less current flows in the magnet windings, which means less magnetic force is applied to the ball.

As the ball drops away from the magnet, the reverse occurs. Less current flows through Q2, which will result in more current flowing through the magnet. The compensator of the circuit keeps that back and forth motion of the ball stable so that it appears to be floating. Remember, potentiometer R2 can be used to adjust the level of that stability.

Construction. The author's prototype for the Levitator was built on two perforated boards and mounted in a case measuring 7½ × 10 × 3½ inches. One board contains all the high-power components.

To begin assembly of the high-power component board, mount capacitors C1 and C4 and resistor R7. Then go on to install diode D1 and bridge-rectifier BR1. Position the board near the back of the case.

Mount the rest of the capacitors and fixed resistors on the other board. Next install IC1 and IC2 on that board, using an IC socket for IC2. Position the board near the front of the case.

Now it's time to add the off-board components. Drill holes in the front of the project case to accommodate potentiometers R2 and R6, and install them. Go on to make holes for M1 and S1, and mount those parts as well.

Next drill a hole on the back panel and mount fuse F2. Also drill holes for the heat sink specified in the parts list. Transistor Q1 mounts on that heat sink. Although the heat sink might seem a little large for Q1, it is necessary because the unit controls up to 2 amps of current at up to 36 volts. That results in a lot of power to dissipate.

Drill another hole in the rear of the case to pass through a power cord. Connect that cord to transformer T1 and mount the latter near the back of the case. You can then complete all the in-case wiring.

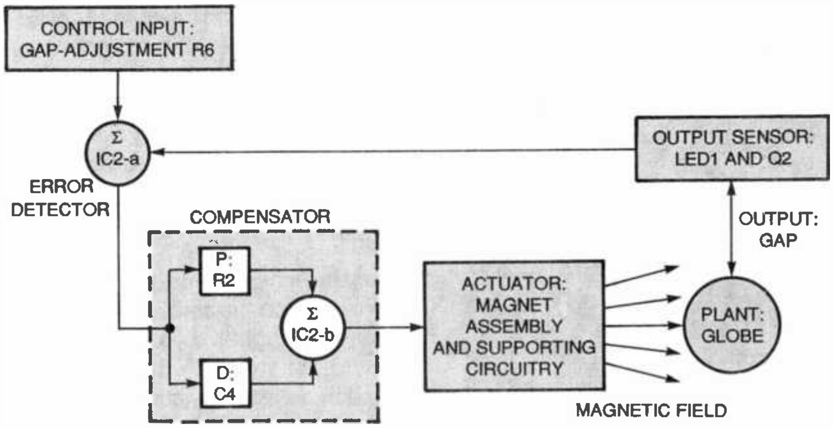


Fig. 5. This block diagram shows how the sections of the Levitator work together to resemble the models of closed-loop systems examined in Figs. 2 and 3.

PARTS LIST FOR THE MAGNETIC BALL LEVITATOR

SEMICONDUCTORS

IC1—LM7812 12-volt regulator, integrated circuit
IC2—LM324 quad op-amp, integrated circuit
Q1—IRF510 MOSFET transistor
Q2—NPN phototransistor (Radio Shack 276-145 or equivalent)
LED1—Infrared light-emitting diode (Radio Shack 276-142 or equivalent)
BR1—Full-wave bridge rectifier, 4-ampere, 50-PIV
D1—GI750 silicon rectifier diode (can be substituted by any 4-ampere, 50-volt unit)

RESISTORS

(All fixed resistors are ¼-watt, 5% units, except where otherwise noted.)
R1, R3, R5—10,000-ohm
R2—10,000-ohm potentiometer
R4—270-ohm
R6—50,000-ohm potentiometer
R7—0.47-ohm, 5-watt, 10%
R8—1000-ohm

CAPACITORS

C1—10-µF, 50-WVDC, electrolytic
C2—1-µF, 50-WVDC, electrolytic
C3—5900-µF, 30-WVDC, electrolytic
C4—3.3-µF, 50-WVDC, electrolytic

ADDITIONAL PARTS AND MATERIALS

L1—Magnet coil (see text)
T1—117-VAC to 25-VAC, 2-ampere power transformer M1—DC voltmeter, 0- to 15-volt range
F1—Thermal-protector fuse (Radio Shack 270-1322 or equivalent)
F2—1-ampere fuse
PL1—6-connector power plug
PL2—2-terminal AC plug
SO1—6-connector power socket
S1—SPST switch
Perforated board, project enclosure, metal globe, SIP socket, 2 orange-juice-can lids, heat sink measuring 3 × 4 × 1¼ inches (JDR Microdevices HS192000B or equivalent), ¾-inch-diameter PVC tubing, 1-inch-diamter PVC coupling, 2-inch-long 10-24 bolt, magnet-core nail (12-inches long by ¾-inch diameter), metal epoxy, magnet pin (¾-inch length of coat-hanger wire), washer, 520 feet of 22-gauge magnet wire, power cord, wire, solder, hardware, etc.

Next, drill holes on the back of the case to mount a 1-inch-diameter PVC coupling. That coupling will be used to support the magnet arm made of ¾-inch PVC pipe. When placed into that coupling, the magnet-arm can then freely turn and be easily removed again. Such a design provides a convenient way to lay the arm down flat on the side of the unit for storage purposes.

To make the magnet arm, you will need to bend a piece of PVC tubing to create an L shape. Cut a 3-foot-length section of the material to work with. Heat the middle 9 inches of the tube gradually and evenly; you can use a gas-range burner, a butane torch, or a heat gun to do that. After the 9-inch section you are heating starts to get rubbery, carefully bend the tube around a large coffee can (a 39-ounce can has a 6-inch diameter, which is perfect) to make a 90° angle. If you try to bend the tube with out using a form, the tube will deform and collapse.

After the tube cools, cut it so that the long part of the L-shaped tube is 12-inches long and the short part is 6-inches long. Drill a 5⁄32-inch hole in the underside of the short end of the mount, about ½ an inch back from its end. The screw that is used to hang the magnet from the mount will pass through that hole.

Now you can put together the magnet assembly; refer to Fig. 5 as you do so. The core of the magnet is a ⅜-inch-thick, 12-inch-long nail (perhaps it should more appropriately be called a spike). Drill a 5⁄32-inch-wide hole ½ an inch into the head of the nail. Next cut the head off of a 2-inch-long 10-24 bolt. Fill the hole in the nail with metal epoxy and drop the cut-off end of the bolt into the hole. When the epoxy hardens, you will have a solid mount with which to hang the magnet assembly from the magnet arm.

Drill ⅜-inch holes through the center of 2 orange-juice-can lids, and use a hand file to remove any burrs, which otherwise could short out the windings of the magnet if left in place. Slide the lids onto the nail, and separate them by a distance of 2 inches, as shown in Fig. 6. Then put on a washer, and mark where a pin hole should be made on the nail to support the bottom lid. Use a 7⁄64-inch drill to make that hole. Cut off a ¾-inch length of

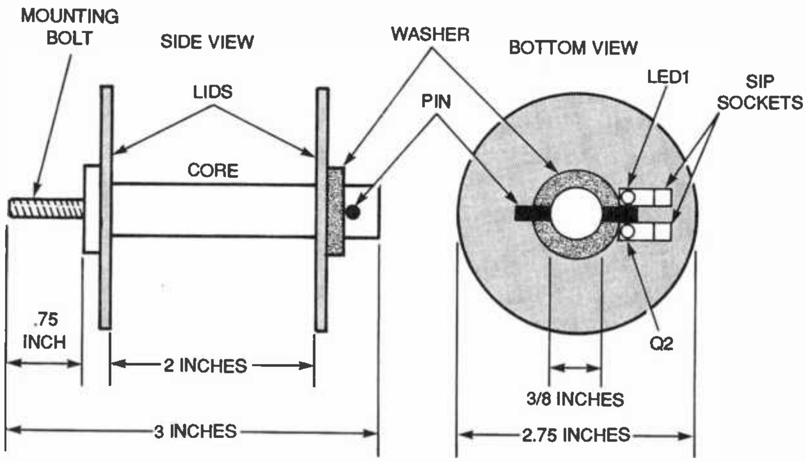
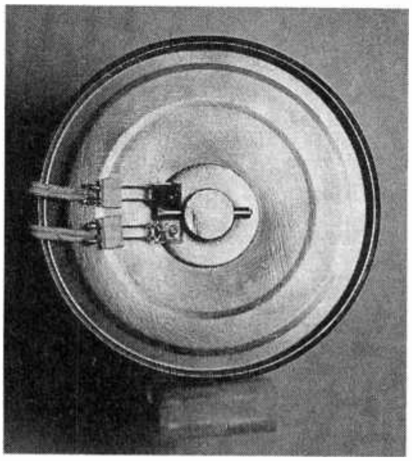


Fig. 6. When building your magnet assembly, use this diagram as a guide.

coat hanger to use for the pin, and insert it.

To make the magnet, you will have to wind 520 feet of 22-gauge magnet wire onto the nail core. There is an easy way to do that: Close the chuck of a hand drill around the point of the nail. Loop the free end of the wire around the core a few times to lock it in place, then set the drill to low and wind the rest of the wire onto the bobbin. After the wire is wound onto the bobbin, use a hacksaw to cut the 12-inch-long nail down to the approximate size shown in Fig. 6. With a hand file, remove any burrs or rough spots from the end of the core.

Then next step is to mount LED1 and Q2 next to each other on the magnet assembly, using two sections of an SIP socket. Position LED1 and Q2 so that the pin at the bottom of the magnet assembly is between them. When you've done that, glue the SIP socket to the bottom can lid (you might have



This bottom view of the magnet shows the placement of the infrared LED and phototransistor.

to rough up the lid with a wire brush or some fine-grit sandpaper first).

When the glue dries, give LED1 and Q2 a gentle twist so that they are pointing towards each other slightly. That allows the reflected light to bounce from LED1 to the globe to Q2 more efficiently. If you don't bend them like that, the sensor might only have a very short range.

Unwind a couple of turns from the magnet coil and cut the wire. Then solder thermal-fuse F1 in series with the magnet winding, and rewind the few turns you unwound. The fuse is now part of the coil.

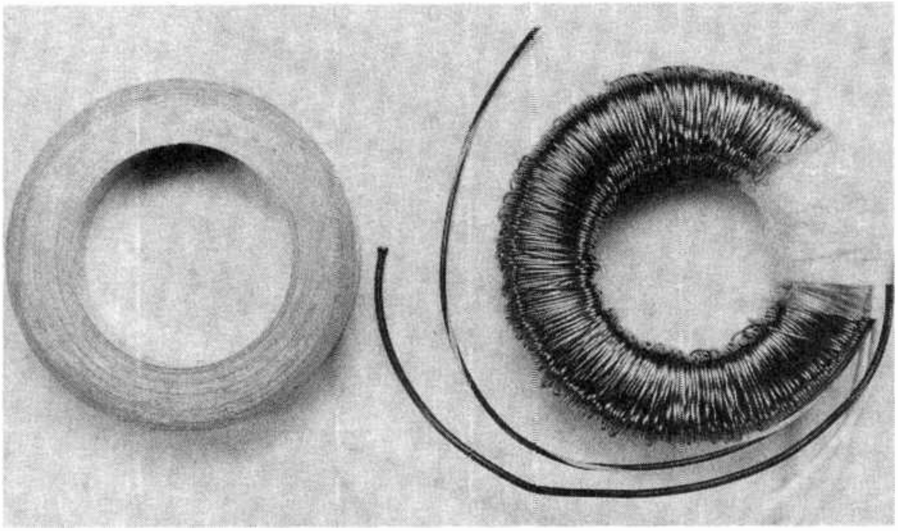
Connect a 6-contact power socket (SO1) to the leads of LED1, Q2, and the magnet. Connect a matching 6-contact plug (PL1) to 3-foot lengths of wire, feed the other ends of the wire through the magnet arm, and make the proper connections to the circuit (using the schematic in Fig. 4 as a guide).

Insert the mounting bolt of the magnet assembly into the hole drilled in the short end of the arm, and place a nut over the bolt with a pair of needle-nose pliers. Holding the nut still, turn the magnet assembly to screw the nut onto the mounting bolt. Connect PL1 and SO1 together, insert the arm into its coupling, and your Levitator is ready to use.

Adjustment and Use. Turn on the unit and place the small metal globe under the magnet. If you bring it too close to the magnet, the globe will enter the sensor's blind spot. As a result, the globe will stick to the magnet. Should that happen, just remove the

(Continued on page 78)

BY CHARLES HANSEN



ALL ABOUT TOROIDAL TRANSFORMERS

Learn about the important advantages toroidal transformers have over other designs, and how to use them.

In these days of shrinking package size, the transformer is usually the largest component in a given circuit. The geometry of a standard transformer limits how small we can make it, as size is proportional to the square root of the total transformer power. However, the familiar E-I or cut-C cores are not the only ones that can be used. For instance, using a *toroidal*, or donut-shaped core makes it possible to reduce the size and weight of a transformer by 20% to 50% compared with conventional cores, without sacrificing performance.

That's possible because core losses in toroids are typically 10% to 20% of the total power loss, with the balance being lost in the windings. That compares with core losses totaling 50% of the total power loss for conventional transformers. Lower core losses provide cooler operating temperatures and low magnetizing current.

The toroidal transformer design best uses the high permeability and low-loss characteristics of a modern transformer core. Toroids are commonly used for current and instrument transformers, where low losses are extremely important. Other advantages are higher efficiency, lower operating temperature, better regulation, and lower noise. The disadvantage is somewhat higher cost, although improved production techniques are making toroidal transformers more cost competitive.

Transformer Basics. The core and coils of a conventional transformer are shown in Fig. 1A, and its schematic symbol is shown in Fig. 1B. In its simplest form, a transformer is an electrical device that, by mutual electromagnetic induction, transfers electrical energy from one isolated circuit to another by means of coils called windings. The left, or *primary* winding is connected to an AC voltage source. The right, or *secondary* winding is connected to a load. The two windings are wound on a common iron core. AC current in the primary winding provides the time-varying magnetomotive force (mmf) that creates an AC magnetic flux in the core. The iron core provides a high-permeability magnetic path that ensures that a high percentage of the flux will be linked to the secondary winding. The voltage induced in the secondary winding and delivered to the load by the AC core flux variations is given by Faraday's law:

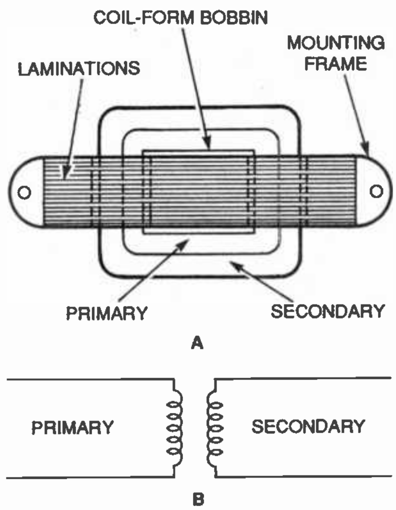


Fig. 1. A typical transformer is shown in A, while its schematic symbol is shown in B.

$$e = kNd\phi/dt$$

In other words, the voltage induced in the secondary winding (e) is proportional to the number of turns (N) and the time rate of change of flux (ϕ). Thus, the voltage can easily be changed from one level to another, lower or higher, by properly selecting the number of primary and secondary turns. Also, at low frequency, more turns are required to develop a given flux than at high frequency. Transformers only work with AC voltages because a time-varying AC flux is required.

In terms of real-world transformer

design, Faraday's law becomes:

$$e = 4.44NBfA \times 10^{-8}$$

where the voltage in a winding is proportional to the number of turns (N), the flux density in gauss (B), the AC frequency (f), and the core cross-sectional area in square centimeters (A).

Transformer Losses. When a voltage is applied to the transformer primary (V_P), the largest part of the current entering the primary winding (I_P) goes toward creating the mmf that produces the mutual core flux, but not all of that current produces useful output power at the secondary. The remaining portion of the primary current is required to provide the core exciting current, I_E, as shown in Fig. 2, the equivalent circuit for a real transformer. The polarities shown in Fig. 2 are the instantaneous polarities of the primary and secondary waveforms of an AC transformer.

Exciting current is the penalty to be paid for the significant advantages of using iron transformer cores. The exciting current is divided into magnetizing current (I_M) and core-loss current (I_C). Those loss components cause a voltage division to occur due to the voltage drop in the primary-winding impedance (R_P and X_P). That reduces the voltage available at the input to the ideal (no-loss) transformer portion of the equivalent circuit (E_P) and reduces the useful primary current (I_1). Thus, additional primary voltage is required to establish the desired secondary voltage, E_S. That additional primary voltage is normally provided for by adding primary turns so the final turns ratio is larger than the desired transformer voltage ratio.

Magnetizing current is the primary current that flows when the secondary is open-circuit and has no load. It is determined by:

$$I_M = 0.794HM_l/N$$

where the magnetizing current is proportional to the mmf (H) times the magnetic path length (M_l) divided by the number of turns (N). Transformer designers attempt to reduce the magnetizing current by minimizing the magnetic path length. That allows the fewest turns for a given primary voltage and has the added benefit of reducing the leakage flux.

The core-loss current is divided into hysteresis (I_{HYST}) and eddy current (I_{EDDY}) components. Hysteresis loss is the power required to magnetize the core and produce the AC flux. The core consists of tiny magnetic dipoles, or domains. Those domains align themselves and rotate with the AC magnetic field. The hysteresis losses can be thought of as the friction caused by those rotating domains.

Eddy-current loss is power wasted by current flow in the conductive iron core. Current is induced in any conductor that is perpendicular to the flux path, including the windings and the lateral dimension of the iron core. For that reason, transformer cores, rather than being a single mass of iron, are laminated into thin strips whose long dimension is parallel to the core flux. Doing that reduces the length of the conductive path in which the eddy current can flow. In addition, silicon is added to the iron to reduce its conductivity and further reduce the eddy currents.

Once a load is connected to the secondary winding, the secondary current (I_S) creates a magnetic field whose back emf (electromotive force) opposes the primary flux. The primary current increases by the amount necessary to restore the original flux density supported by the primary voltage.

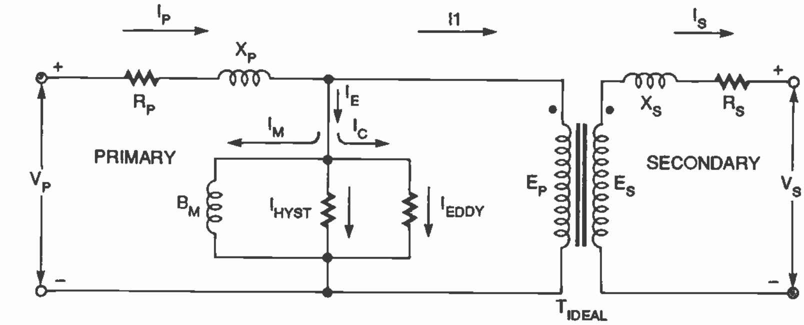


Fig. 2. This equivalent circuit for a real transformer shows us that not all of the input current produces useful output power at the secondary.

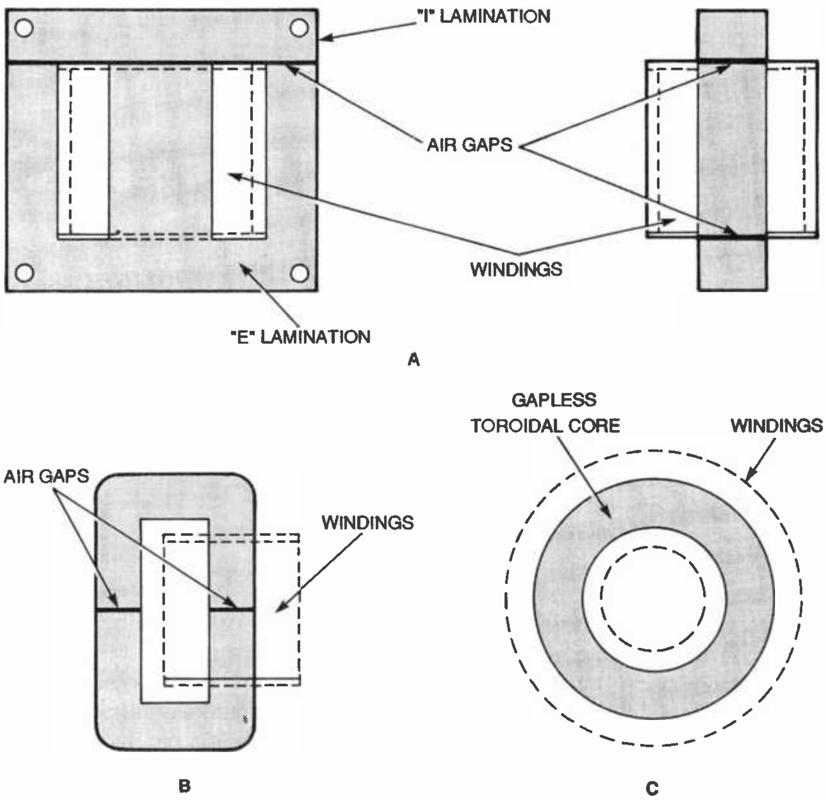


Fig. 3. Three common types of transformer cores. The E-I type is shown in A, the cut-C type in B, and the toroid in C.

As the load current increases, the secondary impedance (R_S and X_S) causes a further reduction in the secondary voltage. The ratio of the difference between the no-load secondary voltage (V_S) and the full-load secondary voltage (V_{SL}) for a fixed primary voltage is called the regulation.

Construction. Figure 3 illustrates the three common types of transformer cores. Unlike conventional transformers, which use stacked E-I (Fig. 3A) or cut C-core (Fig. 3B) laminations, the toroidal transformer in Fig. 3C uses a tape-wound core with essentially no air gap. The stacked-lamination types are generally cheaper to manufacture because the windings are easily wound on separate bobbins or coil forms. Toroidal transformers require special winding equipment that first winds the wire on a circular shuttle inserted through the core center, then "unwinds" the wire from the shuttle onto the core. A tensioned slider on the circumference of the shuttle controls the wire feed, while rollers rotate the core to evenly distribute the winding.

The magnetic core material for most power transformers is made of grain-oriented, cold-rolled, 3% silicon steel that is coated and insulated. That material has lower exciting current and core losses than regular steel. It also has relatively high saturation-flux density with a high degree of squareness. Squareness is the ratio of residual flux density (remanence) to the maximum flux density (saturation), or B_R/B_S. The oriented grain allows the steel to be operated at a higher saturation-flux density than non-oriented steel.

The core material is annealed at high temperature in a dry hydrogen furnace to remove impurities and relieve the material stresses. Annealing also develops the desired magnetic properties, such as high squareness and low core loss. The steel strip is coated with a chemical finish to ensure high resistance between laminations. Finally, the annealed cores are varnish impregnated, cured, and painted or epoxy coated.

Toroidal Transformer Advantages. Higher flux density is possible in a toroidal transformer because the windings are wound symmetrically

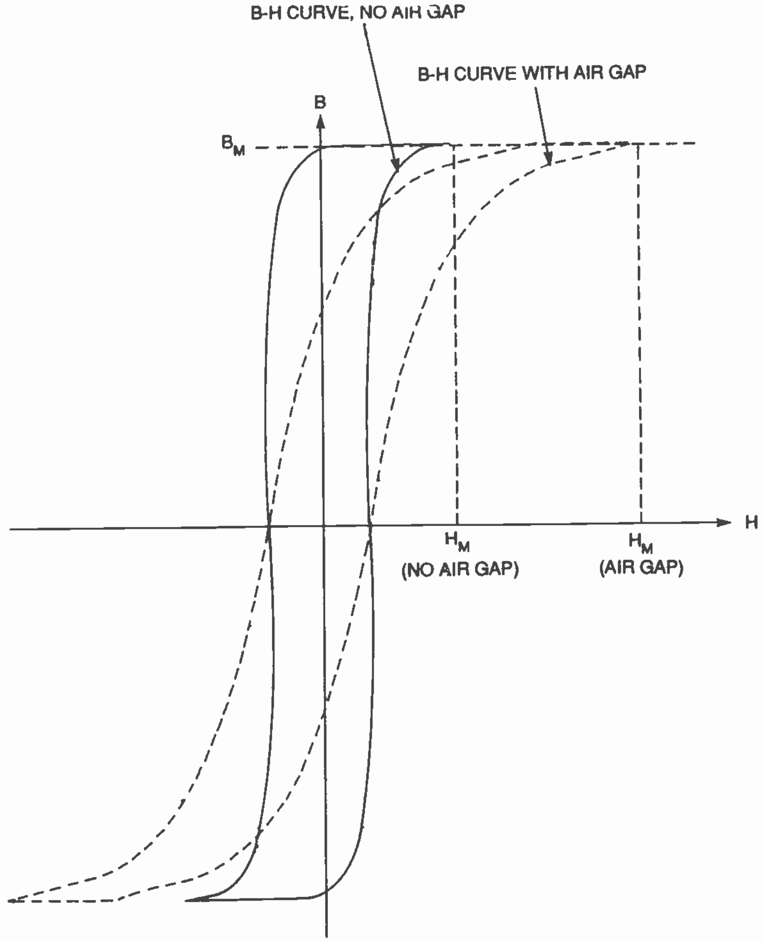


Fig. 4. If an air gap is present, more magnetizing force (H) is needed to produce a given core flux (B).

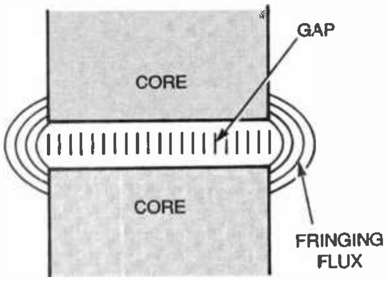


Fig. 5. In flux fringing, a small amount of core flux escapes the core at the air gap, decreasing the useful flux path and increasing core inductance.

over the gapless core. That symmetry results in smaller size and weight of the iron core.

Also, because the windings completely enclose the core flux, stray magnetic fields that could interfere with other circuitry within the enclosure are greatly reduced. Much less shielding is required for use with sensitive or high-gain electronics.

The noise (hum) in a conventional transformer is due to core magnetostriction, which is a very small deformation of the core iron under the influence of the magnetic field induced by the AC primary current. Because the windings completely envelope the core in a toroidal transformer, audible hum is reduced to 10% to 15% of that of a conventional transformer.

Because it has lower losses, the toroid transformer is more efficient and runs at a lower operating temperature. It also has better load regulation than a conventional transformer of the same power rating.

The Effects of Air Gap. Much of the lower loss can be attributed to the reduced air gap of a toroidal transformer core. While intentional air gaps are designed into inductors to prevent DC saturation, air gaps produce a number of undesirable effects in power transformers. For the typical E-I- or C-core power-transformer laminations, the air gap is 0.002 inches. In a toroidal transformer the effective air gap is extremely small (typically less than 0.00001 inch) and can be ignored for design purposes. The lack of a discrete air gap minimizes losses, leakage, and flux-wave distortion, and decreases the mmf needed to produce a given level of flux in the transformer.

The AC inductance is determined by the number of turns, the impressed voltage, and the core cross-sectional area. The magnetic flux path has two components, the core magnetic length and the air-gap length. Those two components are not equal, because air and iron have vastly different permeabilities.

Permeability is the ratio of the change in magnetic induction (B) to the change in magnetizing force (H), and is equal to B/H. The permeability of air is constant at 1, while the permeability of silicon iron depends on the degree of saturation in the core. At 80% saturation, silicon iron has a permeability of about 4000. Because air offers 4000 times more reluctance to flux changes, a very small air gap has a great effect on the magnetizing volt-amperes needed to produce a given output power. An air gap increases the effective length of the magnetic path, reduces the inductance and, as shown in Fig. 4, causes more slope in the B-H curve. That requires more magnetizing force, and thus more primary current, to generate a given core flux. Once saturation is reached, no further increase in flux can occur even if the magnetizing current is increased by raising the primary voltage.

Another disadvantage of an air gap is flux fringing. Not all of the core flux remains within the core cross-section adjacent to the gap. A small percentage curves outward near the edges of the core as shown in Fig. 5, causing core flux fringing. That fringing decreases the useful flux path area and increases the core inductance. Eddy currents are induced where the fringing flux returns to the core perpendicular to the desired magnetic path, causing additional losses. Fringing effect is lower in a C-core than it is in an E-I core because one of the air gaps is enclosed by the windings. The magnetizing force set up near the gap reduces the flux fringing in that gap. However, even if the air gap effect could be eliminated, the core halves cannot be perfectly aligned during assembly, so some fringing will also occur due to misalignment.

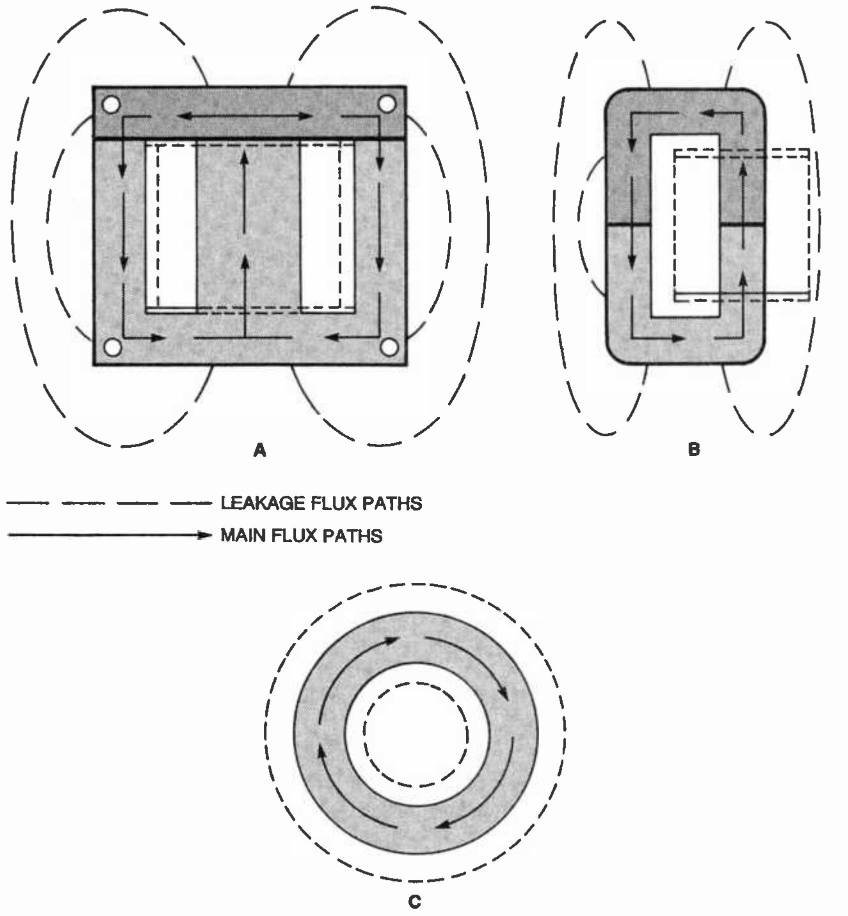


Fig. 6. The main (solid line) and leakage (dashed line) flux paths for the three most common types of transformer cores are shown here. An E-I core is shown in A, a cut-C core in B, and a toroid core is shown in C.

Coupling and Leakage Flux. In a toroidal transformer, the entire magnetic path is contained within the winding, which is designed to be evenly distributed around the core. That maximizes the coupling between windings and minimizes leakage flux. That improved coupling increases transformer efficiency. Figures 6A and 6B show the main and leakage flux paths for E-I and C cores, where the leakage flux paths are completely outside the windings. All flux in a toroidal design is contained within the windings, as shown in Fig. 6C.

Toroidal cores generate a very small flux in the axial direction, but if necessary, that flux can be contained by ring laminations assembled to the top and bottom of the core.

Limitations. Because toroidal transformers have insufficient air gaps to tolerate DC currents, only AC currents can be impressed on the windings. To use a toroidal transformer as a push-pull tube-amplifier output transformer, for instance, would require that perfectly matched tubes with balanced DC plate currents be used.

Toroidal power transformers should not be half-wave rectified. If it is, the core will become polarized and saturated in one direction.

The lack of an air gap can cause high inrush currents during energizing, limited only by the primary winding resistance. For larger transformers, a slow-blow fuse or soft-start inrush-limiting circuit should be used.

The mounting bolt is usually placed through the center of a toroidal transformer. Care must be taken that a circuit is not inadvertently completed between the top and bottom of that bolt. That would result in a shorted

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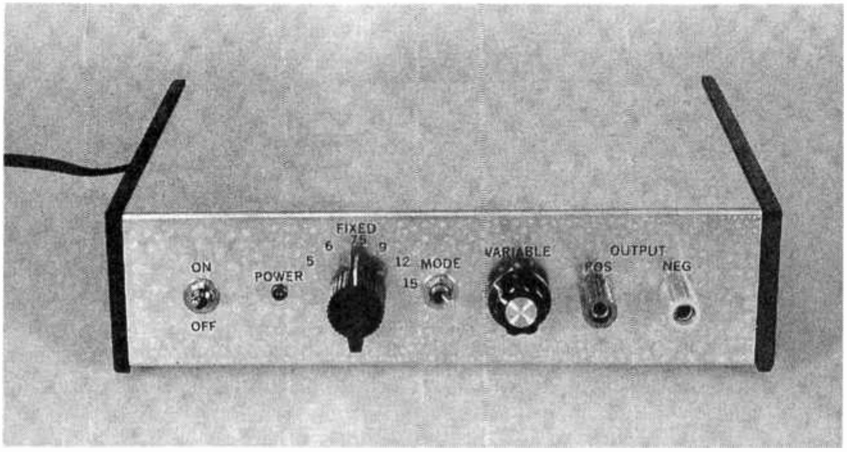
Build a Versatile Power Supply



It's an inexpensive and useful addition to any hobbyist's workbench.

BY MARC SPIWAK

Any project that you ever decide to build is going to need a power supply—any electronic project, that is. So once you have decided on a particular circuit design, the biggest concern is what sort of power supply it needs.

Power can come from many sources, including batteries, AC adapters, and benchtop supplies. For that reason, one can never have too many power supplies on his or her test bench. With every circuit requiring at least one operating voltage, and some needing more than just one voltage, you can see why that's so. Batteries are perhaps the easiest form of power to use, but constantly buying batteries can end up sucking your wallet dry after a while. Clearly, an AC adapter is a more economical method of delivering power, and perfectly suitable for a project as long as portability is not a priority.

However, the main problem with AC adapters is that, with the wide range of necessary operating voltages, all those adapters can really clutter up your test bench or home. And many inexpensive AC adapters simply can't supply enough current for some circuits. What's really needed is a variable-output, AC-derived, benchtop power supply. But most hobbyists know that commercial units of that type can get expensive.

Why should power supplies cost so much? After all, there's really nothing exotic inside most of them—the transformer is usually the most expensive component. So I decided to save some money and build the *Versatile Power Supply* described in this article.

When planning the project, I decided that its two main duties would be to replace a drawer full of AC adapters, and to also be a useful supply for my test bench.

With low cost being a paramount concern, I decided to use as many junk-box components as possible. Over the years, I have accumulated quite a collection of "junk" parts. And because most of our hobbyist readers also have large collections of the stuff, I don't hesitate to recommend using recycled parts as a cost-saving option where possible. Those without junk boxes that are as full as mine shouldn't worry either—the project uses only commonly available parts.

After digging, scrounging, and cannibalizing for some time, I determined that the only part I would have to buy would be a rotary switch from Radio Shack, and that costs less than two dollars, which was my total cash outlay for this project. Even the case I used was an old, unused leftover that I was never sure what to do with. Perhaps you can keep costs down to a similar level, or maybe even cheaper—you might have a rotary switch in *your* junk collection!

Circuit Description. Figure 1 shows the schematic for the Versatile Power Supply. The simple circuit outputs a variety of voltages (customizable by you), and can output up to one amp of current—that's a lot more than most AC adapters. As shown, the Supply outputs between 5- and 15-volts DC.

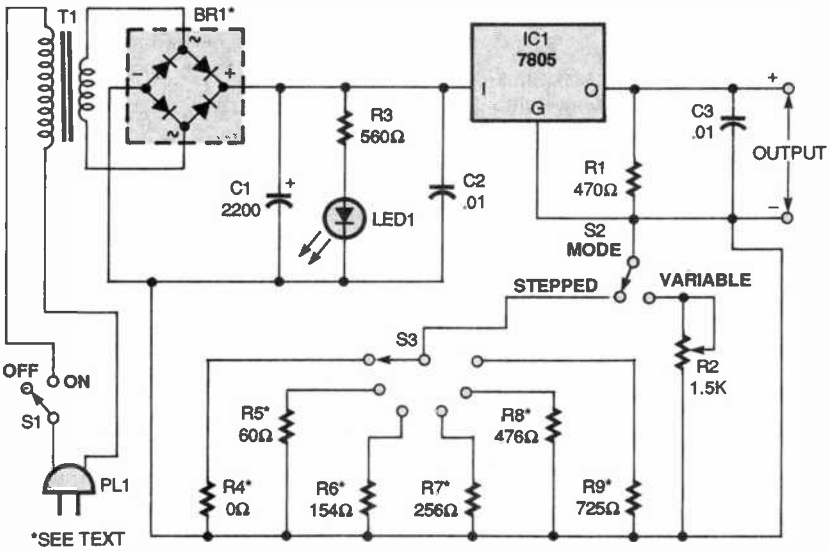


Fig. 1. The Power Supply circuit has an output that can be varied linearly by potentiometer R2 or switched to specific levels by rotary-switch S3.

When PL1 is plugged into an AC outlet, and power-switch S1 is turned on, 117 VAC are fed to transformer T1. That transformer steps the voltage down to approximately 18 VAC, which is then full-wave rectified by bridge-rectifier BR1.

Capacitor C1 smoothes any rippling caused by the bridge rectifier, and stores a charge for the voltage regulator. The other capacitors, C2 and C3, are bypass capacitors that also help condition the voltage fed to and output by IC1, a 7805 voltage regulator.

In most circuits containing them, 7805 regulators are used to output a fixed 5 volts. However, in the configuration shown, the regulator's output can be varied between about 5 and 17 volts (although, as mentioned, 15 volts is set as the maximum).

Here's how the configuration works: Normally, an input voltage higher than 5 volts is applied to the input pin of a 7805 regulator. Pin 2 (G) of the device is normally grounded and it will then regulate the output at pin 3 (O) to 5 volts higher than the potential at pin 2 (normally 0 volts, or ground). But if pin 2 is held at some voltage above or below ground, the output voltage will equal the potential at pin 2 plus 5 volts.

In this circuit, the voltage at pin 2 of the regulator is maintained by a voltage divider made of R1 and either potentiometer R2 or one of resistors R4 through R9. Each of those latter six resistors sets the output to a specific voltage level, while potentiometer R2 allows for a fully variable output.

Assume for the moment that switch S2 is set so that potentiometer R2 is part of the voltage divider. While IC1 tries to maintain exactly 5 volts at its output, the voltage at pin 2 can be varied by changing the resistance of the bottom half of the divider. Therefore, the output voltage is always 5 volts plus the voltage at the divider junction. As IC1's output voltage increases, so does the voltage at the divider junction, which then increases the output voltage, and so on, and so on, until it "runs out" of input voltage. That's how the 7805 regulator is made to have a variable output.

When switch S2 is set so that it connects pin 2 of the regulator to rotary-switch S3, one of resistors R4 through R9 then becomes the bottom half of the divider. The values for those resistors were chosen so that the output could be set to exactly 5-, 6-, 7.5-, 9-, 12-, or 15-volts DC. We'll get to how to determine those values later on.

Construction. The author's prototype was built on perforated construction board using point-to-point wiring. A piece of board measuring approximately 2 × 4 inches should leave plenty of room for all the parts, except the transformer, which should be mounted separately on the enclosure.

PARTS LIST FOR THE VERSATILE POWER SUPPLY

SEMICONDUCTORS

IC1—LM7805 5-volt regulator, integrated circuit
BR1—50-volt, 1-amp bridge rectifier, or four 1N4001 diodes (see text)
LED1—Light-emitting diode, any color

RESISTORS

(All resistors are ¼-watt, 5% units, unless noted.)
R1—470-ohm
R2—1500-ohm, panel-mount potentiometer
R3—560-ohm
R4—0-ohm (approximate value—see text and Table 1)
R5—60-ohm (approximate value—see text and Table 1)
R6—154-ohm (approximate value—see text and Table 1)
R7—256-ohm (approximate value—see text and Table 1)
R8—476-ohm (approximate value—see text and Table 1)
R9—725-ohm (approximate value—see text and Table 1)

ADDITIONAL PARTS AND MATERIALS

C1—2200-µF, 50-WVDC, electrolytic capacitor
C2, C3—0.01-µF, ceramic-disc capacitor
T1—120- to 12-volt AC transformer (see text)
S1, S2—SPDT toggle switch
S3—6-position rotary switch (Radio Shack no. 275-1386 or equivalent)
PL1—2-conductor, AC plug
Perforated construction board, project case, heat sink, two insulated binding posts, coaxial jack, four coaxial plugs, mini phono plug, 9-volt battery connector, banana plugs, power cord, grommet, wire, solder, hardware, etc.

To determine where you will position the circuit board in your project enclosure, begin by mounting transformer T1, which is a common, 120- to 12-VAC, 1-ampere model. Connect a power cord and plug to the transformer. Then wire switch S1 into the circuit.

Next, begin mounting the on-board components, starting with the bridge rectifier. You can use a regular bridge rectifier or four discrete diodes as mentioned in the Parts List.

Next, install capacitor C1, the 2200-µF unit. Because C1's purpose is simply to smooth ripples from the bridge rectifier, any large-value (1000-µF or higher) electrolytic can be used, though the one listed in the Parts List is a good and commonly available choice. Go on to install capacitors C2 and C3, resistors R1 and R3, and LED1.

Continue with installation by mounting the voltage regulator. Connect a heatsink to the regulator to prevent it from overheating when it is outputting more than just a few-hundred milliamps. If you are using a metal case, a wall of the case can serve as a heatsink for the regulator if you mount the regulator on the edge of the board and mount the board up against the wall of the case after assembly is complete.

Connect potentiometer R2 and switch S2 off-board. The output voltage from the circuit should be connected to a pair of binding posts. You can use leads or banana plugs to connect the Power Supply to other circuits, or you can build a custom cable that will be described later on.

Before you can install fixed-resistors R4–R9, you will have to determine what values will work best for your circuit. Because of component tolerances and other factors, the values will probably be different than the ones in the prototype, even if you use similar parts.

Set S2 to VARIABLE, plug the circuit in, and turn on S1. Connect a DMM to the binding posts, and adjust R2 to make sure that the output voltage varies. Next, determine what fixed voltages you would like your power supply to output, and then write them down (you might want to use the ones mentioned earlier).

Adjust R2 to get the first voltage on your list at your output terminals. Then switch S2 to STEPPED (which is an open setting, as it's not connected to anything yet), and measure the exact resistance of the potentiometer using a DMM. Be careful not to disturb the setting. Write down the value of the resistance that gives you the desired output voltage, turn S2 back to VARIABLE again, and perform the same procedures for each output voltage you want.

The next step is to piece together the exact resistance value for each output from individual resistors. In most cases you should be able to get the exact value you need by connecting only two resistors in series—and only one if you're lucky. Three resistors might be needed for some of the values, depending on how well stocked your resistor bin is. Table 1 shows the potentiometer values that were measured for the prototype's output voltages, and the fixed resistors that had to be connected in series to equal those values.

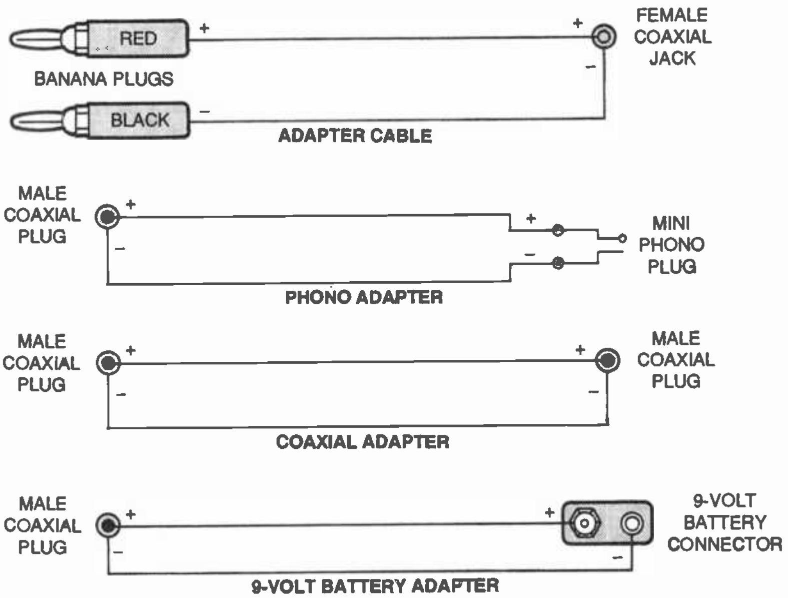
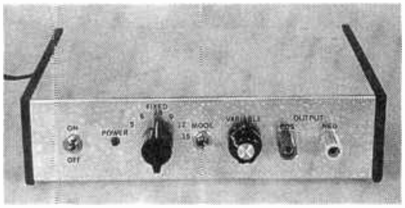


Fig. 2. Assembling these adapter cables makes it easy to connect the power supply to a variety of appliances.

TABLE 1

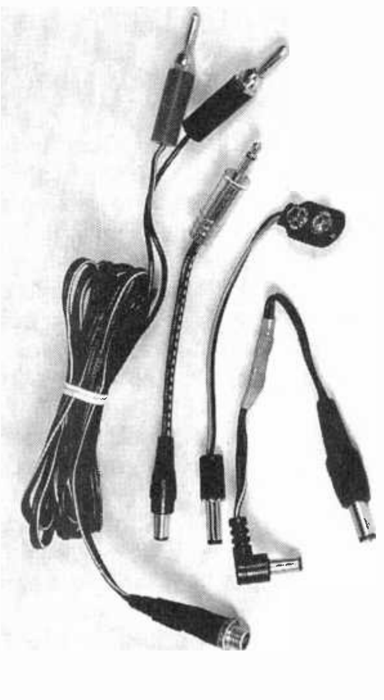
Desired Output	Measured R2 Resistance	Fixed Resistors Used
5 volts	0 ohms	wire jumper
6 volts	60 ohms	56 + 4.7 ohms
7.5 volts	154 ohms	150 + 3.9 ohms
9 volts	256 ohms	220 + 18 + 18 ohms
12 volts	476 ohms	470 + 5.6 ohms
15 volts	725 ohms	680 + 47 ohms



The finished Supply can furnish a variety of fixed and variable voltages.

Once you have determined what resistors will be used, you can add them and rotary-switch S3 to the circuit. That switch in the author's prototype is a 2-pole, 6-position switch (Radio Shack # 275-1386), of which only half is used, providing six fixed settings. After you're done wiring the resistors, use a DMM to make sure each setting is correct.

Carefully lay out and drill holes for the LED, switches, binding posts, and potentiometer in the case you are using. If you are using a metal case, the binding posts must be insulated from it (binding posts come with special plastic spacers that, with the right hole size drilled in the front panel, will keep the center conductor away from the panel). Once all the panel components are mounted, make sure to clearly label the panel so you can identify voltage settings.



Here's what the adapter cables look like when completed.

Convenience Cable. Because one of the intended uses for this power supply is as an AC-adapter replacement, you might want to build a custom cable to do the job. Let's look at how to do that.

Figure 2 contains the wiring connections of the custom cable. Begin by soldering a pair of banana plugs—red (positive) and black (negative)—to the leads at one end of a two-conductor wire. At the other end, attach a female coaxial jack, with the center conductor being positive.

Next make adapters for various jacks that you might want to plug the supply into (Fig. 2 shows a few examples). All the adapters have a male coaxial plug on one end for connecting to the female plug on the end of the banana cable, and some type of plug on the other end. For example, one adapter has a male coaxial plug, another a mini phono plug, and another a 9-volt battery connector. That way, anything that has a coaxial power jack, a mini-plug jack, or uses a 9-volt battery, can be powered quickly and conveniently. ■

The Amazing Micro-Car

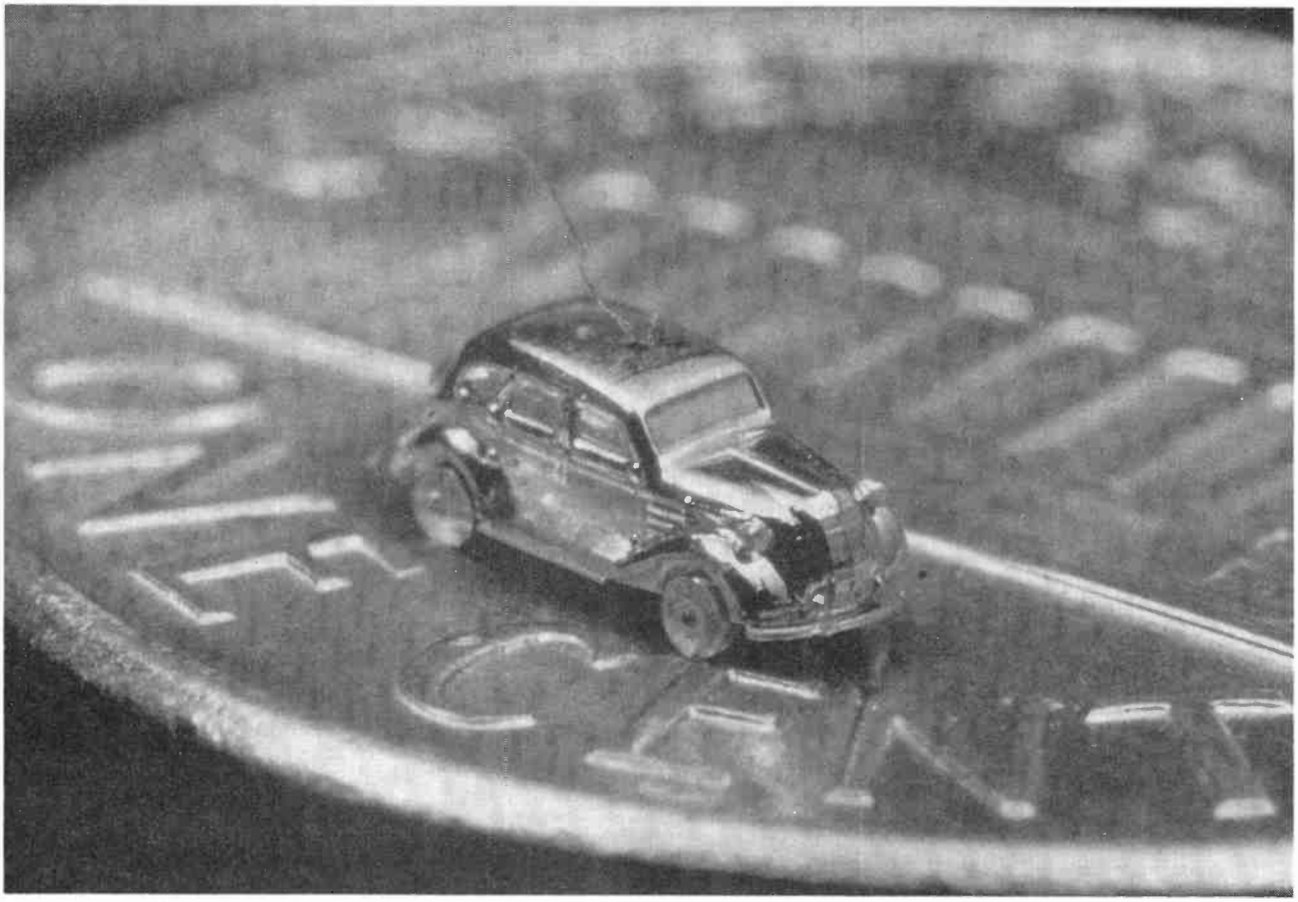


Photo courtesy of Nippondenso America, Inc.

BY BILL SIURU

Learn about a working car that's as small as a grain of rice!

The latest in electronic manufacturing technology includes ultra-miniature components produced using semi-conductor processing, ultra-precision machining, and micro-machine technology. You might have seen motors, pumps, and other micro-machines in the news that were so tiny that they had to be viewed through a microscope.

Recently, Nippondenso Research Laboratories in Aichi Prefecture, Japan unveiled the world's smallest motor car. The Micro-Car, about the size of a grain of rice and shown in the photograph at the beginning of this article, was more than a "just for fun" project. Nippondenso uses it to demonstrate the potential of micro-machine technology for both industrial and medical applications. Researchers also wanted to increase Nippondenso's capabilities in ultra-precision machining and semiconductor-processing technologies.

The Nippondenso "modellers" worked in 1/1000th scale to create a model of Toyota's first passenger car, the 1936 Model AA sedan. The grain-of-rice-sized car is 4.785-mm long, 1.73-mm wide, and 1.736-mm tall.

To appreciate the scale at which they worked, the stainless steel bumpers are 50-microns thin and 220-microns wide. The wheels, which turn, are 500 microns in diameter. (One micron equals 0.001 mm and, for comparison, a human hair is about 80 microns in diameter.)

The model was originally made of 24 separate parts—body, tires, spare tire, wheels, axle, bearings, headlights, rear lights, bumpers, step, number plate, emblem, and so forth. The wheels, number plate, and emblem were made from a glass material and appropriate patterns were etched on them using semiconductor processing technology. To create the body, engineers first made a 1/24 scale model of an actual Model AA sedan. Then they recorded micro-level measurements using a three-dimensional measuring device so they could precision-machine the brass body with a tool called a "machining center."

The first model was "powered" by moving a magnet under the table. Not satisfied with that means of propulsion, the engineers put a tiny electric motor in the car. The 0.67-mm magnetic-type motor consists of five different parts, including a magnet

(Continued on page 78)

ANTIQUE RADIO

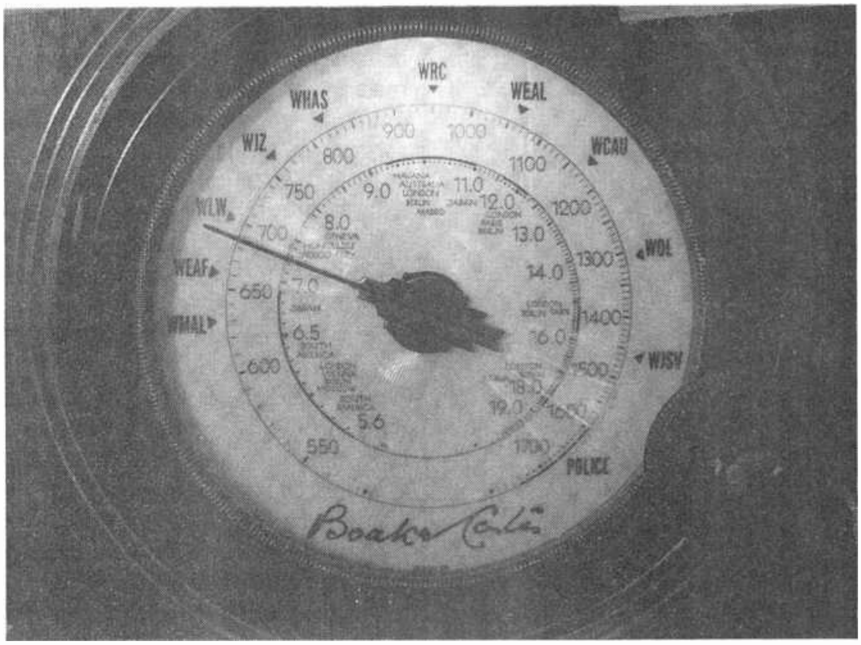
We Hear From the Readers

BY MARC ELLIS

It's been a few months since we last opened the mailbag, so let's take a look at the current batch of letters and see what's on our readers' minds these days!

RADIOS & INFO WANTED

Let's start out with one from the "Oops!" department. In the December 1995 issue, I mentioned that reader Raymond Shetrone (2313 Harvard Ave, Ft. Meyers, FL 33907) was looking for somebody to shed some light on an odd inscription found on the dial of his Philco 38-7 console. Ray wrote to point out that, in discussing the inscription, I had been referring to a photograph of the wrong dial—one from a "no-name" radio also in Ray's collection. Sorry, Ray! Anyway, I'm including the correct dial photo with this column. Can anyone identify the flamboyant cursive signature at the bottom?



Can anyone help Ray Shetrone identify the mysterious inscription at the bottom of the tuning dial for his Philco 38-7?

George J. Pitsakis (Vizantiou 22, N. Smirni, Athens 171-21 Greece) is working on a Hallicrafters S-40B that was given to him by his dad many years ago. He needs a schematic and service notes (particularly alignment data), and will be glad to prepay postage and copying costs. Loren Perkins (13490 Oro-Quincy Highway, Berry Creek, CA 95916) would like information on an unusual "G.M. Ashtray Radio" (shown in a photo elsewhere in this column). He'd like the same for an RCA Model 103 table speaker (the one with the octagonal frame and tapestry grille cloth).

Can someone supply information or documentation on a Commercial Trade Institute tube tester Model TC-20, a Control Radio Set C-845/U (Connecticut Tel. and Elect. Co.), and/or a Signal Corps BC-1306 receiver (Rauland Corp.)? If so, reader Brett A. Hoff (114 Griffin Rd., Ochlocknee, GA 31773) would like to hear from you. Malcolm Aldridge needs sources for vintage grille cloth and for schematics on antique battery sets. Contact him at 6200 Mohawk Trail, Milton, FL 32583.

"What is it?" asks Curt Wagner (431 W. Tiffin St., Fostoria, OH 44830). The recently acquired device seems to be some kind of a capacitor tester, says Curt, but that's only a guess. If you recognize the photo shown elsewhere in this article and can supply some information, please get in touch. Is someone out there into National ham equipment? John C. Dideum (38 Union St., Norristown, PA 19401) is looking for schematics and service information on the NC-33 and NC-173 transceivers.

Richard Nobrega (308 Wilson St., New Bedford, MA 02746) is interested in selling a microphone that's been in his possession for almost half a century. It's housed in a black cast-metal case, and the inscription "Supplied to Victor Talking Machine Co. by Radio Corporation of America" surrounds the mouthpiece. Anyone know the vintage and value of that piece? Brian Gosney (5501 9th Lot 27, Great Bend, KS 67530) seeks documentation and a source of parts for a Hallicrafters S-120.

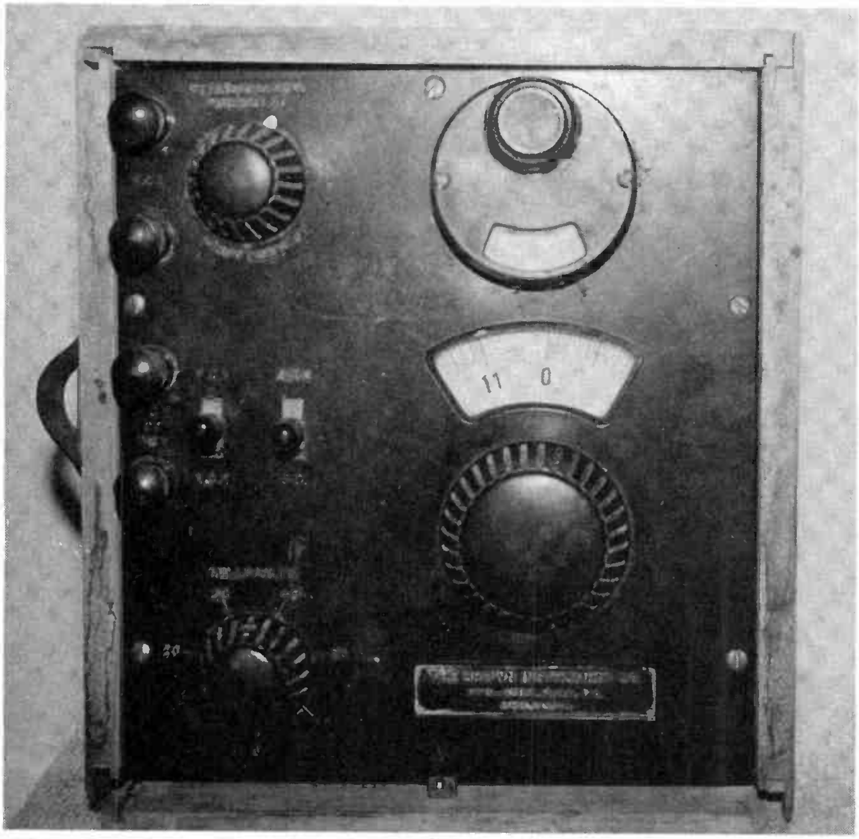
Craig Sellen (Box 1038 RR-1 58-B, Waymart, PA 18472) has a large collection of hobby- and commercial-grade test equipment (the list is too long to print here) mostly for TV troubleshooting and repair. He needs documentation for all of it, so if you have data for that kind of equipment, drop him a line. Craig is also interested in selling his Webster-Chicago wire recorder and Sentinal 10-inch B&W TV, and could use some help figuring out the value of those items.

Do you know where to find a Squires Sanders Model SS1BS radio and/or manual? Contact Harry at 4845 West 107th St., Oak Lawn, IL 60453-5252. Turning our attention to the West coast, we have a request from Earl Dougherty (4675 El Carro Ln., Carpinteria, CA 93013-1306), who is looking for a Hammarlund HQ180AC (or similar) shortwave receiver.

PARTS/TECH ASSISTANCE

When Kevin Tekel (14 Cambridge, Dr., Warren, NJ 07059-6903) first tried his Hallicrafters S-38, it worked but hummed loudly. Then the stations faded out. He replaced the electrolytics and the hum went away—but the stations didn't come back. A professional antique-repair firm quoted $150 to fix the set. Can anyone help Kevin diagnose the problem (he does have a schematic to work with) or suggest a more affordable way to get the set fixed?

Howard Fogle, Jr. (35 Wildwood Rd., Katonah, NY 10536) has a Jackson Model 648-1T tube tester, and would like to put it to work on his stock of old tubes. However, though



"What is it?" asks Curt Wagner. If you know, please contact him!

the unit has settings to use with early tubes, an accessory test panel with proper sockets is required to plug them in. Howard would like to either find the panel or obtain its schematic so he can build a replacement.

Long-time readers of this column will remember the original RCA Theremin we restored in 1991-1992. Introduced by the legendary Russian inventor Leon Theremin, that was the instrument used to produce those chilling sound effects in the science-fiction movies and psychological flicks of the early to mid 1940s.

Over the years, many Theremin construction projects have appeared in the popular electronic press. Reader Dave Eley (17294 58th Ave., Surrey BC Canada V3S 1K8) is in the process of building the one by Lou Garner from the April 1955 **Popular Electronics**. He has all the parts but the Miller #6905 oscillator coil. The coil is long obsolete, but if you happen to have one kicking around in your junk box, Dave would certainly love to hear from you.

Want to know more about the Theremin? Dave suggests writing Barry Eso at the Theremin Enthusiasts Club, 1232 Alexandra Pl., Prince Rupert, BC, Canada V8J 3Y6 (e-mail: beso@cln.bc.ca).

1930's HAM RECEIVER

Here are a few pieces of mail related to our current column project: the 1930's ham receiver. David Goncalves (2 Overlook Circle, Milford, MA 01757) writes about a source for double cot-

Loren Perkins is looking for more information on this interesting "G.M. Ashtray Radio."

ton-covered wire—a commodity that's both difficult to find and an essential material for those who desire to make authentic reproductions of old-time receivers. David suggests contacting MIDCO (P.O. Box 2288, Hollywood, FL 33022). MIDCO, a supplier of crystal-radio items, stocks double cotton-covered wire in 100-foot lengths (available in 20, 22, 24, 26, and 28 gauge). Prices are roughly in the $3 to $6 range.

Bob Davey sent along photos and data of two old-time regenerative receivers he built a few years ago. One was adapted from a couple of circuits found in Lindsay Publications reprints (see book reviews below), substituting JFET transistors for the tubes; the other is a recreation of "The 2-Tube Short Wave DX-ER" from the July 1934 issue of *Short Wave Craft*.

A front-view photo of the latter is included in this column. Bob simulated the look of a 1930's Bakelite or Vulcanite front panel by painting tempered Masonite with Rustoleum Black. (Thinking along the same lines, I had used Krylon gloss black spray over my set's plywood front panel.) I also noted with interest that, just as I decided to do, Bob used a grounded aluminum-foil shield on the back of the panel to reduce changes in tuning due to hand-capacity effects.

Bob's regen circuit uses two '30 tubes lit by a couple of alkaline "D" cells. The 45- and 90-volt plate supply comes from a bank of ten 9-volt transistor batteries wired in series.

VINTAGE REPRINTS

Another interesting outcome of the 30's ham set series was a catalog and several sample books recently received from Lindsay Publications, Inc. (P.O. Box 538, Bradley, IL 60901-0538). The accompanying note from publisher Lindsay read, in part "... and I thought I was the only one who still loved vacuum tubes!"

Bob Davey's recreation of "The 2-Tube Short Wave DX-ER" from the July 1934 issue of Short Wave Craft.

The tag line on the front of the Lindsay catalog reads "Unusual technical books, past and present, of exceptionally high quality revealing skills and secret processes almost forgotten." And the catalog certainly lives up to that promise. Quickly flipping through its 64 lively and illustration-crammed pages, I discovered tomes on how to fix antique telephones, brew world-class beer, build a 40,000-volt induction coil, make neon signs, and even "How to Date Young Women for Men Over 35."

Of particular interest to readers of this column is the nine-page section on "Ancient Radio Apparatus." That section contains a good selection of modern works on old-time radio topics, but I found my eye drawn to the reprints of vintage books that just a few years ago were virtually unobtainable.

From the wireless era, there are the Elmer E. Bucher classics *Wireless Experimenter's Manual* and *Vacuum Tubes in Wireless Communication*. From the 1920s, there are such charmers as H. Winfield Secor's *Loud Talkers—How to Build Them*, and Banning and Cockaday's *How to build your Radio Receiver*. Moving to the mid-1930s, we find Gernsback and Secor's *Official 1934 Shortwave Radio Manual* and *Radio Builder's Manual* by Modern Mechanix.

I had a good time looking over the group of sample books that accompanied the catalog. They were all nicely reproduced on good-quality paper and sturdily bound, most of them between colorful covers of heavy, glossy stock. Of particular interest to me was the Banning and Cockaday *How to Build Your Radio Receiver*, which contains the article on which I based the "NBS Crytal Set" construction series that appeared in this column some months ago.

I also enjoyed the *Official 1934 Shortwave Radio Manual*, which is full of nostalgic circuits and articles. A large section at the back of the book provides schematics and technical data on many commercial shortwave sets of the era. And hidden away at the very end, unannounced in the index, is a surprise modern insert by publisher T.J. Lindsay. In that very valuable piece, you'll find suggestions for scrounging parts to build the old sets, replacing tubes with modern solid-state devices, and coaxing the ancient regenerative circuits into life. Also included are a couple of Lindsay's favorite related articles from *CQ Magazine* and the *ARRL Radio Amateur's Handbook*.

I suppose you can't do a review of this kind without voicing at least one beef, so here's mine: I agree that the type-24 tube, with its pear-shaped globe and top cap, is quite neat looking, but that early-1930's device wouldn't be my first choice to illustrate the cover of Elmer Bucher's classic 1919 vacuum-tube "bible." Bye until next time! ■

CIRCUIT CIRCUS

Simple Diode Circuits

BY CHARLES D. RAKES

The spotlight this visit is centered on the versatile and most-often used semiconductor ever produced—the diode. That small-in-size but large-in-importance device has found its way, in one form or another, into just about every electronic device produced today. So sit back, get comfortable, and we'll look over a few simple circuits using the diode.

BRIDGE RECTIFIER

A friend of mine whose hobby is building Tesla coils came by the other day complaining about the poor performance of the rotary gap in one of his creations. He had purchased a new heavy-duty, brush-type motor and had connected it to a Varaic (a variable AC transformer) for controlling the motor's speed. Unfortunately, the setup just didn't seem to operate as he expected. I asked if the motor had a built-in bridge rectifier or if he had added one. No was his response, so I suggested

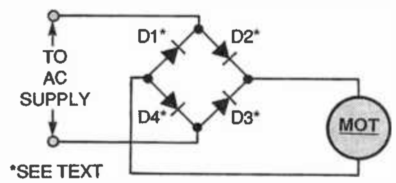


Fig. 1. Brush-types motors work best when fed using a bridge rectifier like this one.

PARTS LISTFOR THE BRIDGE RECTIFIER (Fig. 1)

D1-D4—Silicon diode, see text
MOT1—Brush-type motor, see text
Wire, solder, etc.

he connect one to his motor, as shown in Fig. 1. Doing that allowed his motor to run faster and cooler, and, as a result, his Tesla coil produced longer arcs and sparks.

If you look at the motor in most vacuum cleaners, hand grinders, hand drills, and other similar tools you'll see that the majority use brush-type motors with built-in bridge rectifiers in a setup similar to that shown in the figure, and they all run better because of it. If your brush-type motor lacks that rectifier, you should add one, too. Just make sure to select silicon diodes whose current rating is appropriate for the rating of the motor.

SOUND-LEVEL LIMITER

Our next circuit, see Fig. 2, uses two diodes connected in parallel and back-to-back to clip and limit an audio signal. The circuit's audio output signal can never exceed 1.5-volts peak-to-

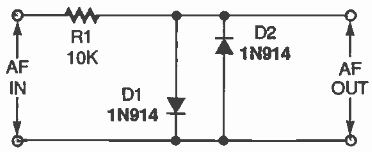


Fig. 2. This circuit clips and limits audio to safe levels.

PARTS LIST FOR THE SOUND-LEVEL LIMITER (Fig. 2)

D1, D2—1N914 silicon diode
R1—10,000-ohm, ¼-watt, 5% resistor
Wire, solder, etc.

peak. A similar circuit, usually two diodes connected as shown in Fig. 2 in a single two-lead package, is connected across your telephone receiver to protect your ear from dangerous sound levels.

TELEPHONE-IN-USE INDICATOR

Our next entry, see Fig. 3, uses two LEDs to indicate when a telephone is in use on a given line. When a telephone is off-hook (in use), a DC current flows through the lines lighting one of the LEDs. Two LEDs are used so that the circuit can be inserted in the line in either direction. Also, the two LEDs protect each other from

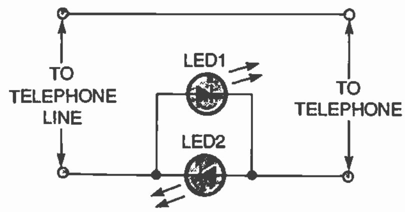


Fig. 3. This super-simple telephone-in-use indicator can be inserted in the line in either direction.

PARTS LIST FOR THE TELEPHONE-IN-USE INDICATOR (Fig. 3)

LED1, LED2—Light-emitting diode, any color
Wire, solder, etc.

reverse voltage when a ringing voltage is present. In most cases both LEDs will light when the phone rings.

DC/AC INDICATOR

Our next circuit, see Fig. 4, uses two LEDs connected in parallel and back-to-back in a DC-polarity or AC-indicator circuit. When the circuit is connected to a DC voltage greater than 3 volts, one of the LEDs will light indicating the polarity. Connecting the "A" lead to a positive source will light the red LED, LED1. If the "A" lead is connected to a negative source the green LED, LED2, will light.

If the circuit is connected to an AC

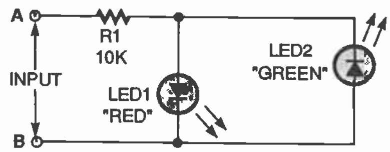


Fig. 4. Learn whether a voltage is DC or AC with this simple indicator. It will also tell you the polarity if a voltage is DC.

PARTS LIST FOR THE DC/AC INDICATOR (Fig. 4)

LED1—Light-emitting diode, red
LED2— Light-emitting diode, green
R1—10,000-ohm, ¼-watt, 5% resistor
Wire, solder, etc.

source, both LEDs will light. The value of R1 shown limits the maximum and minimum input voltage levels at which the circuit will operate. Never connect the circuit to a voltage that can produce a current of over 20 milliamps.

KICK-BACK VOLTAGE LIMITER

The next diode circuit, see Fig. 5, is used to protect the controlling device, symbolized as L1, in an inductive circuit. When power is removed from an inductive load, such as a relay coil, a solenoid coil, or any similar inductive device, the energy stored in the inductor is released producing a high AC voltage across it. Unchecked, that excessive voltage can damage the controlling device. The diode, D1, connected across the inductor clamps the kick-back voltage and protects the controlling device from damage.

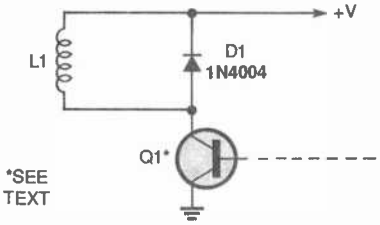


Fig. 5. To protect an inductive load against voltage kick-back, connect a diode across it as shown.

PARTS LIST FOR THE KICK-BACK VOLTAGE LIMITER (Fig. 5)

D1—1N4004, 1-amp, silicon diode
Q1—NPN transistor, see text
L1—Inductive load, see text
Wire, solder, etc.

STEERING CIRCUIT

A steering circuit is shown in Fig. 6. If a positive 12-volt source is connected to the circuit's DC input, diode D1 conducts to close RY1. No current flows through D2 leaving RY2 open. If a negative voltage is applied, the reverse happens; diode D2 conducts, closing RY2, while no current flows through D1, leaving RY1 open.

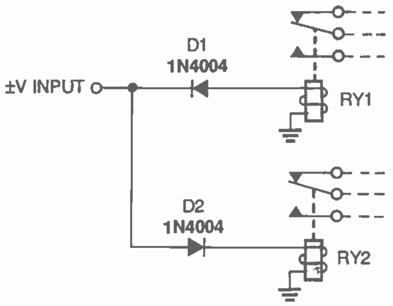


Fig. 6. When a positive voltage is input to the circuit, relay RY1 is activated; when a negative voltage is input, RY2 is activated.

PARTS LIST FOR THE STEERING CIRCUIT (Fig. 6)

D1, D2—1N4004 silicon diode
RY1, RY2—DC relay, 12-volt coil, see text
Wire, solder, etc.

SIMPLE TEMPERATURE SENSOR

Do you need an inexpensive temperature sensor? Well, for occasional use, the one in Fig. 7 will do the trick. It takes advantage of the fact that the typical silicon diode's forward voltage drop varies about 2 millivolts per degree C. Set a digital voltmeter to its lowest DC voltage range and connect it across the diode as shown in the figure. Make up a chart that shows millivolts *vs.* temperature and record the meter's reading at different temperatures. It won't be the handiest electronic thermometer you have ever used, but it will serve as a fairly accurate indicator in a pinch.

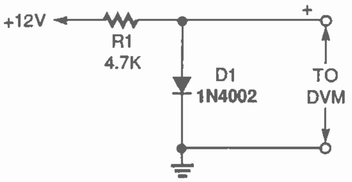


Fig. 7. While this temperature sensor might not be the most handy one to use, it is fairly accurate, and costs about a dime to build.

PARTS LIST FOR THE TEMPERATURE SENSOR (Fig. 7)

D1—1N4002 silicon diode
R1—4700-ohm, ¼-watt, 5% resistor
Digital voltmeter, wire, solder, etc.

DIODE-MATCHING CIRCUIT

Some diode-based circuits work best when all of the diodes are matched. In light of that, let's wrap up this visit with a diode-matching circuit, which is shown in Fig. 8.

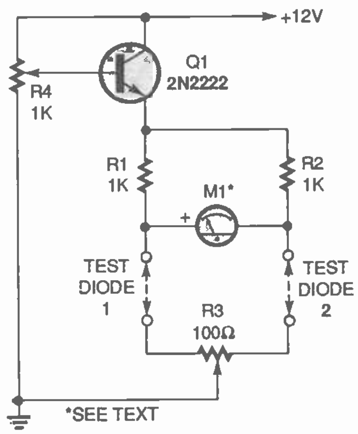


Fig. 8. If you need matched diodes for an application, this circuit can make short work of picking a suitable pair.

PARTS LIST FOR THE DIODE-MATCHING CIRCUIT (Fig. 8)

Q1—2N2222 NPN transistor
R1, R2—1000-ohm, ¼-watt, 1% resistor
R3—100-ohm potentiometer
R4—1000-ohm potentiometer
M1—100-0-100-µA, center-zero meter
Test terminals, wire, solder, etc.

Here's how the matching circuit operates: A 2N2222 transistor is connected in an emitter-follower circuit that's powered by a 12-volt DC source. Potentiometer R4 sets the voltage feeding the diodes under test. Two 1000-ohm, 1% resistors, R1 and R2, make up two legs of a four-element bridge circuit. The diodes you want to test make up the other two legs. Potentiometer R3 is a fine-balance control. Meter M1 is a 100-0-100-µA, center-zero unit.

Setting up and using the matching circuit is easy. Connect jumpers in place of the test diodes, set R3 to mid position, and set R4 to its maximum-voltage position (minimum resistance). Apply power and adjust R3 for a zero meter reading. Disconnect the power and set R4 to its minimum voltage position (maximum resistance) and connect two diodes in the test positions. Slowly increase the bridge voltage with R4 and watch the meter for any change. The diodes are perfectly matched if the meter remains at zero as the voltage is increased. ■

SCANNER SCENE

Not-So-Private Security Forces

BY MARC SAXON

Here's what we call a straightforward, no-nonsense, "meat-and-potatoes" desktop scanner: *Radio Shack's PRO-2037*. It has 200 memory channels and ample features to make it appealing to most scanner users, but is a notch less sophisticated than advanced receivers such as the recent PRO-2035 or the present PRO-2042. However, the PRO-2037 is also priced lower.

In addition to the 200 memory channels (set up in ten banks of 20 channels), there are also ten monitor memories to allow temporary storage of channels located during searches. Searches are done at 50 frequencies per second, while memory channels are scanned at 25 per second.

Radio Shack's PRO-2037 is a new desktop scanner that should appeal to most monitors.

The PRO-2037's frequency coverage is via NFM and AM modes on 30 to 54 MHz, 118 to 174 MHz, 380 to 512 MHz, and 806 to 960 MHz (minus the cellular bands, which cannot be user-restored). The PRO-2037's IF frequencies are 257.5 MHz, 21.4 MHz, and 455 kHz.

Selectivity at ±10 kHz is -6 dB; at ±20 kHz, it's -50 dB. FM sensitivity is 1 mV below 512 MHz, and 2 mV above 806 MHz. Spurious rejection at 154 MHz is 40 dB. AM sensitivity in the VHF aeronautic band is 2 mV.

You can check out the PRO-2037 at your local Radio Shack store. It carries a price tag of $329.

PRIVATE SECURITY

The combination of rising crime rates and stressed public resources has forced law-enforcement agencies to concentrate their efforts where they're needed most. That has often left thinned-out police coverage for other areas, much to the dismay of the folks in those residential and business communities. Private security forces have been hired by companies, malls, and neighborhoods to bridge the gap, guarding those properties from crime.

While private security forces do not have police powers, they provide a uniformed presence that does produce positive results, and they can summon police. They patrol, and stand guard at entrances. As uniformed guards or plain-clothes detectives, they do security jobs that police won't handle. For instance, they perform employee-honesty and shoplifting checks, marital and credit investigations, and concert security. They supply bodyguards, operate central-station alarm systems, trace missing persons, give polygraph tests, and accompany payrolls. They have many roles.

One of the things that communications hobbyists should know about private security forces is that they all use two-way radio. Their operations can be as professional-sounding and complex as many police departments. Their surveillance activities are no less filled with intrigue—and it's all there to monitor on a scanner.

Some private security companies are purely local, but others are national in their scope of operations.

The recent O.J. Simpson trial brought national attention to Westec Security, which is a major private security force in southern California. It's run as professionally as if it were a police department, which is why so many celebrities hire Westec to provide security for their luxurious homes. Westec operates on 859.475, 860.7875, and 957.3125 MHz.

Some large nationally operated security companies and their national frequencies include: the Baker Protective Service, on 151.625, 151.925, 154.57, 460.90, 460.975, and 460.9875 MHz; Burns International Security on 151.625, 154.60, 464.50, 464.55, 469.50, and 469.55 MHz; Pinkerton Security on 151.625, 151.955, 464.50, 464.55, 469.50, and 469.55 MHz; Wackenhut Corporation on 151.625, 464.50, 467.80, 467.90, and 469.50 MHz; and the Wells Fargo Company on 151.625, 464.55, and 545.50 MHz.

Generally speaking, the band between 460.8875 and 461.0125 MHz (in 12.5-kHz steps) is set aside for the exclusive use of private security companies that provide central-station alarm-monitoring services. When an alarm is triggered at a home, factory, warehouse, or office that they are monitoring, they will usually dispatch a mobile unit to the trouble spot. They also dispatch service technicians to repair their alarm systems.

Worried that your local police are going to digital scrambling or trunked systems? Keep those agencies in mind because they use basic FM.

WHAT'S UP?

What with all of the recent space-shuttle activity, there has been some confusion about the mode used for the frequencies in the UHF aeronautical band. Some sources report FM, some AM, and there are those that list no mode.

Private security forces offer new listening opportunities to scanner owners.

Bill Simpson (Rancho Palos Verdes, California) was the most recent reader to write for a clarification. We can report personal reception of space-shuttle transmissions in that band using AM mode. The frequencies most likely to produce reception are 259.7 and 296.8 MHz. They are not very active, however. Most space-shuttle communications are on frequencies beyond the range of scanners.

Whatever shuttle reception might be possible on 259.7 and 296.8 MHz would certainly be helped by an externally mounted antenna cut for the UHF aeronautical band, aided by a preamplifier to boost the low signal levels. In actuality, more activity takes place in Russian on 265.355 MHz (NFM) mode. That might be related to the MIR space lab.

THIS 'N' THAT

A correspondent from Virginia writes to advise us that traffic helicopter pilots in the District of Columbia area have been monitored using 123.475 MHz for their personal chatter. That frequency isn't authorized for such use, but we have had recent reports from other areas of unauthorized chit-chat between pilots taking place on 122.775 and 135.975 MHz. Add those to the unauthorized long-term pilot babbling on 123.45 MHz and you can see a growing trend toward bending the FCC's rules. If you intend to tune in those frequencies, be warned that some of the traffic we have copied on the unauthorized "informal air-to-air" channels is quite salty.

Air-to-air pilot chit-chat is allowed on 122.75 MHz, with 123.025 MHz designated for helicopters.

Fred Atherton (Philadelphia, PA) asks how to scan in on the Amtrak Police. The best bet is to check out 161.205 and 161.295 MHz for those services in the Northeast Corridor. Also worth monitoring is the Conrail police on 160.68 MHz, with car-to-car operations on 160.56 MHz.

Reader P.N.F., of Indianapolis, Indiana, would like to know the frequency of the Midwest Tactical Training Institute, Mount Carroll, Illinois, and also the Internal Intelligence center in Milwaukee, Wisconsin. The Illinois frequency is 151.625 MHz, while the Milwaukee channel is 464.50 MHz. We suspect that there is an interesting story behind that request.

Paul Markowitz, of Florida, dropped us a card wanting to know about the telemetry tones that he sometimes hears around 458.125 MHz. Most likely, those are signals from highway call boxes. Call-box frequencies in that part of the spectrum include 458.025, 458.125, and 458.175 MHz.

UNTIL NEXT TIME

Keep us posted with your questions, comments, loggings, and photos. This column is as good as our readers make it, and we like to keep it the best. To do your part, please write to *Scanner Scene*, **Popular Electronics**, 500 Bi-County Blvd., Farmingdale, NY 11735. ■

Making Noise About Noise

BY JOSEPH J. CARR, K4IPV

Recently, reader George Wroe, of Wroe Electronic Repairs in Maryland, wrote to me asking how 60-Hz noise winds up interfering with reception in the AM-radio band. That topic first came to my attention in the 1960s when a fellow teenage ham operator referred to the "scritching" he heard on the 75-meter ham band. In those days, most 75-meter operation used amplitude modulation, so it didn't take much in the way of noise to cause QRM (FM is essentially noise-free on strong signals, and SSB has a lot less sensitivity to noise than straight AM). So what is "scritching" and where does it come from?

First, let's look at what it's not. If you have a poorly designed DC power supply, a defective power-supply ripple filter, or any of several other defects, then it's quite possible to get either 60-Hz or 120-Hz hum in the output of the receiver. "Scritching" and other noise problems in that category arrive via the antenna line because, by the time you see them, they are bona fide (if undesired) radio signals.

The term "scritching" is basically a verbal description of what the noise sounds like. Tune between stations on the AM broadcast band, and you will most likely hear the noise. Indeed, you will hear it unless your QTH is a lot quieter than most, at least as far as radio noise goes.

"SCRITCHING" SOURCES

There are several sources of noise borne on the AC power lines. Normally, we think of the AC voltage and current waveforms as 60-Hz sinewaves (or 50-Hz in many overseas locations), as in Fig. 1A. If all power-line AC waveforms were pure sinewaves, then there would be no problem. But that's not how things work in the real world.

Many times an hour you will see high-voltage transient spikes on the AC waveform; that situation is shown in Fig. 1B. Those spikes can be several kilovolts in amplitude, and last several microseconds. Some of them are generated by lightning strokes (not strikes) many miles away. Others are generated by machinery and load-switching equipment hooked to the lines.

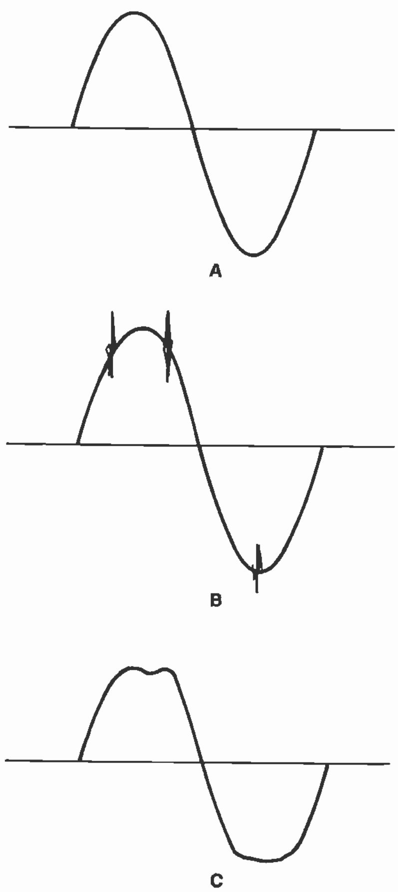


Fig. 1. A perfect sinewave is shown in A, one with high-voltage spikes in B, and a distorted sinewave in C.

In other cases, the normally sinusoidal AC waveform of Fig. 1A is somehow distorted as shown in Fig. 1C. All signals have what is known as a Fourier series, *i.e.* a fundamental sinewave of frequency *f*, and set of sine or cosine harmonics (2*f*, 3*f*, 4*f*. . .). If the waveform is a really pure sinewave, then only the fundamental is present (*f*), but for all other waveforms, including distorted sinewaves, there will be harmonics present—and those harmonics can go quite high in frequency. Which harmonics (odd, even, both) are present, and how high they go, is a function of the exact shape of the waveform.

Another phenomenon seen is the fact that no signal in the real world has zero bandwidth. All real signals consist of the center frequency f_C, which is the frequency we are referring to when we say the station is operating on a specific frequency (*e.g.* 1000 kHz). But there are also upper and lower sidebands, as seen in Fig. 2, even on an unmodulated CW signal. In the case of an AM-broadcast station, where the audio frequencies can go as high as 5 kHz, the sidebands extend out from the carrier ±5 kHz, so that a 1000-kHz signal will actually occupy the spectrum from 995 to 1005 kHz. The same thing is seen on 60-Hz signals induced from the AC power lines, but f_C is 60 Hz, and the noise sidebands are close to 60 Hz. The main frequency f_C and its sidebands form a little signal packet.

When the signal is translated into the higher frequencies as harmonics, the sidebands go with it and produce something like the highly stylized situation shown in Fig. 3. If you operate a receiver, it will have a passband that will take in some number of those harmonic signal-packets, and those are seen as valid signals by the receiver because they are well within the passband of the receiver!

The reason why the signals are heard in the MW and HF bands, even though the fundamental is far removed from those frequencies, is that the receiver is a very sensitive detector, and the harmonics are strong. Even if the harmonics are weak relative to the amplitude of the 60-Hz fundamental sinewave, the power levels (many dozens of kilowatts) flowing in your home and neighborhood will cause even relatively weak harmonics to have high enough amplitudes to cause interference to sensitive receivers.

Another thing seen with regard to "scritching" is that the signal level tends to be affected by turning on and off appliances that don't, in themselves, cause the noise. That effect is due to changing the impedance of the AC power lines as the load changes.

There's not much one can do about most "scritching" unless there is a defective part somewhere. Sometimes, a loose tie wire or connection on the power pole is the cause of the problem. At my home there was a terrible "scritching" level when we first moved in. I complained to the power company, and after some initial skepticism they came out and repaired something or another up above the pole pig transformer outside my house.

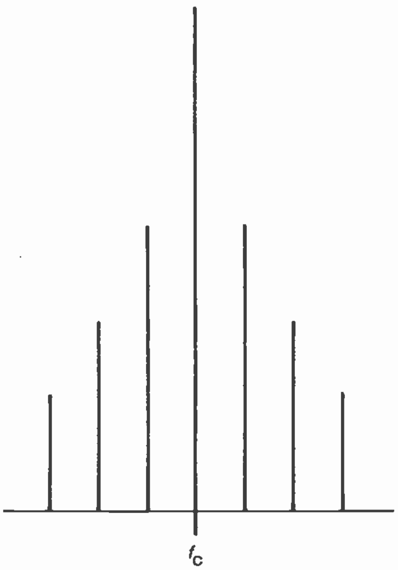


Fig. 2. Even a "pure" sinewave signal will have sidebands on either side of the center frequency (f_C), forming a small "signal packet."

Other types of problems sometimes seen are defective light switches, defective appliance switches, or defective thermostat contacts in electric heaters, fish tanks, etc. In some cases, the problem is loss of tension and dirt on the switch contacts. I cleared up one case of "scritching" a few years ago by replacing an ordinary light switch in my home. In some cases, an L-C filter designed for electromagnetic-interference (EMI) suppression will help those problems, especially in the case of a particular appliance causing the problem. However, **make sure to use only those EMI filters rated for use on AC power lines!**

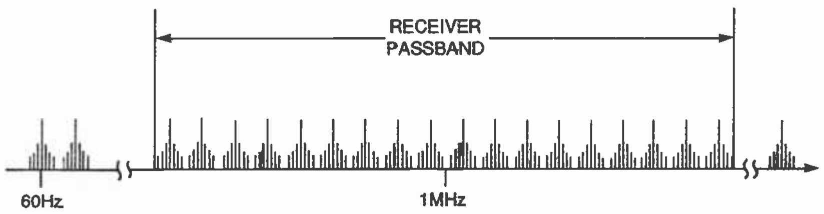


Fig. 3. When the signal is translated to a higher frequency, the sidebands that form the signal packet go with it. If the signal packet falls within the passband of the receiver, it will be treated as a valid signal

OTHER NOISE SOURCES

Figure 4 illustrates another problem sometimes seen—including in my own home. When we moved in, there were a lot of dimmer switches instead of regular light switches. Those cursed things came out the first month! They work by truncating the AC waveform. Let's look at that further: In Fig. 4A we see the regular AC sinewave, corresponding to "full on" or maximum brightness. Figures 4B and 4C show the waveforms associated with progressively dimmer settings of the switch. The problem is that those Triac/SCR-based dimmers distort the AC waveform, and thereby generate about a zillion harmonics (the sharper the waveform, the higher the harmonic content).

Still another problem is fluorescent lighting. If you doubt that, take an AM portable radio and move it close to a fluorescent lighting tube. The "hash" produced is a variant of "scritching." Sometimes it can be filtered with an EMI filter, but often not. Other sources of power-line-borne noise in your environment include electrostatic air cleaners, high-voltage power supplies, hair dryers, and a host of other things.

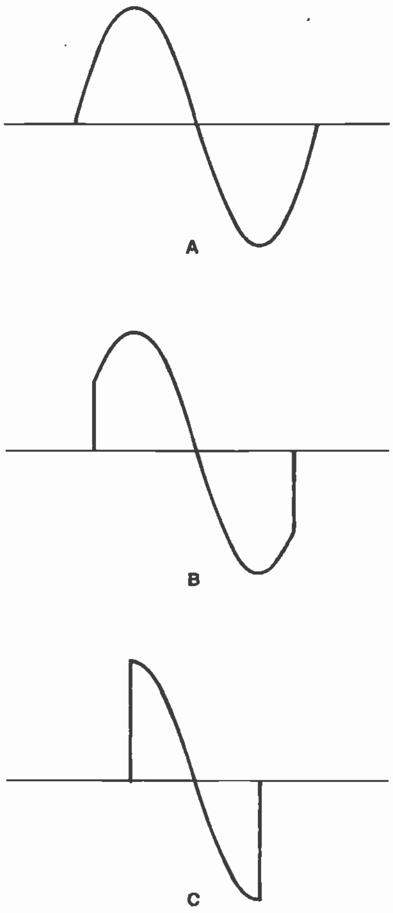


Fig. 4. SCR/Triac-based light dimmers are terrible noise producers as they do their job by taking a normal waveform (A) and truncating it (B and C).

SOME APOLOGIES

It has long been my personal policy to answer as much mail as I can. Although I'm not perfect, I at least try to answer all queries. For nearly a year, however, I was sick on and off, fell too far behind, and misplaced a few letters. I apologize if yours was one of the unanswered letters. If you've written a while ago and not heard back, please drop me another line. I can be reached by snail mail at P.O. Box 1099, Falls Church, VA, 22041, or by e-mail at CARRJJ @aol.com. ■

COMPUTER BITS

Sharing Win95

BY JEFF HOLTZMAN

My kids are Bill Gates' nightmare—and my headache. They have numerous DOS-mode games (*e.g.*, Commander Keen, FIFA Soccer 96, etc.) that can run under Win95, but just don't do so very well. Fine, you say, just run them in MS-DOS mode. Sure, that's, an option, but that way they run slower than maple syrup on a moonlit night in Michigan. And as little patience as I have booting and rebooting, 3-, 7-, and 10-year olds have even less.

In the years "BW" (before Win95), the kids' PC used to boot to a menu with several dozen choices of things to do, including various DOS-mode games, Windows, and the DOS command-line prompt. In keeping with the spirit of Win95, that menu was history. Spirit is one thing, however, and practicality another. Eventually it got to the point where the menu had to be resurrected. But before discussing that, we need to discuss the Win 95 boot process to see how to make the proper system resources available in Win95's pre-GUI command-line mode.

BOOTING Win95

It's fairly widely known that you can boot a Win95 machine straight to a DOS prompt, and subsequently type

LISTING 1

```
@echo off
REM ***** Part 1: Display choices
:START
cls
echo.
echo.
echo A.  Designasaurus        N.  Amy
echo B.  The Playroom         O.  ABC
echo C.  Reading and Me       P.  Alphabet
echo D.  Math and Me          Q.  Animals
echo E.  Raptor               R.  Clock Game
echo F.  FIFA Soccer 96       S.  Hangman
echo G.  Scorch               T.  Mosaic
echo H.  Duke Nukem           U.  Play and Learn
echo I.  Duke Nukem 2         V.  __________
echo J.  Pinball              W.  Windows
echo K.  Commander Keen       X.  Exit to DOS
echo L.  ________             Y.  __________
echo M.  ________             Z.  Fix Screen
echo.
echo.

REM ***** Part 2: Get user input
choice /c:abcdefghijklmnopqrstuvwxyz /n "Choose one: "

REM ***** Part 3: Command dispatch
if errorlevel 27 goto Start
if errorlevel 26 goto DoZ
if errorlevel 25 goto DoY
if errorlevel 24 goto DoX
if errorlevel 23 goto DoW
if errorlevel 22 goto DoV
if errorlevel 21 goto DoU
if errorlevel 20 goto DoT
if errorlevel 19 goto DoS
if errorlevel 18 goto DoR
if errorlevel 17 goto DoQ
if errorlevel 16 goto DoP
if errorlevel 15 goto DoO
if errorlevel 14 goto DoN
if errorlevel 13 goto DoM
if errorlevel 12 goto DoL
if errorlevel 11 goto DoK
if errorlevel 10 goto DoJ
if errorlevel  9 goto DoI
if errorlevel  8 goto DoH
if errorlevel  7 goto DoG
if errorlevel  6 goto DoF
if errorlevel  5 goto DoE
if errorlevel  4 goto DoD
if errorlevel  3 goto DoC
if errorlevel  2 goto DoB
if errorlevel  1 goto DoA

REM else error . . .
goto start

REM **Part 4:Command processing

:DoZ
mode co80
Goto Start

:DoY
Goto Start

:DoX
Goto Exit

:DoW
win
mode co80
Goto Start

:DoV
Goto Start

:DoU
C:
cd\kid\play
play
goto Start

:DoT

...

:EXIT
C:
cls
cd \
```

"win" to run Win95. To do so, get to a command line and go to the root directory of your C drive. Use the ATTRIB command to make the file MSDOS.SYS accessible, as follows:

```
C:\>attrib -r -h -s msdos.sys
```

Then open the file with a text editor. There is a section called Options; in it, you'll see a line that looks like this:

```
BootGUI=1
```

Change the '1' to a '0', which yields:

```
BootGUI=0
```

To prevent the Win95 logo from displaying, you might also want to add the following command:

```
Logo=0
```

Save the file, exit the DOS box, and restart Win95. It will come straight to a DOS prompt.

DRIVER PAINS

In the process of upgrading the kids' machine to Win95, one of my goals had been to eliminate all so-called real-mode drivers—the things we used to run in CONFIG.SYS and AUTOEXEC.BAT. Unfortunately, you won't have access to your CD-ROM or other devices that Win 95 (in GUI mode) normally provides. The solution is to add the old real-mode drivers back to CONFIG.SYS and AUTOEXEC.BAT. One step forward, one step back.

In practice, that meant removing the REM statements that preceded the statements in the boot files that loaded the drivers for the SCSI controller, CD-ROM driver, and MSCDEX.EXE. The downside of that approach is that the drivers remain in memory, even when running Win95 GUI mode (from the menu), even though Win95 substitutes its own drivers in GUI mode.

With all the old drivers back in place, the old DOS games now worked as they should. But what about running Windows? Doing so is easy, and works just like it used to. Just type "win" and press Enter.

The real trick is getting out of Windows and back to the command line. The Shut Down option of the Start Menu brings up a dialog box with four choices, none of which is what we want—or so it seems. The trick is to select "Shut Down The Computer." When the Win95 GUI boots automatically, selecting that option essentially leaves the computer disabled. But if you run Windows from the command line, the same bitmap appears, saying "It's OK to shut off the machine now."

What's not widely known is that, at that point, you're back in command-line mode again. It's just that the video hardware needs to be reset. Doing so is easy, just enter:

```
mode co80
```

Then the familiar C:> prompt returns.

Now we're ready to look at the kids' menu program; a simplified version of it appears in Listing 1, a batch file called KIDS.BAT, which incidentally is called at the end of AUTOEXEC.BAT.

THE MENU PROGRAM

The program consists of four parts: menu display, user input, command dispatch, and command processing.

1) The menu display simply clears the screen and displays the valid choices.

2) User input uses the CHOICE command available in DOS 6.0 and later to get a keystroke from the user. The "/c" parameter lists valid choices, in our case, any letter from a to z. The "/n" parameter says not to display the choices in the prompt. The prompt is the quoted string at the end of the line. After the user presses a key, CHOICE sets the DOS ErrorLevel according to its position in the list of valid choices. For example, if the user presses the key corresponding to the first choice in the list, ErrorLevel is set to 1. If the user presses the 26th key, ErrorLevel is set to 26. The choice is not normally case sensitive, although you can make it so with another command-line parameter ("/s").

3) The command dispatcher then checks for a valid selection, a number from 1 to 26, and then issues a GOTO to the proper procedure for executing that command. It checks in reverse order because the IF statement in DOS's batch language really checks for the greater-than-or-equal-to condition. That's why we check for 27 at the beginning of the command-dispatch routine. Anything greater than or equal to 27 is an error, so we just redisplay the menu and allow the user to make another choice.

4) There are 26 command-processing routines; we only show a few to give you a flavor of how they work. Typically what happens (as shown in choice U) is that we change drives, change directories, run the application, and then redisplay the menu. There are a few exceptions. For example, after running Windows (choice W), we issue the mode command that resets the screen. Choice Z allows the user to reset the screen manually. Choice X returns the user to the root directory of the C drive and terminates the batch file. All unused choices simply have a "goto start" statement. That makes it easy to add additional applications to the menu program later.

There you have it. It's not the most elegant solution, but it works. I'd rather not run real-mode drivers in my 32-bit operating system—but the kids are happy, and that's what counts. ■

Think Tank

Circuits Revisited

BY JOHN J. YACONO
TECHNICAL EDITOR
WINDOWS MAGAZINE

This month we'll look at letters dealing with requests and prior columns. As promised, I'll also continue our discussion on members of the capacitor family, this time looking at aluminum electrolytic units.

With its key characteristic, capacitance, based mainly on geometry, the capacitor has presented a challenge to circuit miniaturization. One significant advance reducing the size of large capacitors was the development of electrolytic capacitors. The most popular of those is the aluminum electrolytic, which has an anode that is coated with an extremely thin layer of aluminum oxide.

Aluminum oxide is a fantastic dielectric. The coating can be made very thin, thus reducing the theoretical size of the capacitor. And remember: As the distance between the plates decreases, the capacitance increases, so not only does the coating save space, it enhances capacitance by way of geometry. The great dielectric properties of the oxide combined with the thinness of the coating allow for larger values of capacitance than would otherwise be possible in the same space.

The cathode consists of a porous spacer saturated with an electrolytic solution. That structure sacrifices some of the thinness of the layer; however, the cathode offers other benefits. For example, because it will conform to the shape of the oxide film, etching the film's substrate increases the surface area of both plates. That boosts capacitance further.

There is a drawback to that configuration, however: The oxide layer breaks down if charged in the wrong direction, making aluminum electrolytics only suitable in DC applications as polarized capacitors. To get around that, the electrolytic can be sandwiched between two oxide-coated plates to form a non-polarized electrolytic capacitor.

As with the other capacitor types we've looked at, aluminum electrolytics have certain limitations. There's a limit to how much voltage they can take, topping off at 450 volts. Also, their tolerance is poor, ranging as high as 75%.

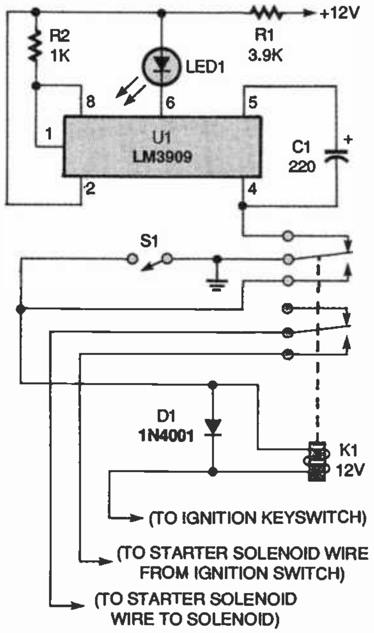


Fig. 1. Combining two functions in one, this circuit is both a passive cut-off device and a fake car alarm. Closing S1 with the key in the run position disables the flasher, and allows the car to start.

The good taken with the bad, aluminum units are ideal for power-supply filtering and other applications where you need to store high amounts of energy to be delivered quickly. Also, the non-polarized units can be put to good use as AC couplers in low-fidelity audio circuits to pass large signals. They can also be used as inaccurate, long-duration timing capacitors.

And now, on to the letters!

PARTS ARE PARTS

In the November 1995 installment of *Think Tank,* Fig. 1 contains a 74LC14 IC. After contacting several major electronic-parts distributors, I have been told that part is not available, nor is a cross reference known.

Please help.

—*Bernie Belkoski, Vicksburg, MI*

No problem. In this case, any 74xxx14 will work. The letters indicate the technology of the chip, and with just a few exceptions, 74xxx14-series chips with identical digits but of different technologies perform the same function. Because the circuit is battery powered, you'll probably want to go with a low-powered Schottky (74LS14) or advanced low-powered Schottky (74ALS14), but a 7414, 74S14, or other variants will work in this circuit.

STOPPED SHORT

Along comes a circuit that I can and want to use, and it's obviously wrong! Frustration. Can you help me? The circuit labeled Fig. 1 in the November 1995 issue has S1 in the wrong place. I can figure that one out and correct the schematic, but what about the diagram as it relates to the IC? Is that correct?

Would you be so kind as to send me a correct drawing of the circuit so that I can build it for my '95 Eagle Vision? Thanks for your help.

Oh, and by the way, your column is the best part of **Popular Electronics**, and something I read first with each issue.

—*Thomas A. Burns, Arcata, CA*

The high-voltage circuit in Fig. 1 of the November 1995 issue looks okay to me. Assuming you might be referring to the January 1996 issue, which featured automotive circuits, read the following two letters. If I'm wrong, send me a letter and we'll discuss it further.

FLASH IN THE PAN

In the January 1996 issue of **Popular Electronics,** page 62 contains a "Flasher Start System." The relay of that circuit will not latch. To get the circuit to work, the ground connection to the top set of relay contacts should be between the contacts and the switch (the correction is shown in Fig. 1 here). The lower set to the solenoid circuit is okay. As a suggestion, I would locate switch S1 in a concealed area, like under the dash.

Hope this can be of help.

—*Roger W. Hamel, Cedarville, MI*

Thank you very much for your help. In fact, there's another problem with the printed version of the circuit now that I look at it. In the original issue, LED1 is upside-down, too; that's also been corrected in Fig. 1. Mr. Herbert Bryon, the circuit's contributor, is not to blame though. The error crept in during the artwork's preparation for publication.

SEEING THE LIGHT

I believe I have found a mistake in your schematic and text in the Jan 1996 column. It is impossible for the circuit to work as illustrated in Fig. 4 of that column. The low beams would be connected to ground through K2's coil! I've enclosed a corrected circuit (shown here as Fig. 2).

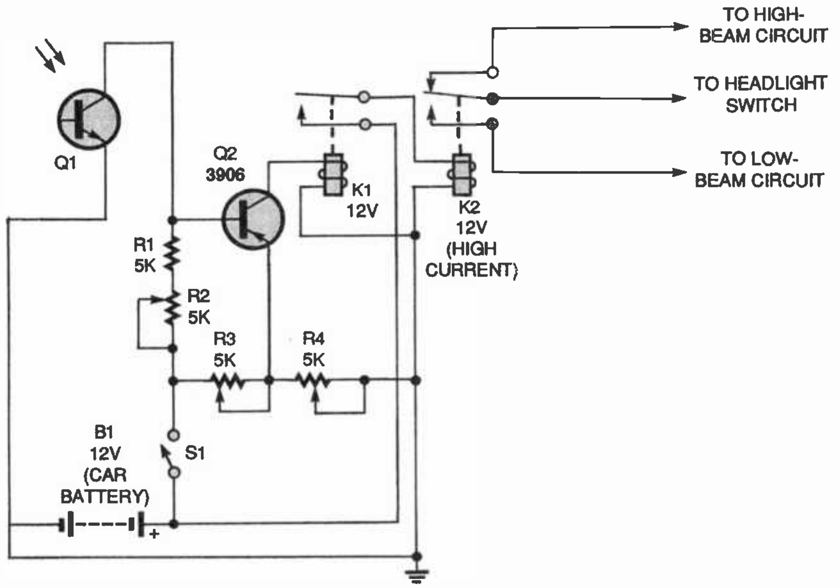


Fig. 2. Do you want maximum illumination from your headlights without disturbing on-coming drivers? This circuit will switch from your high beams to your low beams when cars approach.

—*Nate Morrison, Fargo, ND*

You're absolutely right. The circuit wouldn't work as originally shown. Thanks for your modification.

NUMBER SHIFT

I was hoping the error in Fig. 3 of the January 1994 issue was recog-

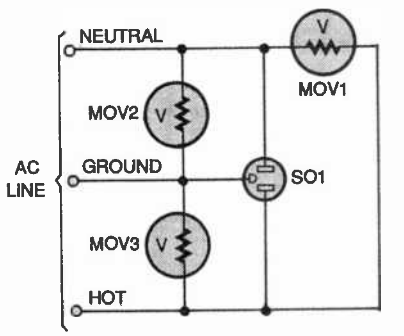


Fig. 3. This configuration of three MOVs provides excellent protection against power surges.

nized and shared in a subsequent issue, but I've searched to no avail. The schematic shows two pin-12 designations for the 556 timer. Which one is correct, and what's the number of the other pin that's wrong? Thank you very much.

—*John M. Rico, Canoga Park, CA*

The pin in error is the one connected to pin 3. That "pin 12" should be labeled pin 13.

SURGING AHEAD

On page 76 of the November 1995 issue you printed the suggestion by William B. Hopf, Jr. that a single MOV be connected across the power leads to protect a computer or other electronic equipment against line spikes. Unfortunately, damaging spikes might occur not only between the hot and neutral leads, but also between those and ground. Hence superior protection is afforded by three MOVs.

In my circuit (shown here in Fig. 3), I tucked three MOVs into the junction box to protect an old XT clone. But I purchased an Isotel to protect a 486. I consider the latter, despite its price, a good investment.

—*Dr. David F. Siemens, Jr., Mesa, AZ*

The three-MOV circuit is definitely better than the two-MOV design. If MOV1 or MOV3 fails completely, permanently shorting to ground, they will trip a house circuit breaker or fuse, indicating the problem. However, if MOV2 shorts, it will compromise the house's grounding system. I would add a fast-acting fuse (like a Pico II) in series with MOV2 component to prevent that problem.

THE LED BLUES

My name is Jeff Stewart and I need advice on astable multivibrator timer chips. Back in 1975 when I was in high school they came out with the LM3909 LED oscillator chip. I immediately etched a small printed-circuit board for the LED, capacitor, and chip for a school project and put the circuit in a small plastic box with an alkaline D battery. After building a couple of those blinkers, I wanted to build something more advanced. When the blue LED came out a couple of years ago I tried to use the LM3909 to flash a blue LED, but I could not get the four volts it required to start it. So I used an LM555 circuit and a 6-volt power supply to run the blue LED, but I found out that the LM555 has an inverted output; it is normally on when it should have a normally off output.

To fix the inverted output, I put a PNP transistor with its base junction between Vcc and the 555 output and the collector from LED and ground. That worked better but it still was complicated and drained the battery too fast because it had a lot of idle current and too long a duty cycle. What kind of timer chip can do that job better.

Thank you.

—*Jeff Stewart, Shelbyville, IN*

You could try a TLC555. Also, you could use a FET in place of the bipolar transistor. I don't know what kind of circuit you're using, but if it suits your purpose, the TLC555 can source current to the LED, allowing you to dispense *with the transistor entirely. Another alternative is to go back to your LM3909 circuit but place a transistor between the LED and the chip output to draw sufficient current through the LED.*

AC POWER CONTROLLER FOR VCR

I am desperately trying to locate a circuit that I believe was in *Think Tank* about two years ago. At that time I viewed the schematic and read the article, but thought that I would never have the need to use it. The circuit had a Triac that provided 120 volts to the TV whenever audio and/or video was present at the audio or video output jacks on the VCR. That ensured that the TV would get AC power whenever the VCR was turned on and turn off the TV shortly after the VCR was turned off.

I recently purchased a VCR that has a TV tuner built-in. I quickly discovered that my new VCR could easily replace the cable box, which I was renting from my local cable company. It works well, but does have one very annoying problem. The VCR does not have an AC Power Jack in the rear that is needed to turn on my TV whenever the VCR is turned on. That might sound unimportant, but it gets frustrating turning the VCR on by remote control, and still having to manually turn the TV on and off.

Please reprint your previous article along with my letter so that it might help electronics enthusiasts everywhere to be creative and save a lot of money in the process.

—Gary W. Stanford, Merced, CA

Sorry, I performed a search of Think Tank letters going back to 1991 for a video circuit including a Triac to no avail. However, I did find a video-signal detector that activates a relay (see Fig. 4). It first appeared in the December 1994 Think Tank. *Negative video is clamped to ground by D1, while frame markers charge C1, eventually clamping K1 via Q3. As long as you are using the RF output of the VCR for the TV—because the TV doesn't have a remote, it probably doesn't have a direct video input either—that should work.*

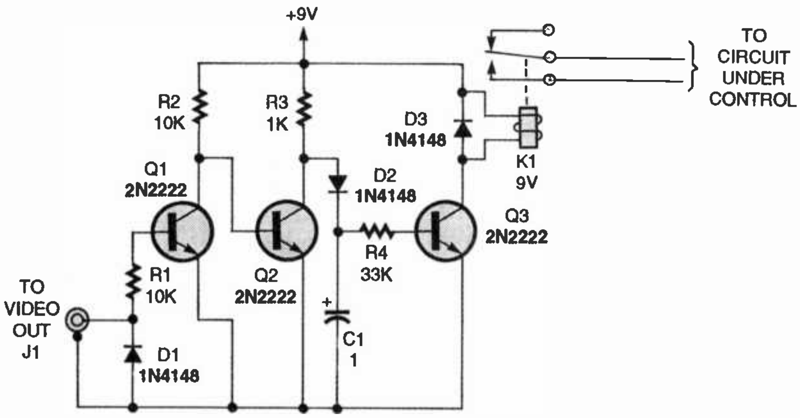


Fig. 4. This circuit activates relay K1 when a video signal is detected, making it desirable to those with remote-controlled VCRs but manual TVs.

OOPS!

Am I number 10,000 to say that you must have meant "dielectric" and not "electrolytic" in your tutorial on capacitors on page 76 of the November 1995 issue? Of course, there are electrolytic capacitors too, but they work differently than the dry types you were discussing in your column.

Best wishes.

—Keith Kunde, Independence, OH

Actually, besides me, you're the only one that caught it. You got me before I had a chance to mention it in print myself. Thanks for bringing it up. Sorry for the error, folks.

That's all for now. Until next time, write to *Think Tank*, **Popular Electronics**, 500 Bi-County Blvd., Farmingdale, NY 11735. ■

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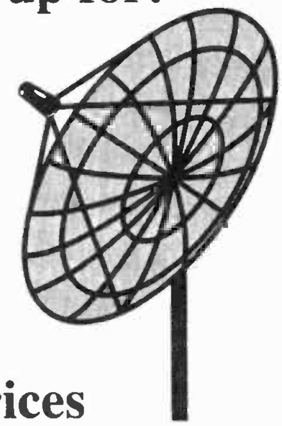

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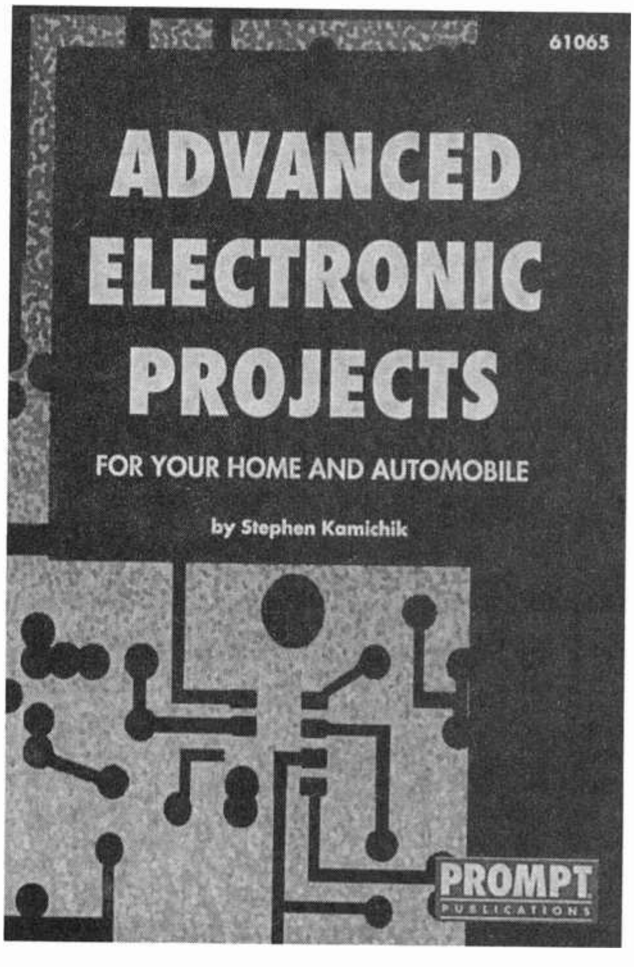
ELECTRONICS LIBRARY

Advanced Electronic Projects for your Home and Automobile

by Stephen Kamichick

Aimed at experienced hobbyists as well as electronic technicians and engineers, this book contains a wealth of useful, feature-laden projects. Each one includes a detailed description of the circuit, and many include printed-circuit-board patterns. All parts are readily available, and all the projects have been thoroughly tested by the author. Building the projects provides valuable experience in the field of advanced electronics, and yields practical devices for use in the home and car.

The book is divided into four sections. The first covers active filters, and includes advice on active-filter design as well as a PLL notch filter, a signal-processing system, and a wide-band notch filter that you can build. Part Two describes a complete home surround-sound system, including a stereo preamplifier, a surround-sound decoder, a stereo power amplifier, and speakers. A discussion of sound and acoustics is also presented. The third section features bipolar power supplies, an infrared remote control, a DC-motor-speed control, an electronic scorekeeper, and a brain-wave monitor. Part Four contains automotive projects, such as an anti-theft system, a back-up battery, a digital voltmeter, and a power inverter that converts the car's battery voltage to household current.



Advanced Electronic Projects for your Home and Automobile costs $18.95 and is published by Prompt Publications, 2647 Waterfront Parkway, East Drive, Indianapolis, IN 46214-2012; Tel. 800-428-7267 or 317-298-5710; Fax: 317-298-5604.

CIRCLE 95 ON FREE INFORMATION CARD

CONVERTER SHORT FORM CATALOG

from Conversion Devices, Inc.

This 12-page catalog provides complete information on Conversion Devices' complete line of 1-watt to 300-watt DC/DC converters. Quick selection guides make it easy to find the right standard product for your application. The catalog provides specifications on more than 700 "off-the-shelf" models, more than 15 new product families, ultra-wide input DC/DC converters, and distributed power DC/DC converters (up to 54 W/IN^3).

The Converter Short Form Catalog is free upon request from Conversion Devices, Inc., 15 Jonathan Drive, Brockton, MA 02401; Tel. 508-559-0880; Fax: 508-559-9288.

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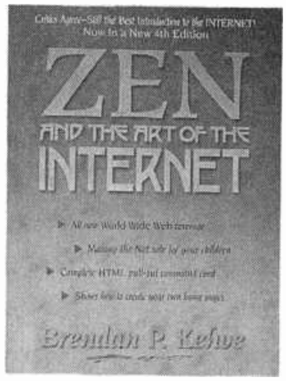
ZEN AND THE ART OF THE INTERNET: 4TH Edition

by Brendan P. Kehoe

This classic beginner's guide to the Internet has been completely updated to reflect the dramatic changes that have been taking place recently. It includes new coverage of the World-Wide Web and the HTML language used by Web documents. The book provides fully updated coverage on just about everything a newcomer needs to know about, such as e-mail, "netiquette," downloading files, Usenet, and commercial services on the Internet. The fourth edition also contains information on keeping children safe on the Internet.



The book takes a friendly, non-technical approach. It shows you the lay of the land of the Internet "neighborhood"—the backroads, the personalities, the hangouts, the history, and the social mores—to help you feel comfortable in Cyberspace.

Zen and the Art of the Internet costs $23.95 and is published by Prentice Hall, 1 Lake Street, Upper Saddle River, NJ 07458; Tel. 800-383-2419; Fax: 201-236-7141; e-mail: corpsales @prenhall.com. ■

CIRCLE 97 ON FREE INFORMATION CARD

MICRO-CAR
(Continued from page 60)

and core. The motor's windings use a thousand turns of 18-micron-thick copper wire. The motor operates on 3-volt, 20-mA AC at a speed of 600 rpm. Power is transferred to the car via wires in the roof. In the future, power could be supplied via a microwave setup and the researchers are also thinking about adding air-conditioning!

Installing the working motor required a new thin-wall body. First the body was made of aluminum alloy, which was plated with nickel. Then, the aluminum was removed using an advanced melting process leaving a 30-micron-thin nickel-body shell. Gold plating was added for decoration.

Nippondenso's feat of engineering was acknowledged by an entry in the 1995 issue of the *Guinness Book of Records*. The project also was awarded one of its "World Record Certificates" for the world's smallest motor car. ■

TOROIDAL TRANSFORMERS
(Continued from page 56)

turn, causing excess heat and damage to the transformer.

Summary. The ideal transformer, which introduces no additional losses or voltage drops in the circuit, was characterized by MIT in 1943 as follows: It would have no losses due to winding resistance and perfect coupling so there is no leakage flux. The core would have infinite permeability so there would be no saturation. It would also have infinite resistivity and therefore no hysteresis or eddy-current loss. The core B-H curve would be a vertical line through zero so it would not take any mmf to produce the flux. Finally, there would be no winding capacitance.

While far from that ideal, the toroidal transformer does a better job of reducing those losses to their minimum practical values than any other production core form. Why not try to use one in your next project? ■

PC POLLER
(Continued from page 44)

Therefore, we can address the proper array element by changing line 34 to read

34 k(((i − 1) × 81) + ((j − 1) × 9) + k) = 1

From that formula we can readily see that as many as 81 individual switches can be scanned with just a single control board.

The remainder of the software modifications are up to you and depend on your individual application. You have to decide how you would like to store and/or display the results of the k array.

To use the security application, you will also have to make a simple hardware modification. Instead of installing a rotary switch on the keypad board, connect individual wires to the board's numbered pads and one terminal of the remote switches. The switches' other terminals should all be wired together and connected to the pad on the board that is connected to diode D1. ■

BALL LEVITATOR
(Continued from page 52)

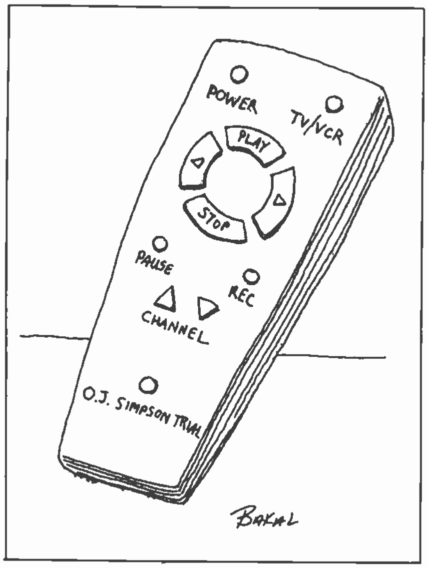
globe and find a good distance until the globe "levitates." Adjust the distance of the gap with potentiometer R6 and note how the floating globe moves up and down.

You might notice the globe is bouncing insanely. Adjust potentiometer R2 to correct such an instability.

If you use the Levitator in a bright room, the sensor might become overloaded. That will result in the Levitator occasionally dropping the globe. To correct that problem, simply dim some of the room lights.

Once you have the unit working, you might feel the suspended globe vibrating very rapidly and almost buzzing. That is actually a 60-Hz power hum caused by the room lights. The intensity of an incandescent light is not constant and carries a 60-Hz component, which the sensor picks up. Such a vibration should not affect stability, but can be annoying. To totally eliminate the problem, operate the Levitator in a room with only natural light.

That should just about do it. Go ahead and experiment with the unit, maybe trying different-sized metal globes. And don't forget to show the Levitator off to your friends, they will be impressed and think that you are a genius. If you have any problems getting your system to be stable, or any other problems at all, feel free to contact the author via e-mail at 75104.3104@compuserve.com. ■



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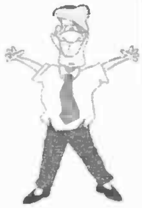

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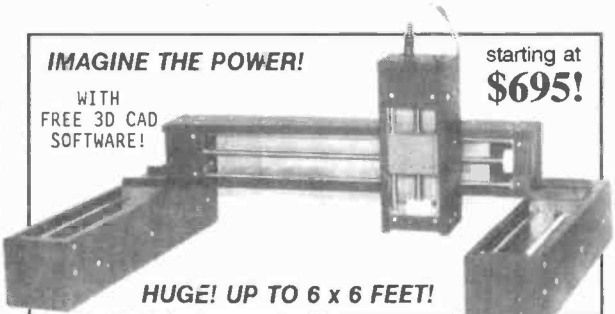

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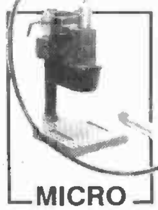

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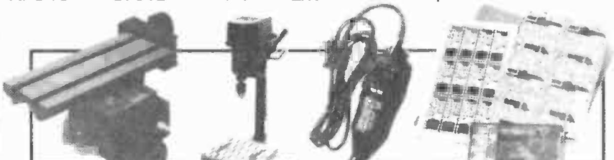

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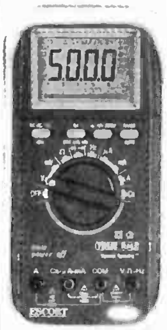

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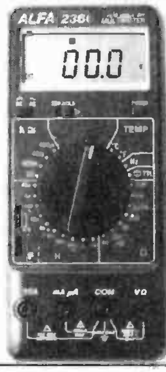

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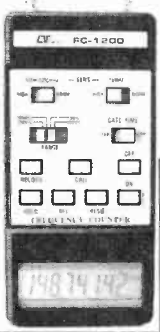

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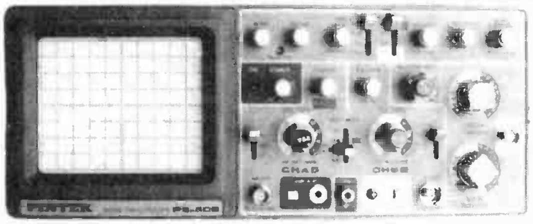

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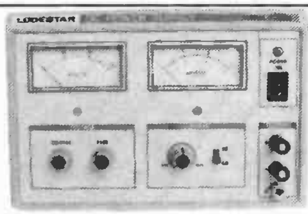

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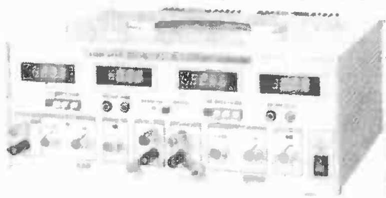

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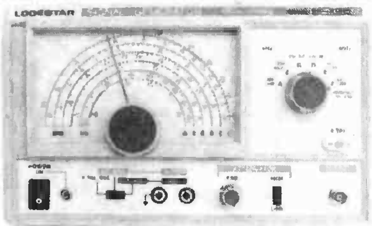

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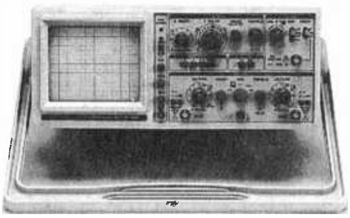

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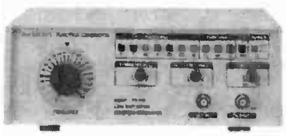

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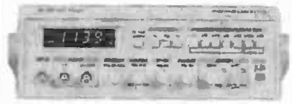

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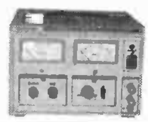

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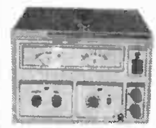

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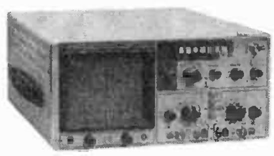

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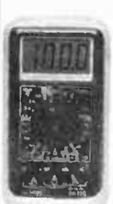

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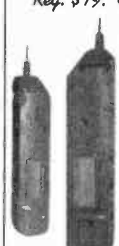

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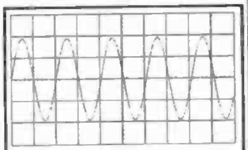

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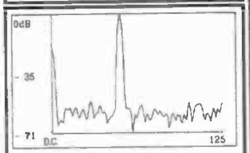

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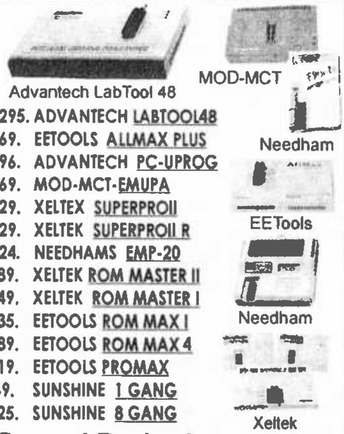

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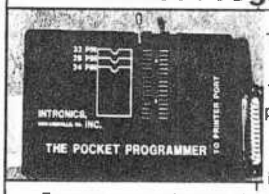

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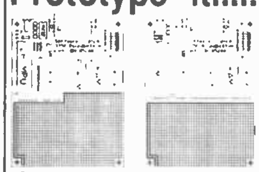

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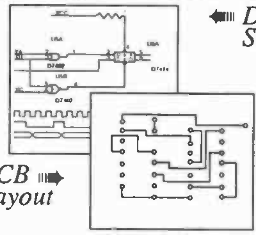

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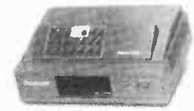

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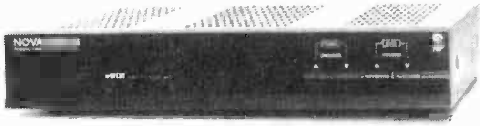

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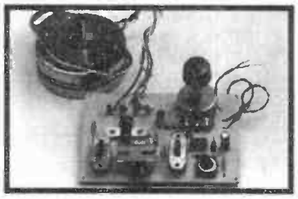

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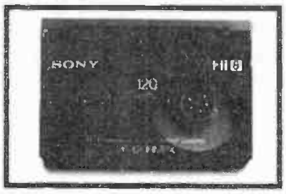

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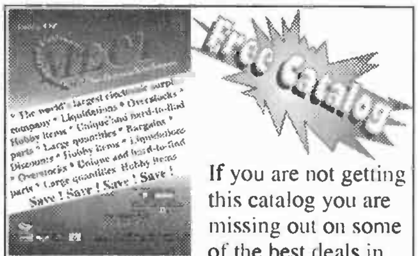

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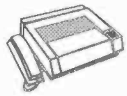

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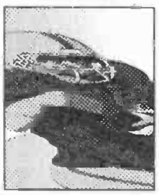

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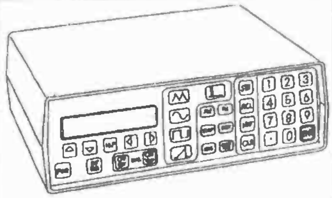

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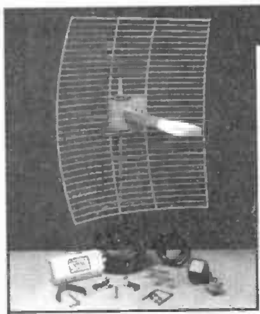

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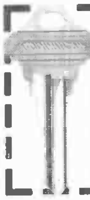

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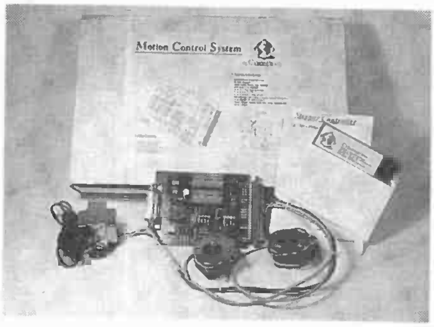

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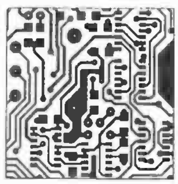

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HEATH COMPANY is selling photocopies of most Heathkit manuals. Only authorized source for copyright manuals. Phone: (616) 925-5899, 8-4 ET.

GREEN Thumb alert — 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. "Electronic Projects for the Garden" only $9.95 (price includes shipping **ELECTRONIC TECHNOLOGY TODAY, Inc.**, PO Box 240, Massapequa Park, NY 11762-0240.

SILENT SAM Turn Signal Reminder. This patented reminder keeps you from going down the road flashing, inadvertently. Just $30.00 postpaid. Visa/MC, 30 day money back guarantee. Great gift for that forgetful someone. Literature available. Toll Free **1 (800) 398-5605.**

SMALL stun guns, telephone listeners. Plans: $3.00 each, $5.00 both. **SAM WEINER,** Department #570, Box 762, Whitehall, PA 18052.

170+ forbidden manuals. Jam radar, telephone taps, electronic sabatoge. Free catalog. **INFO 9,** 680 Grapevine Hwy., Hurst, TX 76054.

MISCELLANEOUS ELECTRONICS FOR SALE

THE Case Against Patents. Thoroughly tested and proven alternatives that work in the real world. $28.50. **SYNERGETICS PRESS,** Box 809-C, Thatcher, AZ 85552. (520) 428-4073. Visa/MC.

57 Electronic Journals. How to get free subscriptions. $5.00. **CABLETRONICS,** Box 30502PE, Bethesda, MD 20824.

BUILD Electronic Surveillance Devices! Secrets revealed! Download phone bug plan from BBS! Free information! **TECHNOTES,** Box 388-PE, Tehachapi, CA 93581-0388. BBS/Fax (805) 823-1549.

F&M Electronics — inwall speakers, intercoms, central vac systems. For the do it yourselfer. Free catalog **1 (800) 699-1484.**

POOR reception on your A.M. radio? Our signal booster will help. Guaranteed! Send $2.00 for details (refundable with order). **FALA ELECTRONICS,** PO Box 1376, Dept. 4, Milwaukee, WI 53201.

BASIC - programmable computer in a 24-pin DIP. BS2IC has 16 general purpose I/O pins for digital and analog uses. Programmed in BASIC using DOS software. Complete programming package-$119.00. BS2IC-$49.00. $5.00 S/H. **BCO ENTERPRISES,** Box 454, Sea Girt, NJ 08750.

Use POPULAR ELECTRONICS Classifieds

READ BY BUYERS OF ELECTRONIC EQUIPMENT ACCESSORIES AND PARTS

INSTRUCTIONS FOR PLACING YOUR AD!

HOW TO WRITE YOUR AD

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.**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

CATEGORIES

- 100 -- Antique Electronics
- 130 -- Audio-Video Lasers
- 160 -- Business Opportunities
- 190 -- Cable TV
- 210 -- CB-Scanners
- 240 -- Components
- 270 -- Computer Equipment Wanted
- 300 -- Computer Hardware
- 330 -- Computer Software
- 360 -- Education
- 390 -- FAX
- 420 -- Ham Gear For Sale
- 450 -- Ham Gear Wanted
- 480 -- Miscellaneous Electronics For Sale
- 510 -- Miscellaneous Electronics Wanted
- 540 -- Music & Accessories
- 570 -- Plans-Kits-Schematics
- 600 -- Publications
- 630 -- Repairs-Services
- 660 -- Satellite Equipment
- 690 -- Security
- 710 -- Telephone
- 720 -- Test Equipment
- 730 -- Wanted

CLASSIFIED AD COPY ORDER FORM

Place this ad in Category #________   **Special Category $20.00 Additional ______________________**

1 - $26.25	2 - $26.25	3 - $26.25	4 - $26.25	29 - $50.75	30 - $52.50	31 - $ 54.25	32 - $56.00
5 - $26.25	6 - $26.25	7 - $26.25	8 - $26.25	33 - $57.75	34 - $59.50	35 - $61.25	36 - $63.00
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				
17 - $29.75	18 - $31.50	19 - $ 33.25	20 - $35.00				
21 - $36.75	22 - $38.50	23 - $40.25	24 - $42.00				
25 - $ 43.75	26 - $45.50	27 - $47.25	28 - $49.00				

Total words ________ $1.75 per word = $______

Bold Face ________ $0.40 per word = $______

Special Heading ________ $20.00 = $______

Other________ = $______

TOTAL COST OF AD $ ______

Total classified ad payment $________ enclosed

[ ] Check [ ] Mastercard [ ] Visa

Card # _ _ _ _ _ _ _ _ _ _ _ _ _ _ _ _ Expiration Date _ _/_ _

Signature________________________________

Name ________________________________ Phone ________________________________

Address________________________________ City State Zip ________________________________

ADVERTISING INDEX

POPULAR ELECTRONICS magazine does not assume any responsibility for errors that may appear in the index below.

ADVERTISING SALES OFFICE

Gernsback Publications, Inc.
500 Bi-County Blvd.
Farmingdale, NY 11735-3931
1-(516) 293-3000
Fax 1-(516) 293-3115

Larry Steckler, EHF/CET
President (ext. 201)

Christina Estrada
Assistant to the President (ext. 209)

For Advertising ONLY
1-516-293-3000
Fax 1-516-293-3115

Larry Steckler
publisher

Arline Fishman
advertising director (ext. 206)

Michele Torrillo
advertising assistant (ext. 211)

Adria Coren
credit manager (ext. 208)

Subscription/
Customer Service/
Order Entry
1-800-827-0383
7:30 AM - 8:30 PM EST

ADVERTISING SALES OFFICES

EAST/SOUTHEAST

Stanley Levitan
Eastern Sales
1 Overlook Ave.
Great Neck, NY 11021-3750
1-516-487-9357, 1-516-293-3000
Fax 1-516-487-8402

MIDWEST/Texas/Arkansas/ Oklahoma, Colorado, Arizona

Ralph Bergen
Midwest Sales
One Northfield Plaza, Suite 300
Northfield, IL 60093-1214
1-847-559-0555
Fax 1-847-559-0562

PACIFIC COAST/Mountain States

Anita Bartman
Hutch Looney & Assoc., Inc.
6310 San Vicente Blvd.
Suite 360
Los Angeles, CA 90048-5426
1-213-931-3444 (ext. 227)
Fax 1-213-931-7309

TECHNOLOGY UPDATE

Fifteen years of microelectronic 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!

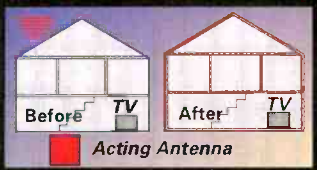
by David Evans

Technology corner

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

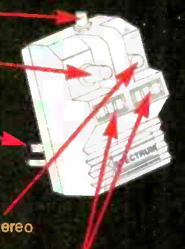
- When TV signals are tuned at the TV channel's center frequency, optimum tuning has been achieved.
- Other antennas can't offer center frequency tuning like the Spectrum Antenna can. They only offer such tuning up to the edge of the center frequency. As a result your TV picture remains snowy.

2. 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.

3. Spectrum antenna features



Parallel 75 ohm resistance
For minimum loss of signal

Signal search control
For selecting multiple antenna configurations

Polarized three-prong plug for grounding
For optimum signal grounding to eliminate noise and static

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

Dual AC outlets with built-in surge protection
For plugging in additional TV/stereo equipment guarding against damage and electrical surges

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 suddenly display a sharp, focused picture thanks to its advanced design "Signal Search" and "Fine Tuner" controls.

Who can use Spectrum?

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

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 twelve of the best antenna configurations.

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.

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.

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

Spectrum Antenna™ ....$39 $4 S&H

Additional antennas just........$34 S&H free

Please mention promotional code 1491-PL-6653.

For fastest service, call toll-free 24 hours day

800-992-2966

COMTRAD INDUSTRIES
2820 Waterford Lake Drive, Suite 106
Midlothian, Virginia 23113

You Won't Miss a Thing With SCOUT™

*Scanner not included

Reaction Tune

The SCOUT™ Has Taken Tuning Your Receiver To a New Dimension

Featuring Automatic Tuning of your AR8000 and AR2700 with the Optoelectronics Exclusive, Reaction Tune (Pat.Pend). Any frequency captured by the Scout will instantly tune the receiver. Imagine the possibilities! End the frustration of seeing two-way communications without being able to pick up the frequency on your portable scanner. Attach the Scout and AR8000/2700 to your belt and capture up to 400 frequencies and 255 hits per frequency. Or mount the Scout and AR8000/2700 in your car and cruise your way into the future of scanning. A simple interface cable will connect you to a whole new dimension of scanning.

The Scout's unique Memory Tune (Pat.Pend.) feature allows you to capture frequencies, log into memory and tune your AR8000/2700 at a later time. A distinctive double beep will inform you when the Scout has captured a new frequency, while a single beep indicates a frequency that has already been recorded. For discreet monitoring, a pager style vibrator will inform you of any hits the Scout captures.

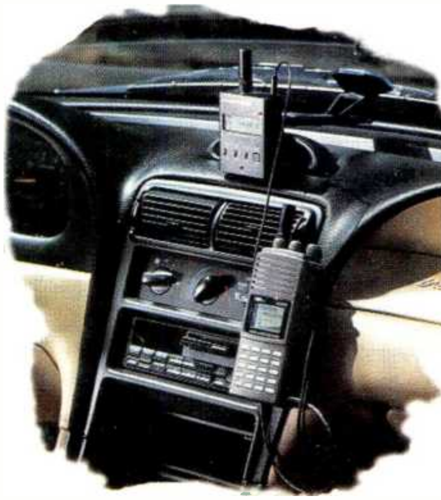
The Scout will also Reaction Tune and Memory Tune Icom CI-V receivers: (R7000, R7100, and R9000) and (Pro 2005/6 equipped with OS456, Pro 2035 equipped with OS535). Download the Scout frequencies to a PC with the Scout Utility Disk and CX-12AR (optional), then compare them to the Spectum CD-ROM/PerCon FCC Database (optional).

Act Now!! Let the Scout Reaction Tune you into The World of Scanning

SCOUT™ $449

Features

- Automatically tunes these receivers with Reaction Tune (Pat Pend.) CI-V receivers (ICOM's R7000, R7100, and R9000). (Pro 2005/2006 equipped with OS456, Pro 2035 equipped with OS535) or AOR models (AR2700 and AR8000).
- Records and saves 400 unique frequencies
- Records 255 hits on each frequency in memory
- Digital Filter and AutoCapture (Pat Pend.)
- 10MHz-1 4GHz single frequency range
- View frequencies in RECALL mode
- 10 digit LCD with EL Backlight
- 16 Segment RF signal strength bargraph
- CX-12AR Computer Interface (optional)
- PC Utility Disk for downloading memory to PC
- Rapid charge NiCads with 10 hour discharge time
- Scout Spectrum CD-ROM/PerCon FCC database (optional)
- AC Adaptor/Charger
- DB 32 VHF/UHF mini-antenna shown with Scout (optional)
- Distinctive Beeper/Vibrator indicate frequency hits



At right: Scout shown with CLIPMATE™. A handy windshield mount for Scout, for quick access and visibility.

CLIPMATE™ $25.00

OPTOELECTRONICS®

ORDER LINE 800•327•5912
Tel:305/ 771-2050
Fax:305/ 771-2052

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Contact Factory for shipping prices. Visa, Master Card, & C.O.D.(cash or money order only)
All prices and specifications are subject to change without notice or obligation

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CIRCLE 43 ON FREE INFORMATION CARD