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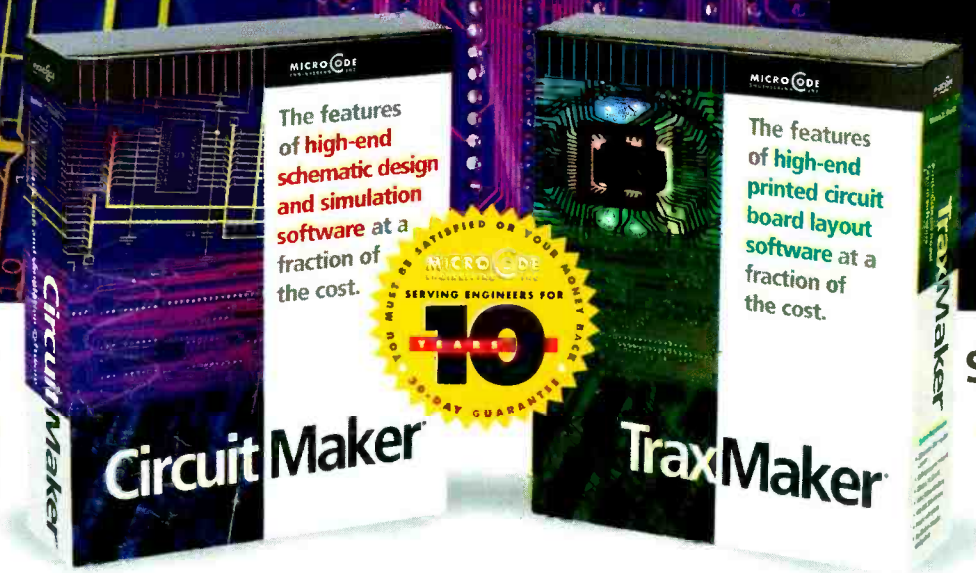

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August 1999, Vol. 16, No. 8

Popular Electronics®

THE MAGAZINE FOR THE ELECTRONICS ACTIVIST!

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Editorial

The Fixed Deadline

There's no escaping it ... January 1 will come. And like any day talked about frequently, it will arrive in a manner that makes us think of how abstract time is. You'll hear many expressing, in one form or another, how hard it is to believe that the year 2000 is finally upon us.

Of course, you might also hear many people complaining about the damage this date has caused them. Will their bank accounts disappear? Will their computers show blank screens on bootup? These and even more horrible thoughts, like planes falling out of skies, for instance, have been circulating. What's the truth behind the terror?

We'd like to help you sort it out with two stories created for this special survival-guide issue.

In "Solving Your Y2K Problem," our *Computer Bits* columnist explores what you can do to protect your precious computer equipment from harm this New Year's Day. Even if the world doesn't erupt into chaos, there's no sense in losing months of stored data or, in a worst-case scenario, your system itself. Find out the simple steps you can take and products that could help, beginning on page 29.

Then, check out "Will the Clocks Stop?" for a sane look at what the experts think will really happen on January 1. Our *Peak Computing* columnist has done extensive legwork on the subject and has returned with some eye-opening facts and educated guesses about how society as a whole will be affected. Turn to page 36 for the story.

Then, after you've gotten your fill of Y2K information, you might want to turn to our new *Amazing Science* column. Capturing the excitement of amateur science from the days of pulp magazines and combining it with the very latest in electronics and technology, the column is your ticket to a world of experimentation you might never have thought possible. It's sci-fi made sci-fact, and in coming months will bring you instructions for making inexpensive holograms and other projects that bring the essence of the 21st Century to your life today. Our first installment explores a groundbreaking LED plant-growth experiment, which could make horticulture in space practical. *Amazing Science* begins on page 70.

We like to think **Popular Electronics** magazine has really evolved these past few months, and we'll keep focusing on meeting the needs of the hands-on hobbyist. As always, if there's anything you'd like to see, feel free to drop us a line. We're listening.

Konstantinos Karagiannis
Editor

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NET WATCH

KONSTANTINOS KARAGIANNIS

Online Investing

Everybody's doing it—your neighbors, your parents, even those characters eyeing you over the tops of newspapers. With the Dow consistently closing at the above-ten-thousand mark, trading in the stock market is hotter than ever.

Okay, maybe not everybody's doing it. Your columnist, for example, hasn't played the stock game for about eight years. While my last experience was profitable, it felt like far too much of my money was going to the phantom voice over the phone: my stockbroker. I can't claim that this seemingly high commission/fee is the reason I stayed out of the market for so long, but it's part of it.

Now it looks like I just might have a motivation to get back in.

The Internet keeps on revolutionizing the way people do things, and Wall Street hasn't been left untouched. Online investing is becoming enormously popular, with good reason. Some Net brokers let you make trades for about the price of lunch, and with a little savvy you can enjoy control of the board just like the big boys do. Of course, the Internet will only put you on the trading floor virtually, but you'll still have access to all the quotes and changing data that keep brokerage houses furiously active.

Before we get to a couple of these online trading floors, I have to stress something. I am in no way a stock-market guru. The reviews of the following two sites are only intended to introduce you to a new way of investing. I'll be providing no trading tips—please only take those from individuals who have made a killing in the market, and even then, carefully weigh such advice.

Remember, in the stock game you're playing with real money ... your money.

With DLJdirect's downloadable Windows application, you can keep track of the market without even firing up your Web browser.

DLJDIRECT

If you want great support in your investment strategies, but don't want to pay more for it, consider DLJ*direct*. Whether you trade online or over the phone, you'll pay the same $20 commission for up to 1000 shares traded (its 2 cents a share above that amount). Nice to think that you could make a few thousand dollars on a trade and not even notice your "broker's cut."

While DLJ*direct* has only been in business for about a year at the time of this writing, it is the online aspect of a prestigious company—Donaldson, Lufkin & Jenrette—which handles about ten percent of the daily volume on the NYSE (New York Stock Exchange). No fly-by-night-related fears here.

When you first log on to this or any other online broker site, you have to realize that you have very limited browsing options until you set up an account. After all, you can't trade in stocks without the latter. Still, those "just looking" at the DLJ*direct* site can check out the Market Monitor and get an at-a-glance summary (chart) of how the DJIA (Dow Jones Industrial Average), NYSE Composite, NASDAQ

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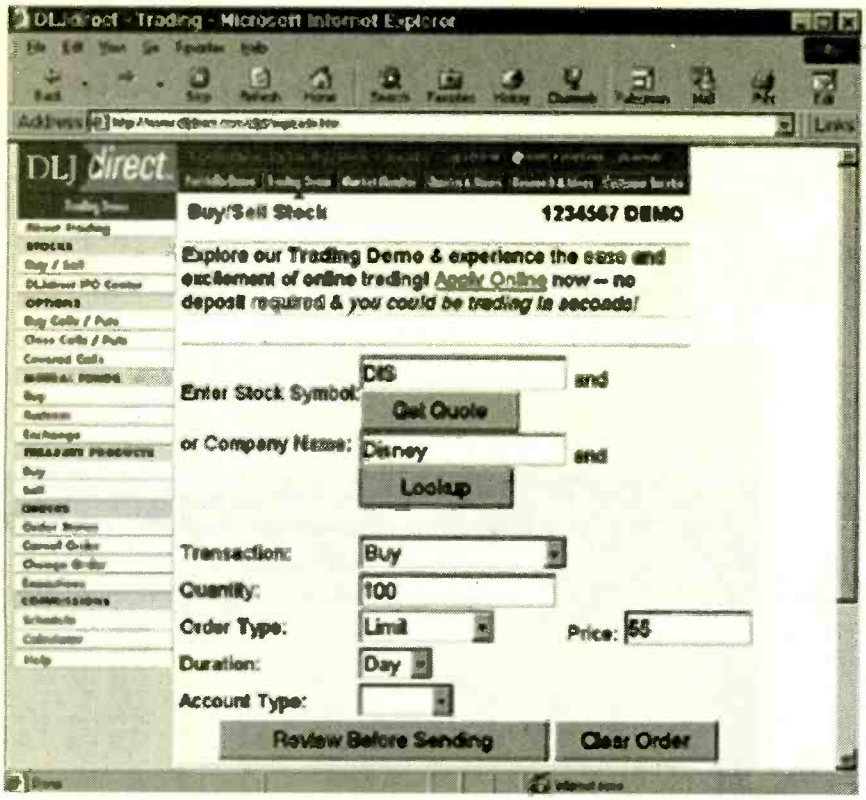

For a taste of how easy it is to trade stocks online, check out DLJdirect's Trading Demo.

Composite, and S&P 500 and 100 are going (with 15-minute updates). The Monitor also shows you the current market indices, top ten most active stocks (with their full activity statistics and prices), and a nice amount of Reuters business news headlines. You can also access Stocks in the News, Commentary/Insight, Ecohomic Indicators, and many more informed text discussions.

Without a doubt the way to really make use of all this information is to apply online for a free account. Approval is fast, and in no time you can be making your first trades (payment for these must usually be made within three days).

Members who want to make their trading easier can download the *DLJdirect for Windows* application. With this program you get the ability to manage your portfolio, keep track of research, and monitor those stock quotes that are of interest to you. Data can even be used as a screensaver, for those who can't be away from their portfolios for a moment. A built-in stock ticker can be activated, too—it forms a scrolling, Wall Street-style readout at the bottom of your PC's screen.

While all the preceding information might be fascinating to some, there are no doubt many of you who would like to know one simple thing: What's it really like to trade online?

If you'd like to simulate the act of pointing and clicking your way through the stock game, check out the Trading Demo at DLJ*direct*. While it won't add any value to your net worth, it will let you see how easy and quick it is to be a part of the action. The speed factor is a key consideration in trading—who wants to make a call and wait on hold to buy a volatile stock?

Another way to take advantage of time is to trade at night. Most online brokers will let you place bids after the market is closed, so that when it opens your trade is as good as made.

Overall, the DLJ*direct* experience is a satisfying one. If you're a confident investor who just needs access to trades, and who can make sense of gathered market data, you'll be happy with the site.

SURETRADE

Could you do without custom portfolio software (like the one provided by DLJ*direct*)? If so, you may be able to save even more on your trades. Remember when we said that you could buy stock with a commission similar to the cost of lunch? Here's the company that makes it a reality: SURETRADE, Inc., a two-year old Fleet Financial company.

For only $7.95, you can trade up to 5000 shares! That's incredibly reasonable and not noticeable even if you end up losing money through a trade.

(Continued on page 8)

At $7.95 per trade (up to 5000 shares), SURETRADE is sure to make a lot of friends in the investment community.

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TED NEEDLEMAN

COMPUTER BITS

Making Your Own Gold Record

CD Recordable (CD-R) and CD ReWriteable (CD-RW) drives have become affordable enough so that many of you should be considering adding one to your PC. Doing so is a quick and easy project, and the benefits are substantial. With the prices for write-once CD discs down to under a buck a piece (when you buy them in 50-disc bulk quantities without the jewel case), a CD-R is a great way to back up large files, most of a hard disk, or several subdirectories. I often use them to store large scanned images (I take a regular wallet-sized photograph, scan it at 2400-dpi resolution, and print 5 × 7 or 8 × 10 enlargements from the file, but that's another column), or send large files to other people by burning them onto a CD-R and mailing the disc. It's a lot slower than transferring the files by e-mail, but doesn't require that I stay connected to the Internet for the 6, 8, or even more hours that it takes to upload a 25MB file at the 33.6-Kbps connect speed I usually wind up at.

CD-R is a write-once device and media. It can read standard CD-ROMs, audio and photo CDs, and CD-Rs that have been burned on standard CD-R burners. A CD-RW is similar, but works just a little bit differently. Both CD-R and CD-RW drives use a low-powered laser to read and write to and from the media. With a CD-R drive, the laser actually burns a small pit in the dye layer. Later, during the read process, the laser beam power is reduced, and the beam is reflected back to a sensor by the parts of the disc that haven't been "written," while the beam is dispersed when it hits one of the pits that have been burned. The resultant data stream is interpreted as binary ones and zeros.

Before installing the CD-RW drive, make certain that the drive jumper is set to the correct Master/Slave status (see text).

A CD-RW disc uses a different type of dye, and the laser beam is a bit more powerful during both the read and write cycles. Rather than actually burning a pit during the write process, as a CD-RW does, the different dye used in a CD-RW disc undergoes a phase change that alters its reflectivity. When the read beam hits one of these altered areas, it is dispersed just as if it had hit the pit on a CD-ROM or CD-R disc. Altering the power level of the laser beam again allows the area that underwent a phase change to return to its original state, so it can be written over again.

CD-RW discs can be written and rewritten hundreds and even thousands of times. And, in the long run, they are more economical than CD-R media. But to purchase them initially, they cost about $12 or so each, compared to $1 for a CD-R. So you won't want to use a CD-RW for storing files for months at a time, or sending a large file to a friend.

Fortunately, CD-RW drives can write CD-Rs as well, so you have the best of both worlds. In fact, the reason that CD-RW drives haven't completely displaced CD-R drives is that the drive itself costs about $100 or so more than a CD-R-only drive. And, if you are sure that you won't want or need the capability of using a CD-RW, why spend the extra money?

SHOPPING TIPS

I generally don't advise anyone to

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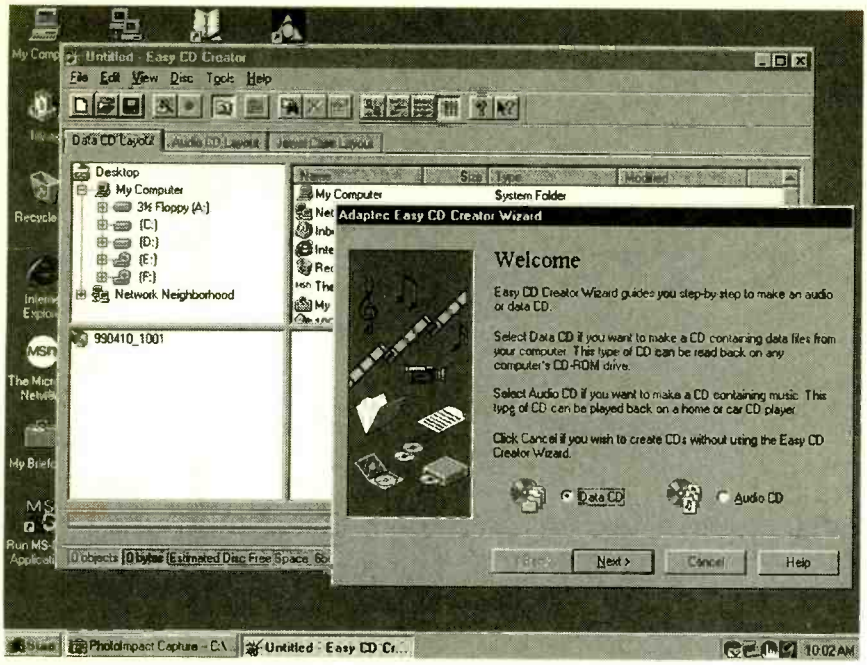


Easy CD Creator *has Wizards that take you step by step through the process of burning a disc.*

buy a strictly CD-R drive any more. After all, while the extra hundred bucks isn't insubstantial, a CD burner isn't a peripheral you buy every day, or replace every year. You may want the capability of using CD-RW discs, and spending a bit more right up front assures you of that capability in the future without additional expense.

Finding a CD-RW drive is easy—there are literally more than a dozen vendors selling drives at every price point. I've tried most of them, and all have something to offer. Two of my favorite vendors, however, are Micro Solutions and Smart & Friendly. Micro Solutions makes a series of terrific external *backpack* drives that attach to your PC via the parallel printer port. They feature printer pass-through ports so that you don't lose the use of your printer. Offered in versions that can write up to 4X, Micro Solutions' backpack drives are among the easiest peripherals to install. But they are somewhat pricier than internal drives.

One good compromise between cost and performance is the *CD-Racer* from Smart & Friendly. Priced at about $325 on the street, Smart & Friendly bills this drive as a CD-Recordable with rewriteability, rather than as a CD-RW. The difference is subtle, but there is a difference. And the difference is in the way you need to rewrite a CD-RW disc. Most CD-RW drives come with several software utilities. One of these utilities is used to create CD-Rs or a complete CD-RW. The most popular of these is *Easy CD Creator* from Adaptec. The other, called a packet-writing utility, allows the CD-RW disc in the drive to be used essentially as huge 600MB+ floppy disk. Adaptec's utility, *Direct CD 2.0*, is the most popular packet-writing utility.

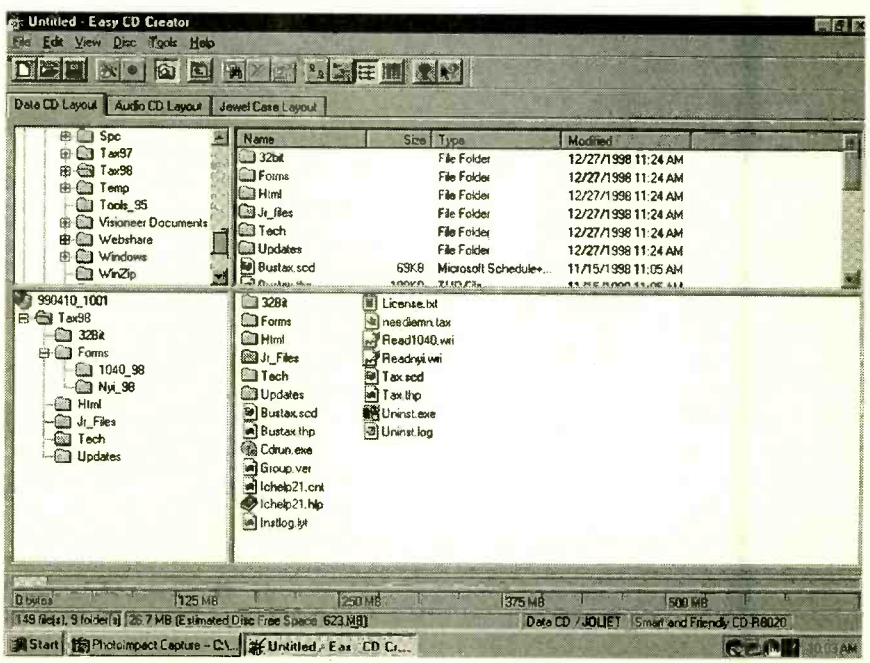
Smart & Friendly's CD-Racer includes *Easy CD Creator*, as well as a number of other useful utilities for making Web pages or recording audio CDs, but eliminates the *Direct CD* packet-writing utility. You can rewrite a CD-RW disc in the CD-Racer by building a new CD layout in the *Easy CD Creator*, and essentially re-burning the disc, but you can't drag and drop files directly onto the CD-RW disc as you would be able to if *Direct CD* was installed. You can buy a copy of *Direct CD* directly from Adaptec if you really want this capability. Or, you can choose another vendor, as most (other than Smart & Friendly) do include it with their CD-RW drives.

One thing to keep in mind about CD-RW discs is that they must be formatted before being used for the first time. This is only done once, to lay down the file structure, but can take up to 90 minutes.

INSTALLATION

Installing the CD-Racer (and most CD drives) is easy. If your current CD-ROM drive is slower than 24X, I suggest that you simply replace it with the CD-Racer, as the Smart & Friendly drive writes and rewrites at 2X, but can read at 24X.

If you are replacing an old drive with the new one, open up your PC and remove the small screws on either side of the drive cage that are holding the CD-ROM in place. Remove the rib-



You can skip Easy CD Creator*'s Wizard and just drag the files you wish to include on your CD-R/RW down to the bottom panel.*

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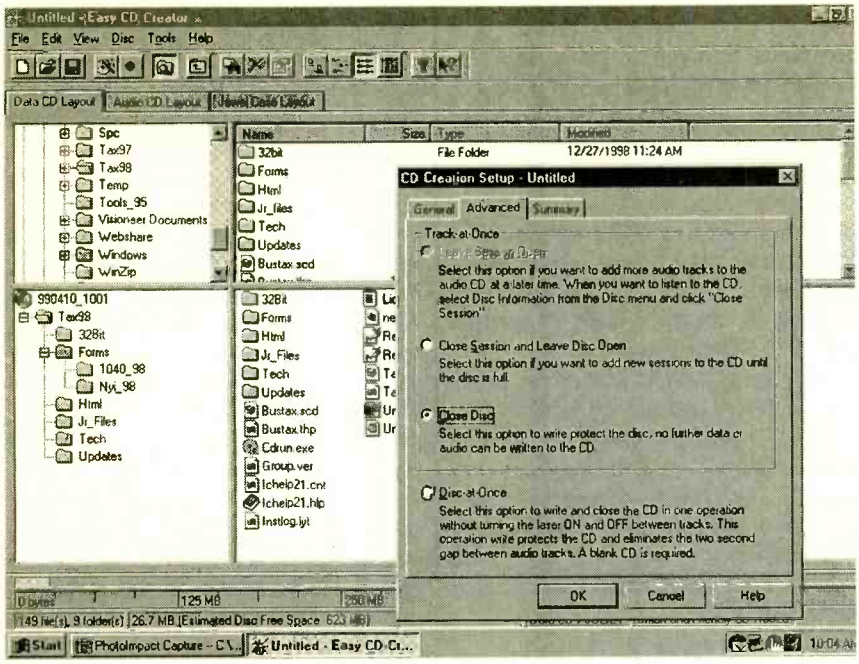

Remember to check the Close Disc button. The default setting, leaving the disc open, lets you add more files to the CD-R/RW, but you may have trouble reading the disc in a standard CD-ROM drive.

bon and power cable from the rear of the drive, noting the direction the red stripe on the ribbon cable is oriented. Slide the CD-ROM drive out of the PC. Before you place the CD-Racer in the PC, check to make sure the drive jumper is set correctly. This is at the rear of the drive, and has two positions, Master and Slave. If the drive is to be the only optical drive in your system, replacing the current CD-ROM, the jumper must be set to Master. If it is going to be added to your current IDE CD-ROM, set the drive's jumper over the two pins for Slave. This tells the PC how to access the unit.

WHERE TO FIND IT

Adaptec
691 South Milpitas Blvd.
Milpitas, CA 95035
408-945-8600
www.adaptec.com

Micro Solutions, Inc.
132 W. Lincoln Ave.
DeKalb, IL 60115
800-890-7227
www.micro-solutions.com

Smart & Friendly, Inc.
20520 Nordhoff St.
Chatsworth, CA 91311
800-959-7001
www.smartandfriendly.com

If you're replacing the current CD-ROM drive, slip the CD-Racer into the drive bay that you removed the current CD-ROM from. Depending on your PC, you may have to transfer a set of drive rails from the old drive to the new drive so that the CD-Racer fits correctly into the bay. Plug in the ribbon and power cables (making sure that the ribbon cable is correctly oriented—the power cable is polarized, and only fits one way). That completes the physical installation.

Those of you adding the CD-Racer as a second optical drive will have to fasten the drive into an open bay. Make sure that it is close enough to the original CD-ROM drive so that the second plug on the ribbon cable will reach the connector on the CD-Racer. Then plug in a power connector from the power supply. If your PC is short on connectors, a "Y" splitter, which provides an additional power connector from an existing one, costs a few bucks at RadioShack.

Boot up Windows and open My Computer—you should now see the new drive assigned a letter. It will function as a CD-ROM without any additional software, but to make use of the CD-R and CD-RW capabilities, you now need to install the Adaptec *Easy CD Creator* software.

Depending on which vendor's CD-RW drive you buy, you may get the *Deluxe Edition* or the *Standard Edition* of *Easy CD Creator*. The CD-Racer comes with the *Standard Edition*. The *Deluxe Edition* includes utilities for burning Video discs, as well as an application that reduces pops and scratches from audio tracks you've captured before burning audio CDs. Smart & Friendly includes several different utilities with the CD-Racer, including Macromedia *Backstage Designer Plus*, for creating Web sites, and *Cut Enhance*, which is used to clean up audio tracks before recording them to a CD-R or CD-RW.

IT'S BURNING TIME

Actually burning a CD-R or CD-RW is a piece of cake. Just select which files you want to include on the disc, and either use the Wizard provided in *Easy CD Creator* to select these files, or just drag and drop them from the Windows Explorer-like panel on the top of the screen down to the bottom. A standard CD-R can hold up to about 650MB of files, while a CD-RW, because it uses a different file structure, has a slightly lower capacity.

When you've finished selecting the files you want to include, just click on the red button icon on the toolbar and the menu that actually lets you burn the disc is displayed.

A couple of pointers are necessary here. There are three tabs on this panel. On the first panel, you may want to use the Test and Create button until you are sure that your writer functions correctly. It's easy to ruin a disc if your hard disk, where the files are stored, is badly fragmented. Once the write procedure begins, the CD-RW drive needs to receive the data in a steady stream to keep the buffer on the writer filled. If it doesn't, a buffer under-run occurs, and you might wind up with a $1 shiny coaster. Defragment your hard disk frequently before burning CD-R/RWs, and use the test function until you get a good feel for the conditions that create problems. CD-R/RW drives are a lot less sensitive to this problem than they were a couple of years ago, but it does still happen.

Also, make sure that you click on the tab labeled Advanced before burning a disc. The default setting is to close the session, but leave the disc open. This setting lets you add files to the disc in the future. You're generally

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better off changing this setting to Close Disc. You won't be able to add more files to it, but the disc will be readable in most CD-ROM drives. If you leave the disc open, you may find it difficult to read on other PCs.

If you need to make multiple copies of a CD-R, you can create a disc image on your hard disk first. This option is available on the File menu, and creates the CD-R on your hard disk first. Then use the menu option to burn the CD-R/RW from the disc image, and you will find that creating multiple copies gets speeded up.

Finally, two caveats. The CD-Racer is a 2X-write drive on both CD-R media and CD-RW discs. Some drives offer considerably better performance (albeit, at a considerably higher price tag). For example, Smart & Friendly's CD-Rocket can burn a disc at up to 8X. The 4X-speed CD-R burners are also very popular. At higher burn speeds, CD-R/RW drives seem to be very sensitive to the media being used. For example, I can burn the "buck-a-disc" CD-Rs at 2X speed in a 4X or 8X burner, but burning discs at high speeds seems to require more expensive "Name-Brand" media such as Sony or HP discs. Burning at 8X in the CD-Rocket drive from Smart & Friendly, my most consistent results were achieved with S&F's own "Rocket Fuel" discs, which cost a couple of bucks each. You can use cheap media at high speeds, and the software will tell you that the disc was created okay, but there's a good chance you won't be able to read the disc in another PC's CD-ROM drive.

And lastly, all CD-RW drives come with software utilities for copying CD-ROMs. These are handy for making backup copies of CDs you use frequently, but please respect the copyright and keep these copies for your own backup. ■

NET WATCH

(continued from page 4)

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That's all for this month. As usual, feel free to send us any questions or comments via snail-mail to *Net Watch*, **Popular Electronics**, 500 Bi-County Blvd., Farmingdale, NY 11735; or e-mail to netwatch@gernsback.com. ■

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MULTIMEDIA WATCH

MARC SPIWAK
TECHNICAL EDITOR
WINDOWS MAGAZINE

DVD—PC Optional

DVD has already taken off as far as I'm concerned. The format is far better than VHS and offers so many more features than laserdisc. Because of its superiority, DVD is really what you want in any new PC, be it desktop or notebook. DVD is also what you want in any state-of-the-art home entertainment system.

I've talked about DVD on the PC many times over the past couple of years, and I really do like it. This month I'll report on the latest DVD kit from Creative Labs. Not only is it the only way to play DVD games, but a DVD-ROM drive also lets you watch DVD movies on your PC. And most PC-DVD setups have composite and S-Video outputs so you can watch the movies on a big-screen TV. You can even buy RF transmitters that beam movies through walls to a TV set in another room.

Unfortunately, the more complicated a computer-DVD setup you have, the more equipment you have to turn on and set up. And no matter what DVD-ROM package you have, you're bound to come across a few movies that simply won't play on it. I've come across several DVD movies that will play on one PC but not another, and vice-versa. It makes no sense.

Having DVD already on my PC, I never went out and bought a DVD player for my TV. But I was curious if a set-top DVD player would choke on various discs like my PC has. So I asked a contact at Philips if I could check out a set-top DVD player. I was soon spinning discs on a Philips *DVD815* DVD player connected to my home-entertainment system.

PHILIPS DVD815

The DVD815 has played every movie I've thrown at it, regardless of whether that movie gives a particular PC trouble. And I don't have to turn on my PC to play the movies. I guess in the same way that playing games on a PC will never be as trouble-free as dedicated gaming systems, playing movies on a PC will never be as easy as playing them on a set-top player. Of course, I'll never be able to do word processing or do spreadsheets on the DVD player, which attests to a PC's versatility.

Philips' DVD815 is easier to use than a VCR because there's no clock to set. It's a great way to enjoy the benefits of DVD technology from your easy chair.

The Philips DVD815 looks like a CD player with composite and S-Video outputs and stereo audio outputs. It's even easier to use than a VCR because there's no clock to set. You can't record on DVD just yet, so there's no need for the player to know what time it is. The DVD815 is smart: if you press eject while the unit is off, the disc tray will slide out as the player comes to life. If you turn off the player while the tray is open, it closes before power shuts completely.

Inserting a movie usually brings up an introductory video and/or a menu. The remote control has the typical four-point and center buttons that let you navigate through menus and whatnot. DVD discs usually contain the main feature, sometimes both full- and wide-screen versions, a trailer perhaps, and maybe some other neat extras like games, commercials for other movies, and trivia, so you'll use the remote quite a bit. I guess people who've never used a remote control will not like DVD's relative complexity, but I doubt they'll buy into DVD anyway. People who've grown up surrounded by remote controls will like the one that comes with the DVD815.

When playing DVD movies on a PC, if you dare mess with the controls, say to view a different angle of the film or even skip chapters, you could possibly cause the film to grind to a halt—perhaps along with the rest of your PC. But the DVD815 never stumbles when I speed forward or backward at up to 30X, freeze-frame, jump to the main menu, or whatever. I guess this is expected from an appliance, but it was a pleasant surprise to a DVD enthusiast raised on PCs. Philips' DVD815 has a suggested retail price of $399, and probably sells for less in stores. I recommend it for watching movies. If you're tired of the crummy picture from your VCR (though you won't know just how crummy it is till you get a DVD player), check out DVD. Lots of video stores now rent out DVD movies, so you don't have to buy them.

PC-DVD ENCORE 6X

DVD discs cannot be read on a PC without a DVD-ROM drive—period. Without such a drive you'll be barred from playing DVD movies, games, and any other discs recorded in the DVD format. So it makes sense to have a good DVD setup on your PC even if you already have a set-top DVD player. Creative Labs jumped the gun on the competition with its original PC-

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DVD Encore bundle, and it has upped the ante once again with the *PC-DVD Encore 6X*.

The PC-DVD Encore 6X with Dxr3 technology is Creative's third-generation product, and the latest in speed and functionality in DVD-ROM. It reads DVD-ROM at 6X and CD-ROM at 32X, though the equivalent transfer rate for DVD-ROM is still much faster than CD-ROM. That's because DVD data is more densely recorded so more of it flies by the laser for any given time period. The drive also supports DVD-R, CD-R, CD-RW, and CD audio.

The new Dxr3 decoder board delivers improved image quality and better color processing at high resolutions. It can also feed Dolby Digital (AC-3) audio to a 5.1-channel system or Creative Labs' own DeskTop Theater 5.1 sound system for theater-quality audio. This compact sound system is perfect for turning your PC-DVD setup into a full-fledged home-entertainment system. You can also simply connect the Dxr3 to a sound card for CD-quality stereo sound. The PC-DVD Encore 6X has a suggested retail price of $249, and it's well worth it.

The ALPS MD-5000 prints at 2400 dpi using proprietary Micro Dry ink in a dye-sublimation printing process.

TEAC 6X24

Getting off the subject of DVD, because DVD recording is still in its infancy, let's talk about CD recording, or CD-R, and Teac's latest external recorder that can burn discs at 6X and read them at 24X. Teac's *6X24 CD Recorder* lets you create a 650-megabyte disc in about 15 minutes. The SCSI drive has a 150-ms average access time. It's Windows 95/98/NT compatible and comes with Adaptec's *Easy CD Creator* software that lets you do just about anything you might need to do on a blank disc, such as making a data backup, an audio CD, and more. Adaptec's *Direct CD* is a drag-and-drop file storing system, *and CD Copier Deluxe* makes it a snap to copy other discs.

The external drive measures 5.75 by 1.6 by 7.56 inches (WHD) and weighs 5.2 pounds. You can buy it for less than $400.

ALPS MD-5000

A while back I reported on a different kind of printer from ALPS, one that used a proprietary Micro Dry ink in a dye-sublimation printing process. That was the MD-1300, which held four cartridges that look like small cassette tapes—you load various combinations of cartridges into the printer depending on the colors required for the particular job. But the four-cartridge limit was a pain in the neck at times. The latest printer from ALPS, the *MD-5000*, uses the same technology but at 2400 dpi. And this newer model holds seven cartridges so most jobs can be done without having to swap them.

A new primer-ink cartridge allows the use of plain paper while still pro-

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NEW SOFTWARE

If you've ever played with Adobe *Photoshop*, then you know how much fun it can be and how creative you can be. I recently stumbled across some software that provides you with countless additional effects that can greatly enhance your projects and the functionality of *Photoshop*. Alien Skin's *Xenofex 1.0*, a plug-in for *Photoshop*, features 16 special effects filters such as lightning, baked earth, stain, clouds, and so on. Just like with *Photoshop*, filter effects can be combined to produce a particular desired final effect. *Xenofex* includes over 160 presets for creating all sorts of complex effects. Each filter features a resizable and zoomable preview window, with a thumbnail of the image for navigating through the preview image. *Xenofex 1.0* cost approximately $129.

Alien Skin's *Eye Candy 3.0* contains 21 filters for use with *Photoshop*, as well as other programs. This pack features effects such as fire, smoke, perspective, shadow, cutout, carve, and a lot more. *Eye Candy* also contains over 200 single-click preset combination effects. The add-on is fully compatible with *Photoshop 5.0*, and its preview window lets you zoom in or out from 6% to 1600% original size. *Eye Candy* 3.0 costs $129.

I've got two new titles from Legacy Interactive, one for adults and one for children. *Emergency Room 2* is almost like the TV show *ER*, except that it's up to you to save the incoming patients. You're an attending physician on duty in an ER. You have to examine patients, do tests and x-rays, and administer treatment. If you're successful enough, you could be promoted to Chief of Staff. Fail and it's a trip to the morgue. *Emergency Room 2* features 3D graphics, realistic body parts and injuries, and all sorts of fun for the not so squeamish. *ER 2* costs $29.95.

Piggy in Numberland, also from Legacy Interactive, is a game for children age 4 to 7 that helps teach

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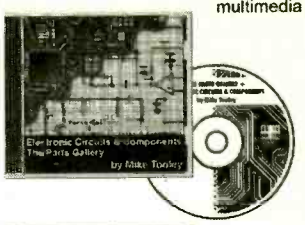
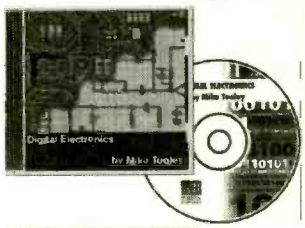


Electronic Circuits and Components provides a sound introduction to the principles and applications of the most common types of electronic components and how they are used to form complete circuits. Sections on the disc include: fundamental electronic theory, active components, passive components, analog circuits and digital circuits. Includes circuit s and assignments for Electronics Workbench.

The Parts Gallery has been designed to overcome the problem of component and symbol recognition. The CD ROM will help students recognize common electronic components and their corresponding symbols in circuit diagrams. Quizzes are included. The Parts Gallery is free with Electronic Circuits and Components.



Digital Electronics details the principles and practice of digital electronics, including logic gates, combinational and sequential logic circuits, clocks, counters, shift registers, and displays. The CD ROM also provides an intraduction to microprocessor-based systems. Includes circuit s and assignments for Electronics Workbench.

Analog Electronics is a complete learning resource for this most difficult subject. The CD ROM includes the usual wealth of virtual laboratories as well as an electronic circuit simulator with over 50 pre-designed analog circuits, which gives you the ultimate learning tool. The CD ROM provides comprehensive coverage of analog fundamentals, transistor circuit design, op-amps, filters, oscillators, and other analog systems.

"...hammers home the concepts in a way that no textbook ever could." Electronics Australia

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written by John Barker

The complementary development kit includes a reprogrammable PIC16C84, which you can program via your printer port. The institution version (designed for use in schools, colleges and industry) includes a quad 7-segment LED display and alphanumeric LCD display. The development kit provides an excellent platform for both learning PIC programming and for further project/development work. Assembler and send (via printer port) software is included on the CD ROM.

development board (institution version)

Prices and Versions

Institution versions are suitable for use in schools, colleges and industry. Student versions are for student/home use.

	student version	institution version
Electronic Circuits & Components	$56	$159
Digital Electronics	$75	$189
Analog Electronics	$75	$189
PICtutor (CD and development board)	$179	$350

Shipping costs to Canada an additional $5. Overseas orders please contact CLAGGK Inc. for shipping costs.

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numerical concepts. Children explore Numberland via an animated pig, discovering hidden places and playing games. The more kids play, the more "brain power" they develop. When enough brain power is built up, kids can access the Imagination Machine that makes toys that kids can sell in Bee's toy store. This game costs about $20.

If you're looking for a math learning tool for all ages, then consider *ABACUS/The Basics* from ABATEC Educational Software. *ABACUS/TheBasics Version 3* teaches you how to add, subtract, multiply and divide numbers in your head. The software runs in English, German, and Dutch. You can download a fully functional demo of version 3.0, and register it for only $19.

If you use a Palm Pilot, you might be interested in an add-on software product for it. *OneStep Connect* is a personal organizer that links to Palm Pilot and Palm III. *OneStep Connect* features direct links to the PalmPilot and Palm III for one click access to fax, the Internet, e-mail, and more. It features contact management, address book, calendar, to-do lists, a time zone map, and a lot more. *OneStep Connect* has a suggested retail price of $69.95.

New from Psygnosis comes *Drakan Order of the Flame*, an action-adventure with aerial- and ground-based action. You play Rynn, a warrior-heroine teamed up with a fire-breathing dragon. You wander through Drakan seeking Rynn's kidnapped younger brother. You have access to over 50 different weapons plus dragon attacks and magical spells. Of course, there are also puzzles to be solved in this involved multimedia game. This game costs about $40.

If you'd like to brush up on physics or are studying it in school, you might be interested in *Open Physics 1.0*, a complete multimedia course on the subject. OpenTeach Software sells *Open Physics* as two separate discs, *Part 1* and *Part 2*. The discs teach mechanics, thermodynamics, molecular physics, mechanical oscillations and waves, electricity and magnetism, optics, quantum physics, and more. Featured are interactive simulations, problems to be solved, video, and so on. Check both discs out at just $39 each.

New from Humongous Entertainment is another title that my son loves, another jaunt with Putt Putt, the happy little animated car, in *Putt Putt Travels Through Time*. This title is for kids aged 3 to 8. My son is able to accompany Putt Putt to different points in time, such as the dinosaurs, the old west, the future, and more. His favorite is the dinosaurs, which I guess is a favorite topic for all kids at one time or another. There's also *Putt Putt Goes to the Zoo*, where kids can see all the animals and have a fun time spending the day with Putt Putt. All kids love Putt Putt. Each game costs $10.

Last this month is bunch of great software from Houghton Mifflin Interactive, some of it for kids ages 3 to 8, and some of it for kids over 10. *Awesome Animated Monster Maker Math*, for kids 7 to 10, involves making monsters that will help solve mathematical problems. The program retails for $44.95.

For kids over 10 there's Houghton's *Inventor Labs Technology* and *Inventor Labs Transportation*. Both titles are filled with the technical hows and whys of what makes things tick and who invented them. Kids can even help out with the original laboratory experimentation. For kids over 10 that like the outdoors more than machinery, there's *North American Birds* on CD-ROM, a complete multimedia guide to all the birds native to this continent. All of these titles are reasonably priced at about $10, and kids love them. ■

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PEAK COMPUTING

Updates, Upgrade, and Patches

Quite frankly, this is a chatty little column I was hoping to save for the Fall, but with the recent Melissa and CIH virus scares this Spring I thought I would cover it now. Why? Read on.

Updates and upgrades and patches are files that can be used to improve the way existing hardware and software operate on your machine. In the case of the latter—software, manufacturers usually ship "broken" programs to meet sales expectations and some determined shipping date. And they're safe, too, knowing that if it functions less than perfectly they have options.

Software companies have a "ship it and fix it later" attitude, expecting to write little software programs that iron out the kinks in the product they shipped. These tiny (or sometimes several megabyte) programs are patches, like a digital version of the kind used to plug a flat tire. Companies depend almost exclusively on the Internet to distribute these files and control patching costs.

Don't get me wrong. This cynical view of software vendors doesn't tell the whole story. Sometimes a patch, upgrade, or update has an egalitarian purpose. Sometimes a software company actually finds a way to make the program run faster and better, or even adds free new features via an update.

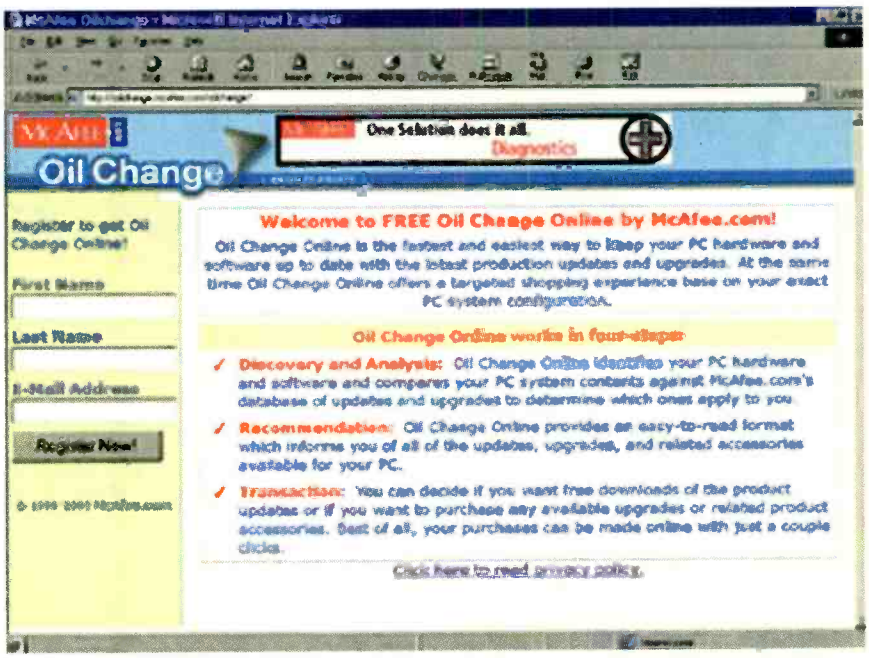
WHY CARE?

What does all this have to do with the recent viruses I mentioned? Why bring up the CIH or Chernobyl virus that wipes hard drives as clean as the day they were bought? Why mention the New Jersey-born Melissa Virus that exposed a weakness in Word's macro feature and sent a copy of itself and one of your documents to fifty of your closest friends? In the case of CIH, there were program updates that would have found the virus when patched onto their respective antivirus programs. With Melissa there was a Word patch out that fixed the macro vulnerability and would have made the whole issue moot. Both fixes had been out for months at the time.

Many people who own a computer system never think to check if these little gems are available or even necessary. Gamers, more than others, have had a heightened awareness of patches, as their game software and sound- and video-card drivers are always being improved to heighten the multimedia experience. But even computer users with productivity in mind can benefit from such upgrades.

The most important reason to check for updates and patches revolves around security/Internet issues. Any program you have is susceptible to breech. If there is personal or financial data entered in such an application, the need is even greater to ensure that the program has the latest updates.

Functionality is the second most important reason to keep up to date. Programs that always crash in the same place, are slow, or have awkward-to-use features can sometimes



McAfee's Web site provides access to its free Oil Change Online service, which is made available through targeted advertising.

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piece that can be upgraded.
ware—like joysticks, modems,
e, video cards, Zip drives, *etc.*—
ses drivers (little software apps) that tell the hardware what to do and how to behave. Over time, the manufacturer may have corrected a problem or a conflict and created a new driver to run the device more effectively. Any software program you use probably has an update or patch available, whether it's a Web browser, word processor, or some little gimmicky thing. Even your operating system—any flavor of Windows, the Mac OS, Linux, you name it—has patches out to upgrade functionality, resolve conflicts, and improve security or stability.

Figuring out what to upgrade and how to upgrade it can be a bit like wandering through a dark forest: you don't know where you're going, and everything looks the same and different. There is no easy way to learn what needs to be upgraded and what doesn't; however, there are ways of automating part or nearly all of the process.

Sites like WinFiles.com are great general clearinghouses for updates and patches that most Windows users can take advantage of.

THE OVERLOOKED OBVIOUS

Software is becoming increasingly easy to fix. All that is needed is an Internet connection. The most user-

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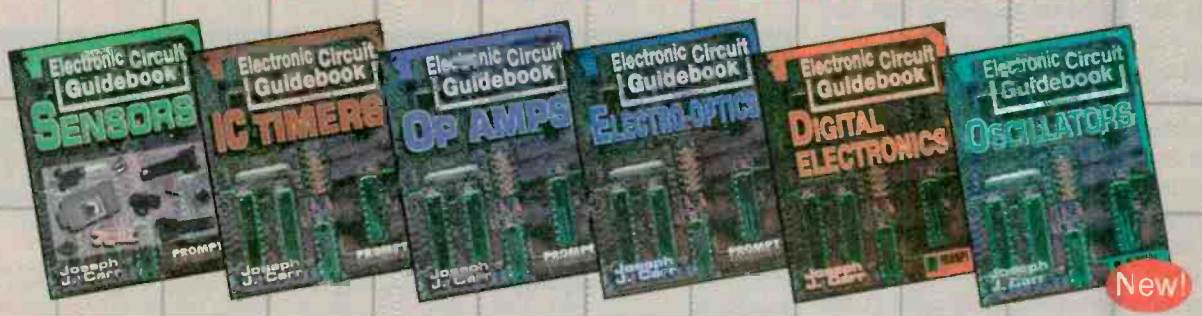

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PROMPT PUBLICATIONS

CIRCLE 175 ON FREE INFORMATION CARD

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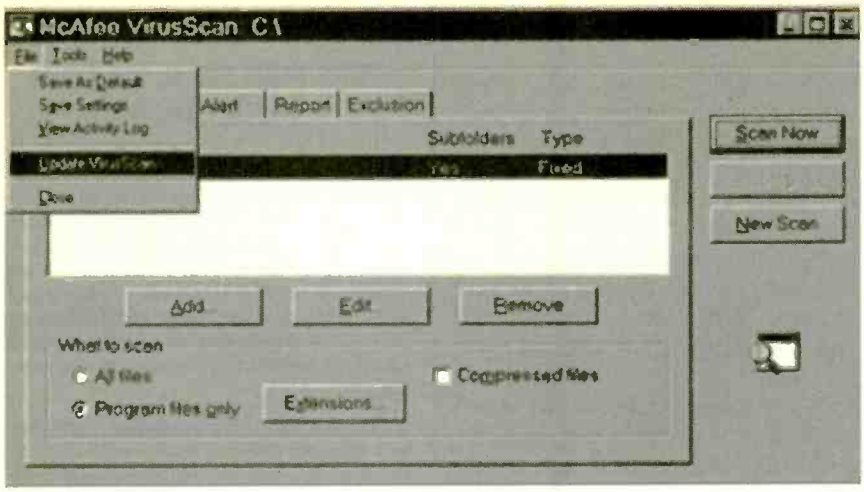


Programs like McAfee VirusScan have built-in auto-update features.

friendly programs have a button or menu option called something like "click to update." It then opens your Internet connection and checks for itself if updates are available. Antivirus programs are a good example of software with this type of functionality. Not as user friendly but still helpful are programs that open your browser and take you to a manufacturer's Web site support page. Software without either of these features forces you to manually open your own browser and go to the manufacturer's support site. No matter how you get an update, though, installing it is usually easy. It's often a matter of just double clicking it to start the install. Some of the more automated programs do it for you.

Windows 98 and Internet Explorer 5 make it about as simple as possible to update them. In Windows 98 you click the Update Now icon on your Start bar. Internet Explorer 5 is updated as easily, under its Tools menu. Both had security patches (among others) available shortly after their release, making these features worthwhile almost immediately.

When downloading a patch or update, it is important that you download the right one for your software version. You can usually check the version of a program on your machine under its Help menu, in the About tab. It will list version number, down to the last decimal place, and sometimes the date of the version. Often, the right patch will be for a whole series of versions, and this will be indicated with a notation like "update for 3.2.x," meaning version 3.2.1 or 3.2.2 and so on of a particular program can be updated by this patch.

Hardware with an obvious software component, like a programmable joystick with a software interface or something more advanced like a CD-R drive, may either have available a new driver, new interface software, or both together.

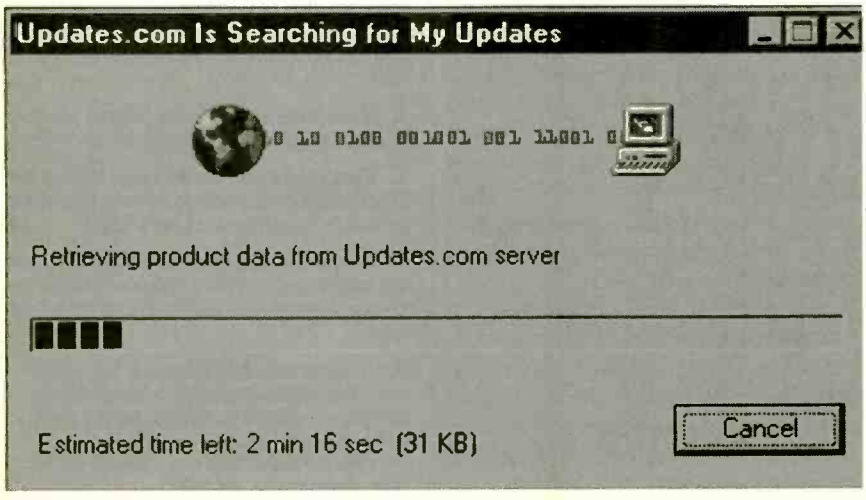
Hardware without any obvious software component, like a modem, is trickier where version numbers are concerned, but Windows lends a helping hand here. It will tell you that the driver you are trying to replace is newer than the one you are trying to install if you make a mistake. The best place to identify a driver's version number is in the Device Manager, found under the system icon in the Control Panel.

The Device manager lists every bit of hardware installed on your system, generally by category. Clicking on a category expands the section to list every item in it. After choosing the item in question, clicking on the properties button brings up a new series of tabs, including the driver details tab.

GREAT PLACES TO START

There are a few paths through this confusing forest of software and hardware, and you don't necessarily have to go to a manufacturer's site to find what you are looking for. Web sites such as *www.cnet.com* or *www.winfiles.com* are depositories of updates and patches for operating systems, printers, hardware, games, and almost anything else that needs a tiny bit of software to run on a PC. All that is needed is to click on the right link or request a search. These sites are extremely useful if you already know what you want (for instance, a new Canon BJC 5000 printer driver).

There are also a few update sites that will inspect your system, tell you



Updates.com takes a few moments to search for "My Updates"—files your personal system can benefit from.

UPDATE SITES

CNET
www.cnet.com

Norton Web Services
www.norton.web.com

Oil Change Online
www.mcafee.com

Updates.com
www.updates.com

WinFiles.com
www.winfiles.com

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what is out of date, and then provide you with the option to download the updates right then and there. These sites range from free to $29.95 for a year of service. They are convenient, but you shouldn't expect them to find everything that needs fixing (though they come close to doing so). These kinds of sites are useful when starting out, when you are unused to updating or, since it is all centrally located, when you have a lot to download.

They are also great training grounds. You can learn more about what's installed in your system by watching and discovering what is out of date than by manually inspecting your system. After a while of observing the update-site diagnostics, your familiarity with your PC will expand.

Both free and fee update sites work basically the same way. They may or may not require you to install a small program on your hard drive, but either way when you visit the site, the latter interrogates your hard drive, presents you with a list of updates, and waits for you to choose one or more.

GENERAL RULES OF THUMB

With all so-called updates, make sure that the file version you download is higher and later than the one on your PC. If it is, and you're ready to go ahead and install it, follow the instructions it comes with to the letter and read all "readme" and text files that come with the patch, or any documentation linked on the Web site. While most companies try to make the process as simple as possible, not doing it right can cause a lot of grief. For (a rare) example, to update the driver for the Turtle Bay Montego II sound card (sold with most new Dell systems), a user must first uninstall the card through the Device Manager and then uninstall two entries in the Control Panel's Add/Remove Program app before installing the new driver. Not doing so has the potential to lead to all kinds of grief.

And that's exactly not the point to updating, upgrading, and patching. Have fun. Don't do it all in one sitting; you'll be there for hours and possibly days if you've never done it before. Once you start, you'll never stop, and you'll be surprised at how much of your software needs to be updated after checking. My guess? All of it. ■

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Be sure to include copies of all correspondence.

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LETTERS

COURTESY-LAMP TIMER CORRECTIONS

There is an error in the Fig. 2 caption in my article: "Remote-Controlled Courtesy-Lamp Timer" (**Popular Electronics**, June 1999). Where it states "make sure that the 'VT' signal doesn't exceed 15 volts," it should read "...doesn't exceed 5 volts." It is correct in the text of the article.

On a different note, the #RF60 matching Transmitter and Receiver Pair mentioned in the article has since been discontinued by the manufacturer (Visitect, Inc.). They currently offer Remote Transmitters with 150º range (RF300T) and 300º range (RF300XT). The matching Receiver board for use with either Transmitter is #RF300RM.

One additional source for suitable Remote Transmitters/Receivers is MCM Electronics (www.mcmelectronics.com). They stock kits by Velleman Inc. as well as pre-assembled units by CEBEK.

Brian Pliler
via e-mail

NETZERO CONFUSION

Your *Net Watch* column in the July 1999 issue was terrific. I would love to have free Internet access; however, I can't figure out how to dial 888-NETZERO. There's no "Z" on my phone.

Bill Garver
via e-mail

Sorry for the confusion. While some phones do come with the letters "Q" and "Z" associated with the "1" button, many do not. To dial 888-NETZERO, use 888-638-1376.
—Editor

LETTERS MISSED AND A CORRECTION

The June issue of **Popular Electronics** gave me a big surprise. The *Letters* column was missing. In the past, I have enjoyed seeing others' comments, views, and suggestions.

I am also writing to correct the schematic in the article: "Tele-Computer Controller" (**Popular Electronics**, June 1999). Pin 10 of IC2 should go to the +5V line and the intersection of R14 and R10 should go to IC2 pin 16. Those using the parts-placement diagram will find that the board and the diagram are correct—the aforementioned mistake was only in the schematic.

G.B.
Montreal, Canada

Thanks for your observation of the discrepancy between the schematic and PC board. You're right; the latter and the parts-placement are correct.

Never fear, we have not discontinued the Letters *column, as you no doubt noticed. What happened was that in the June issue there were no corrections to be published and no bits of information that were time sensitive. Due to space considerations,* Letters *was omitted, and some of its contents saved for July.*

We apologize for any confusion this might have caused.
—Editor

KEEP IN TOUCH

We appreciate letters from our readers. Comments, suggestions, questions, bouquets, or brickbats ... we want to hear from you and find out what you like and what you dislike. If there are projects you want to see or articles you want to submit—we want to hear from you. And now there are more ways than ever to contact us at **Popular Electronics**.

You can write via snail mail to:

Letters
Popular Electronics
500 Bi-County Blvd.
Farmingdale, NY 11735

Please note the above address is the snail-mail way to get the quickest response. Some readers send letters to our subscription address, and although the mail is forwarded to our editorial offices, it does increase the time it takes to answer or publish your letters.

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And don't forget to visit our Web site: *www.gernsback.com.*

A REQUEST

I enjoyed your home-automation issue of **Popular Electronics** (June 1999). It was nice to see such a well-rounded combination of circuits that appeals to some of us older folk as well as to the computer generation. I'm looking forward to building the "Lamp Timer." As for the PC-related projects you're running, they're getting me interested in having my grandson teach me a thing or two about the computer in his living room!

If you plan on doing any more home-automation type articles, you should consider doing security projects. I can't imagine a neighborhood anymore that couldn't benefit from surveillance cameras, motion sensors, or some other devices that can bring some peace of mind.

H.S.
Philadelphia, PA

We always appreciate a good suggestion. As it turns out, we do have a couple of stories in the works that might fit some of the applications you touched on. While we can't promise a comprehensive security issue in the next few months, we can certainly guarantee that you'll be seeing cameras and other covert gadgets.
—Editor

HAVES & NEEDS

I am looking for an IC, quad. op-amp from Fairchild: μA4316. I'd also be willing to buy another chip that replaces it, if any such substitution is available.

Any help would be greatly appreciated—thanks in advance.

Jose Vitale
P.O. Box 1147
Orlando, FL 32802
Fax: 407-841-1440 ■

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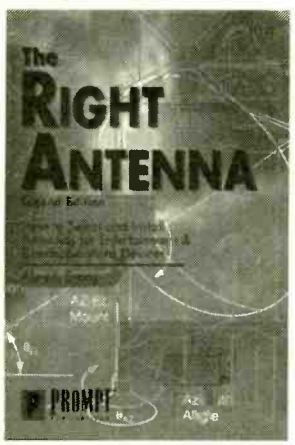
Electronics Library

THE RIGHT ANTENNA, 2nd EDITION

by Alvis J. Evans

With easy-to-understand text and clearly illustrated examples, this book gives readers the confidence to choose and set up the antennas that meet their needs. The author explains how antennas work and provides clear information on a wide variety of antennas, separating them into TV and FM for discussion purposes.



The basic concepts of cellular telephone systems operation are explained and the most popular antennas are discussed. A separate chapter is devoted to interference and antennas used by hams for antenna band operation. There is also a chapter on SW antenna projects that can be constructed easily. This edition also includes informative chapters on DSS and other satellite TV antennas.

The Right Antenna, 2nd Edition costs $24.95 and is published by Prompt Publications, Howard W. Sams & Company, 2647 Waterfront Parkway, East Drive, Indianapolis, IN 46214-2041; Tel. 800-428-7267; Web: www.hwsams.com.

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Filled with products for testing, repairing, and maintaining electrical and electronic equipment, the 56-page catalog features tool kits, test equipment, and supplies. Among the products highlighted are the latest DMMs and oscilloscopes, power supplies, cable testers, tool cases, shipping containers, label printers, precision hand tools, cordless drivers, telecom test sets, magnifiers, soldering supplies, and ESD protection equipment.

There is also a 16-page special section of standard, custom, and modifiable tool kits. Brand names include Fluke, Tektronix, Hewlett Packard, Huntron, BK Precision, APC, Harris, Ideal, Brady, Xcelite, Lindstrom, Weller, Pace, Hakko, Loctite, and 3M.

The Service Supplement is free upon request from Contact East, Inc., 335 Willow Street, N. Andover, MA 01845; Tel. 800-225-5334 or 978-682-2000; Fax: 978-688-7829; Web: www.contacteast.com.

THE DIGITAL SIGNAL PROCESSING HANDBOOK

by Vijay K. Madisetti and Douglas B. Williams

This complete guide to the field of digital signal processing outlines both introductory and specialized aspects of information-bearing signals in digital form. It also explores the use of computers and special-purpose digital hardware in extracting information or transforming signals advantageously.

Subjects covered include telecommunications, computer engineering, acoustics, seismic data analysis, DSP software and hardware, image and video processing, remote sensing, multimedia applications, medical technology, and radar and sonar applications. The complete range of DSP is presented—from theory to application, from algorithms to hardware. Also discussed are the current and future directions of DSP applications.

The Digital Signal Processing Handbook costs $129.95 and is published by CRC Press, 2000 Corporate Blvd., N.W., Boca Raton, FL 33431; Tel. 800-272-7737 or 561-994-0555; Fax: 800-374-3401; Web: www.crcpress.com.

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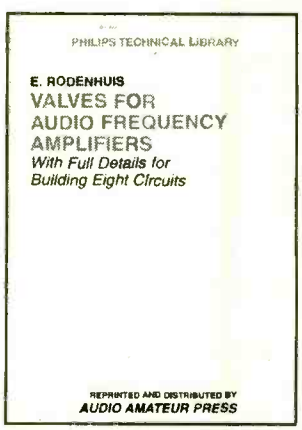
VALVES FOR AUDIO FREQUENCY AMPLIFIERS

by E. Rodenhuis

Originally published in 1954 and now reprinted, this is one of the Philips Technical Library's books on vacuum tube audio. It joins a growing collection of reprinted classic books on tubes, highlighting the tremendous resurgence of interest in this old-becomes-new-again technology.



This is a practical guide for those who want to design and build electronic projects with vacuum tubes. Beginning with a set of rules for build

(Continued on page 87)

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New Models with Newly Added Features!!

TOUCH DISPLAY MODULE

CTD1047 COLOR

10.4-inch color TFT

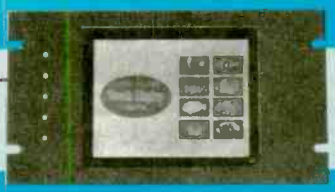
NEW

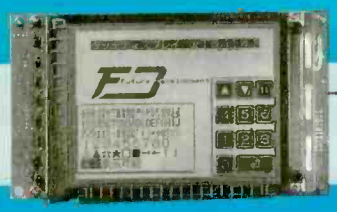
CTD5741 COLOR

5.7-inch color STN

Model in photograph enclosed in case. (CTD5741-11)
CTD5741 is 100% compatible with μTD4141.

NEW





μTD4141

5.7-inch monochrome

Development Support Tool

For Windows 98/95

$150

NEW

New Features

Personalized Color Pallets

You can personalize the tone of the built-in 16-color pallet by setting RGB (brightness) level.

Copying

Areas of the screen can be selected and copied onto other screens.

Expanded Flash Memory

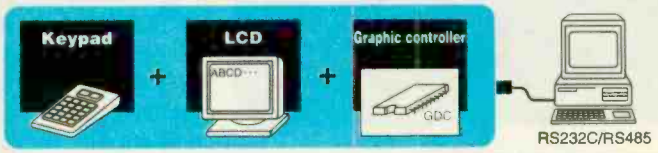
Image Manipulation

Images imported from digital cameras or other sources can be easily bitmapped and registered on screens or keycaps. (The demonstration fish was created with the Development Support Tool.)

Screen-to-Screen Group Move

Screen data can be selected, grouped and moved to other screens.

●System Setup Example



Specification / Model		μTD4141	CTD5741	CTD1047
Display	LCD	5.7-inch, monochrome	5.7-inch, color STN	10.7-inch, color TFT
	Resolution	320 × 240	320 × 240	640 × 480
	Maximum digits	40 columns × 30 lines	40 columns × 30 lines	80 columns × 60 lines
	Effective display area (mm)	116 × 87	116 × 87	211 × 158
Key matrix input		10 × 6	10 × 6	13 × 10 (640 × 480)
Key size (mm)		12 × 14	12 × 14	15 × 15
Power supply		5V DC 0.8A	5V DC 1A	5V DC 1.2A
Dimensions (mm)		W189 × D112 × H32	W189 × D112 × H32	W272 × D205 × H43
Standard price		**$555**	**$740**	**$1225**

※Escutcheons and cases available for all models.

- Via RS-232C communications, simple commands let you easily display characters, draw graphics or collect key-input information.
- The built-in display memory can hold 4 full screens, making paging and other screen operations more convenient. (Up to 54 screens can be added with the Expanded Flash Memory.)
- Expansion features can be easily used with the Development Support Tool optional software.
- A wide array of characters can be displayed including kanji, kana, alphabet, numerals and special patterns.
- Key-input can be selected between polling and interrupt.
- Equipped with buzzer ON/OFF and backlight ON/OFF commands.
- Characters can be displayed as large as 64 × 64 dot.
- Easy backlight replacement (for color LCD models).
- Portrait monitor and RS485 model are available as special specification.

URL = http://www2.dango.ne.jp/onomichi/inh/

E-mail = inh@orange.ocn.ne.jp

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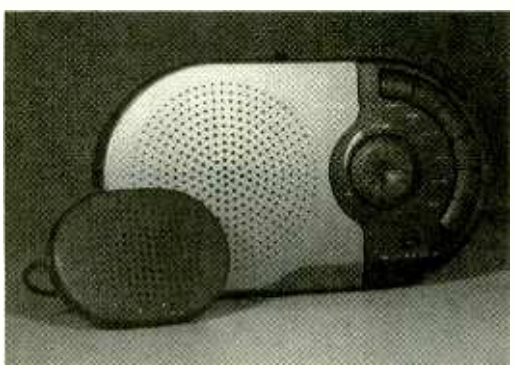
Study after study shows that Americans are starved for sleep. Many of us just can't seem to put aside the eight hours out of every 24 that experts recommend for shut-eye. But if your sleep deprivation stems from sleep *quality*, not quantity, you might just want to help yourself get some refreshing rest with the *Sleep Machine* ($39.95) from RadioShack.

The Sleep Machine produces six different sound effects intended to help you relax and fall asleep "naturally." You can opt to be lulled by the soothing sounds of a babbling brook or a tropical rainfall, lose yourself in the rhythms of a train or the pounding surf, be borne away on a gentle wind, or slip into some more generic "night sounds."



A sleep feature can be preset to shut off the system after 30, 60, or 90 minutes. You can listen to the speaker built into the main unit or to the pillow speaker that doesn't disturb anyone else who might be trying to get some shut-eye in an even more natural way.

Reading, Writing, and CD-ROMs

Ever wish you had so much space on your hard-disk drive that you'd never have to worry about running out of room? The *SCW-230 CD-R/RW* drive ($279) from Samsung's Storage System Division can make you feel that you have just that.

The SCW-230 offers 6X read and 2X write speeds, a 1MB data buffer, and a 350-ms seek time. The ATAPI drive comes packaged with everything needed for easy setup, including an audio cable, driver diskette, software driver, one CD-RW disc, one CD-R disc, Adaptec's *DirectCD Easy CD Creator* software, and a user's manual/installation guide.

It records up to 650MB of data per disc and uses the ANSI standard multimedia command set for maximum compatibility with software applications. The OPC error-reduction system ensures the ability to record to discs that have gotten some fingerprints or dust on their surfaces. The SCW-230 offers several recording methods, including Disc-at-Once (DAO), Track-at-Once (TAO), multisession, and fixed and variable packet writing.

Storage Media Storage

Once you start dubbing your own CD-ROMs, you'll probably find your collection growing in leaps and bounds. Case Logic offers CD-ROM storage solutions with its *KSR* line of cases made of durable, leather-like Koskin. The material is weather-resistant, and thick foam padding adds extra protection. The organizer line features patented ProSleeve technology with double-sided black pages that protect the delicate surface of the discs. A convenient thumb cut makes it easier to remove discs from its pages.

The three models in the line are designed to reduce desktop clutter and provide a means of safely transporting CD-ROMs for mobile use. The *KSR-24* holds 24 CD-ROMs or 12 discs with instruction booklets; the *KSR-48* holds 48 discs or 24 discs with booklets, and the *KSR-72* holds 72 CD-ROMs or 36 with booklets.

The CD-ROM organizers cost $11.99, $16.99, and $24.99, respectively.

Radar/Laser/Safety Detector

The *Performance Solutions* line of "radar" detectors from Beltronics includes the high-end model *BEL 880* ($239.95), which offers optimum sensitivity on all bands, including X, City X, K, Super Wideband Ka, laser, and instant-on detection. It also can pick up Safety Warning System (SWS)

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signals that, when transmitted, warn drivers as they approach potential hazards such as construction sites or accident scenes.

The BEL 880 features patented "Total

Tracking Laser" technology, which is said to ensure 360-degree laser protection. Twin laser ports, with front and rear detection diodes, are designed to capture diffused energy far outside the main laser beam for superior off-axis coverage and a wide field of view.

The unit's improved design is said to increase detection distance by a factor of two and reduce "falsing" alarms associated with highly sensitive radar devices. The detector provides digital voice prompts and/or audio alerts for X/K/Superwide Ka/radar, laser, and SWS modes. It also features a dot-matrix LED display to identify the radar band and signal strength via a bar graph and also to show feature selections, display FCC-approved SWS messages, and to indicate the presence of laser speed traps.

Road Warriors

Psygnosis brings road rage to the PlayStation and PC with *Rollcage* ($44.95 and $49.95, respectively), an "ultra-destructive, no-rules racing game." It's filled with fast and furious, armed and dangerous vehicles, capable of incredible speeds and outlandish maneuvers. Forget about staying on a track—these low-slung machines can race along walls and ceilings. Their indestructible designs allow them to survive death-defying flips, drops, and crashes, and keep on racing.

Winning requires more than mere speed. The vehicles are battle ready, and you pick up more weapons as you go. Playing dirty is encouraged—it's the only way to win this non-stop battle for road supremacy.

The game includes 20 tracks. Besides the 10 league tracks, three tracks designed for multiplayer gaming, and a practice track, there are several "ultimate-skill hidden tracks" that are located in four unusual racing environments where "the unique effects of alien gravity and local

weather can hugely affect the driving conditions." LAN and Internet play is supported on the CD-ROM version. A split-screen mode is included on both platforms.

Pager-Watch Combo

When a watch beeps, it's because an alarm has been set as a reminder, right? Well, usually. But if that watch is the *BeepwearPRO* pager-watch ($159; paging plans start at $8), that beep might be a page. Made by Beepwear Paging Products, a joint venture between Motorola and Timex, the device is touted as the world's smallest (1.3 ounces) alphanumeric pager. It incorporates patented Timex Data Link technology, which allows you to download schedules and contacts from a desktop PC and store up to 150 telephone and name entries. A tiny receptor on the watch face converts digital information from flickers on a PC monitor into stored text; the watch can serve as an instant link to daily calendar and scheduling information. Timex Data Link software is included on a CD-ROM.

The BeepwearPRO is also the first personal electronics communications device to use SkyTel's FLEX paging network to set and maintain accurate time even when changing time zones. From the moment the watch battery is inserted, a paging signal sets the watch to the correct local time. Whenever you enter a new time zone or encounter a Daylight Savings change, the watch resets automatically. No more will you have to remember to change it by hand.

The pager-watch can receive e-mail and can be programmed with up to 10 different alarms as daily, monthly, or yearly reminders of meetings, appointments, or anniversaries. The alarms can be set manually, by PC, or via a page. The paging function also allows someone to send you a page to inform you of a schedule change and simultaneously set an alarm to remind you of that change.

Now you won't have any excuse for

being late, missing an appointment, or forgetting your anniversary! (And they call that progress....). Of course, being human, we can still forget or ignore the reminders.

STAR LIGHT, STAR BRIGHT

"Did you ever think about the universe?" That phrase might sound like a relic from the psychedelic 60s, but we're serious here. The truth of the matter is that most of us haven't

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given much thought at all to the stars and planets that populate the heavens above us.

There were times in human history when the night sky was firmly entwined with religious and magical rituals, when people were intimately familiar with the constellations and the legends spun around them, when the stars were used to guide travelers—and when stargazing, instead of television watching, was entertainment at day's end.

But in today's world, our time is spent indoors. Our electric lights have dimmed the stars, and the limited astronomical information dished out in our high-school science classes has removed much of the mystery and magic from stargazing. Maybe a few of us glanced uneasily heavenward following last year's releases of *Armageddon* and *Deep Impact*. But, in general, unless we're vacationing far from the city lights or helping the kids with a science project, we don't have the time or the inclination to study the stars or to appreciate the majesty of the night sky.

Most of us can pick out the Big and Little Dippers, and perhaps the North Star, but that's as far as our knowledge goes. And that's a shame, because the same spectacular stars that entranced hundreds of generations of our ancestors are there for our enjoyment and enlightenment.

Now it's easier than ever to determine precisely which stars and constellations are in view, and to learn more about the universe in which we live, thanks to two different (but compatible in spirit) consumer-electronic products. From Excalibur Electronics comes the *Night Navigator* ($129.95), a handheld computer-based device that displays an image of the actual night sky above you and offers color-coded charts that explain what you're seeing, based on the location, time, and date that you input. For those who prefer to do their stargazing from the comfort of their desks, there's the *Planetarium Gold CD-ROM Gift Set* ($39.95) from JC Research. Planetarium Gold offers various views of more than 20 million stars, galaxies, constellations, comets, and planets. View the heavens from any spot on Earth or get a close-up with the Hubble Space Telescope view. Then pull out the included stellar scope and compare what's on your screen with what's in the sky. Before you know it, you'll be an amateur astronomer.

The Night Navigator

The notebook-size (10 × 12 × 1-½ inch) Night Navigator requires two hands to hold comfortably. Its top panel is dominated by a six-inch-square "sky chart display." Below that are a small LCD readout and control buttons. Three battery compartments on the rear panel hold a total of four AA and two C cells (not included). Don't try to install the batteries by the light of the moon; the two AA compartments are fastened by tiny screws that are easily misplaced even in well-lighted areas.

Setup requires inputting the current time and date (including whether or not Daylight Savings Time is in effect) and your location (latitude, and "magnetic" and time zones, all of which can be found on the maps provided in the manual). If you bring the Night Navigator on your vacation travels, you'll need to reset it to reflect it your new location and time zone.

The Night Navigator offers two modes: Find and Identify. In Find mode, you can search for specific stars, planets, or constellations. The "+" and "−" keys are used to select the category and scroll through the options displayed on the small LCD. If you're looking for the Big Dipper, for instance, the display would show the constellation's name and might say "viewable C15" above it. That lets you know that the constellation is visible, and that map C15 shows the current position of the Big Dipper relative to your time and location. (The first time we pulled the Navigator out of its box, in our office, every star, planet, and constellation was labeled "not viewable"—due to daylight, of course.) Press the SCROLL key to reach that map, and the Night Navigator literally scrolls through the sky charts that are rolled up inside it. You can even hear the mechanics whirring as the charts scroll. It might not be particularly high-tech, but it works. And it's a tremendous improvement over carrying one big cardboard map of the entire night sky, and a flashlight with which to read it.

The Night Navigator provides 16 sky charts. Each is a circular map of a segment of sky, showing the principal stars in red, with red lines connecting the stars within each constellation. The green lines show the ancient Greek inter-pretations of the constellations, from which their names were derived. Those names appear in green along the outside of the circular map outline. The names of nearby constellations—those falling just outside the map's boundaries—are printed in red.

You can adjust the brightness of the backlit display and the control buttons so that they are easily seen, but not distracting, in the darkness. A built-in magnetic compass allows the Night Navigator to determine which direction you must face so that the displayed map matches your view. The LCD readout tells you which way, and how many degrees, to turn. (It might say: "Viewable 060. <—Turn 336.") The Night Navigator beeps and a red light comes on when you're facing the right direction. Next, the unit tells you how far it must be rotated so that

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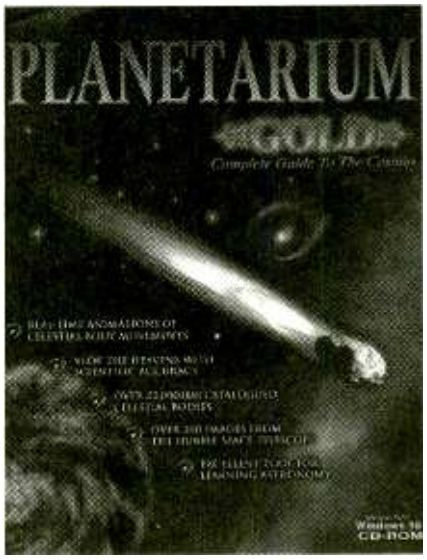
it is properly aligned with the view. Once again, it will beep, and a second red light will come on. When the beeping stops, the Night Navigator is properly oriented to your view of the sky. Finally, the LCD tells you where to look—low, mid, or high in the sky—to find the object that you are seeking.

The Night Navigator provides an easy, hands-on approach to astronomy. Perhaps our imaginations have been dulled by too many nights spent contemplating the TV instead of the stars, but without the red lines connecting the stars, and the turquoise drawings of their namesakes, we'd have a hard time identifying Orion as a hunter, or Aquarius as a woman pouring water from a jug. The Night Navigator made finding and learning the constellations fun instead of frustrating—and that was especially true for kids.

We all got a kick out of locating and identifying planets (many of us had thought that they were just bright stars). The manual offers dozens of helpful hints and interesting trivia, including: "To find a planet, look for a bright point that is not on your chart! Planets, from the Greek for 'Wanderers,' travel through the sky, from one zodiacal constellation to another... Planets are generally bright and don't twinkle as much as stars, offering a steadier light." The manual also offers "guided tours" of the seasonal night skies, pointing out special things to look for at different times of the year.

Far more detailed information can be found in the included brochure, *Navigating the Universe*. The 42-page booklet was written by Sam Lee, the inventor of the star-finding system on which the Night Navigator is based, with teacher and author Al Lawrence. It is full of FAQs (ranging from "Why is the sky blue?" to "What is the Doppler Effect?"); a look at our closest neighbors in the universe and our position relative to theirs; a discussion of attempts to measure the universe; "The Secret Lives of Stars," which takes into account the Big Bang theory and black holes; and pointers on watching meteor showers. It also examines the possibility of life on other planets, offers advice on making observations of the night sky, and provides helpful charts. The booklet is a pleasantly written, concise short course on astronomy—easy reading that complements the Night Navigator, and includes some colorful photographs of the planets.



If you find your curiosity piqued by the Night Navigator and "Navigating the Universe," you can check out *www.excaliburelectronics.com* to find monthly updates (written by the same authors) on what to look for in the night sky. In "Navigating the March Sky," for instance, they point out that Mercury is visible in Pisces at the beginning of the month, that Venus "continues to climb toward a March 19 rendezvous with Saturn"; that Jupiter and Saturn will be visible; and that Mars "shines brilliantly throughout the spring months and well into summer." The update tells you which Night Navigator charts to use for March stargazing, and presents a March calendar of celestial events, including two full moons.

The Night Navigator might not be particularly high-tech, it doesn't have any bells or whistles, and it's not exactly streamlined or pretty. Its elegance lies in its laid-back but efficient approach to introductory astronomy. It's easy enough for anyone in the family to use, and it's exciting to match the sky chart to your own view of the sky. And we're not sure which is better: That the Night Navigator inspires kids to ask questions like "Why does the same side of the Moon always face Earth?" or "What is a black hole?"—or that "Navigating the Universe" provides the answers!

The Armchair Astronaut

Planetarium Gold: Complete Guide to the Cosmos takes a more sedentary approach to star-gazing. You can get comfortable, pop in a CD-ROM, and explore the universe without leaving home (or even glancing out a window). You have your own planetarium at your fingertips.

The disc contains a huge amount of information and seemingly countless images—many from the unique and up-close viewpoint the Hubble Space Telescope. The program displays some 260,000 stars. More than 180 galaxies, star clusters, and nebula can be viewed, as well as 88 constellations with or without their lines and boundaries. You can see—in real time—the relative positions of the sun, moon, and planets; the phases of the moon; and the changing sky.

The main screen is a silhouette of the horizon, with scattered buildings and trees huddled under an enormous sky. That sky is populated with the actual planets, stars, and other heavenly bodies that would appear in the sky at the place and time you specify. The sky realistically brightens at dawn, dims at dusk, and falls dark at night.

The software allows you to view the sky from any position in the world (by inputting latitude and longitude) and from any time frame. It

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allows you to see what the ancient Greeks saw when they looked skyward and named the constellations, and to see how the planets were aligned at the exact moment of your birth. You can view simulations of upcoming astronomical events, such as solar and lunar eclipses; the grand planetary conjunction, set to occur on May 5, 2000, when Mercury, Venus, Earth, Mars, Saturn, and Jupiter will be aligned; and the return of Halley's Comet on July 31, 2061. Sounds pretty cool, doesn't it?

Well, it is—and it isn't. If you're an amateur astronomer, you'll love the unique views and in-depth information that's provided by *Planetarium Gold*. Ditto if you're trying to come up with a new angle for the old solar-system science-fair project or are researching a paper for your astronomy class.

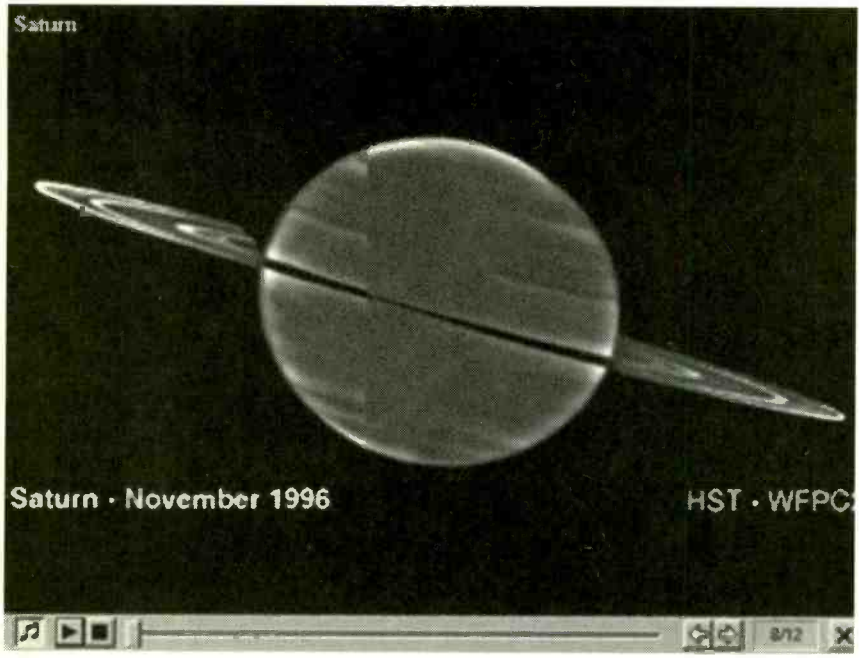
But *Planetarium Gold* is not *2001: A Space Odyssey*, with its grandeur and mystery. Nor is it *Star Wars*, with its action-packed adventure—or *Star Trek*, with its sense of discovery and fun. The program takes a cut-and-dried look at the universe.

Planetarium Gold packs in a lot of information, but packs very little punch. The female voice that narrates many of the animated sequences speaks in a computerized, clipped British accent, completely without inflection or spirit (and certainly none of the personality—or psychosis—of *2001's* HAL). Even the Trivia Quiz more closely resembles a pop quiz in astronomy than any game. It poses questions, and it supplies the answers. It doesn't give you points for correct answers or let you compare your score with those of other "players."

The *Planetarium Gold* Gift Set comes with a stellar scope, a small telescope-like device designed to take the place of paper star charts. Setup involves aligning the time and date units on the side of the scope, inserting the proper latitude adjuster ring (four are supplied: 50° to 60°, 40° to 50°, 30° to 40°, and 20° to 30°), and focusing the lens to compensate for your eyesight. The clock dial is also marked with N, S, E, and W. Whichever direction you face, the corresponding mark should be facing down. (For instance, if you want to observe the western sky, hold the stellar scope so that the W is facing toward the ground.) The view shown inside the stellar scope should closely resemble the night sky above you.

We enjoyed giving *Planetarium Gold* a workout. Perhaps it's because we have an innate interest in the sciences, although we've always been weak in astronomy. All the information we wanted was there, and we even began to feel "in command" of the night sky as we created simulations of astronomical events and viewed "time-lapse" versions of the heavens.

Had we not had that innate interest, however, *Planetarium Gold* would have left us cold. Although it's a fine program, don't expect it to turn your jaded teenager into a budding Copernicus.



The program's "telescope view" provides interesting shots of planets. According to the voice-over accompanying this photo, "This is a rare view of Saturn's rings seen just after the sun has set below the ring plane. The perspective is unusual because the Earth is slightly above Saturn's rings and the sun is below them. Normally, they would be fully illuminated by the sun."

The Next Wave

We had a Bose Wave Radio on the nightstand for a few years. It kept accurate time, didn't take up much room, had a neat little remote control, and it even had an audio-in jack for our portable CD player. Most important, the Wave Radio sounded terrific—at least until that unfortunate incident with a cat, a moth, and a glass of water left carelessly atop the radio. The radio ended up on our basement fix-it bench, awaiting the day when we come up with enough time to actually repair anything down there.

In the meantime, Bose has come

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up with a new and improved version: The *Wave Radio/CD* ($499). Standing only ¼-inch taller than the original model, the new unit incorporates a full-featured CD player. Otherwise, it retains the same shape and audio quality as the original.

It's been several years since we reviewed the Wave Radio, so let's recap some of its most pertinent features. At the top of the list is the patented waveguide speaker technology that manages to produce deep bass from a very small driver and enclosure. (The Wave Radio/CD measures just 4⅜ × 14 × 8½ inches.) The waveguide efficiently transfers energy from a small driver over a wide range of bass frequencies. The 27-inch waveguide is folded into intricate patterns to fit inside the Wave Radio/CD's compact enclosure.

The system includes an AM and FM stereo radio and a dual alarm clock. It provides 12 radio presets (six AM and six FM), inputs for an additional sound source, and a battery backup to save the alarm settings and station presets in case of a power failure. (Batteries are included for the remote control as well as for the backup memory.)

The Wave Radio allows you to fall asleep listening to one station and wake to a different one in the morning. You can even program it so that the wake-up station comes on at low volume and gradually increases until it reaches your preferred "wake up" setting. A credit-card-sized remote control allows easy operation from either side of the bed (which comes in handy when the one unit is used as an alarm clock for two people who wake at different times), or from across the room—which is the acoustically proper location for the system.

The remote control can be used to operate the radio and CD player, including volume and mute controls, tuning the radio up and down the dial or selecting preset stations, and scanning or skipping CD tracks. A small square of self-stick Velcro can be used to mount the tiny remote in a convenient location. If you constantly misplace remotes (as we do), we'd recommend adding a couple of extra mounting squares so you'd have one on each nightstand and one on the radio itself. The tiny remote manages to slip beneath pillows, fall under the bed, get closed inside the book you were reading before falling asleep, and otherwise disappear into thin air.

The same controls are found atop the Wave Radio/CD, along with those needed to set the two alarms and to select the CD mode (random or repeat). The sleep/snooze button is by far the largest, and is easily distinguishable by touch thanks to three raised dots on its surface. Unfortunately, all the other buttons are too similar. They're not segregated by function, and it's far too easy—when groping in a sleepy stupor—to hit the wrong one.

Using the Wave Radio/CD—whether as a radio, CD player, or alarm clock—is simple and straightforward. So is setting the time and alarms and programming in the preset stations. The CD compartment is built into the top of the unit, tucked neatly beneath the control panel. There is no powered mechanism to open the compartment; it simply lifts up. All of the usual CD features and

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modes are provided, and all are easy to access.

(It's occurred to us that the products that are most intuitive to use—the ones with which you can get by on the basics without referring to the user's manual—are those that come with the clearest, most well-written instructions. The Wave Radio/CD is no exception—its manual is concise, heavily illustrated, and has both a table of contents and an index.)

An AM antenna is built into the radio, and it's possible to adjust the AM reception by rotating the radio from side to side. The power cord serves as the FM antenna, although there's also a connector for an external FM antenna. Reception was better than that of most stereo receivers available today.

One of the best things about the new Wave radio is that it eliminates the need to keep a portable CD player on the night table. Now there are no more wires—unless you decide to take advantage of the new unit's inputs and hook up, say, a TV or computer. Adding the Wave Radio/CD to the typical TV and VCR found in a bedroom can significantly improve their sound.

Should you decide to use the system in a home office, your PC can be connected to it for improved sound from games and other programs. Note that the Wave Radio/CD's speakers are not magnetically shielded, so the radio must be placed at least 12 inches from a TV or monitor to avoid any interference. It's also possible to connect powered speakers (with volume control) to the Wave Radio/CD, or to use it as an extension of the Bose Lifestyle music system.

Wherever and however you choose to use it, you're sure to like the sound generated by the acoustic waveguide, and the convenience offered by this streamlined audio system.

Running Hot and Cold

When we had an addition put on our house a couple of years ago, we had the contractor make the upstairs a separate heating zone. Downstairs, we have a pretty accurate thermostat. Set it at 65°, and it will be comfortable. Upstairs, it's a different matter altogether. The numbers printed on the face of that thermostat have no discernible relation to the temperature. Sometimes a slight adjustment causes the temperature to spike or drop dramatically; other times, a good spin of the dial has no obvious effect.

Yes, we could just replace it. In fact, that's item number 78 on our indoor to-do list (which loses precedence during the warm months to the just-as-lengthy outdoor to-do list). In the meantime, we can set Oregon Scientific's *Model EMR-812A* ($78.95) cable-free thermometer on our kitchen counter. From there, it can conveniently show us if we're wasting fuel oil heating the upstairs to 95 degrees when no one's even up there, or if we're in for some shockingly cold feet when we go upstairs to bed.

The EMR-812 is an indoor/outdoor thermometer that can monitor up to three different areas of the home and yard. It comes with a main unit with built-in temperature sensor and a large LCD readout. One weather-resistant remote sensing unit, with its own LCD readout to show the temperature wherever it is located, is also included. Two additional remote sensors can be added. The standard unit (model *THR-128*) costs $29.95, and a weatherproof, wired probe (model *THC-128*), intended for monitoring swimming pools, spas, or aquariums, costs $35.95. The remote units use radio frequencies to send temperature data to the main unit from as far as 120 feet away. Each runs on two AAA batteries.

The main unit, which is powered by two AA cells, can be wall mounted or propped upright on its table stand. Its most distinctive feature is a 2-½ × 3-inch display—large enough to be seen clearly from across a room. Below the display are three blue buttons; two speakers round out the front panel. The CHANNEL button is used to select channels when more than one remote sensor is in use. The MEMORY button is used to recall the minimum and maximum temperatures; the CLEAR button erases those temperature limits.

As soon as the batteries are installed, the main unit begins searching for signals from the remote sensors. The display is divided into two sections. The upper portion shows the temperature at the remote location, while the lower line shows the temperature at the main unit. All readings are continually updated at 30-second intervals. The upper portion also includes a "kinetic wave" display that indicates signal strength, and a temperature trend icon—an arrow pointed upward, downward, or horizontal depicts rising, falling, or steady temperature.

The EMR-812A allows you to set minimum and maximum temperatures for each zone. If the reading drops below (or climbs above) the programmed "comfort zone," an alarm will sound. The buttons used to set the high/low temperatures and to turn off the alarm are found on the rear panel of the main unit.

The wireless configuration makes it easy to track temperatures from floor to floor, inside and outside. Monitor the temperature out in the garage, down in the wine cellar or workshop, or in the garden or greenhouse without running lengths of cable all over the property. Keep tabs on the temperature in your swim-

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ming pool or aquarium with the THC-128 probe. Or, in our case, keep the upstairs heat on an even keel, avoiding high oil bills or pneumonia-inducing chills.

GIZMO NEWS

Future Computers?

What's in store for the manufacture of computers? DNA, says one research team. Laser-tooled chips, postulates another.

Researchers at the University of Basel in Switzerland discovered that DNA can act as an electrical conductor, operating as efficiently as a good semiconductor, but not as well as copper. According to Hans-Werner Fink and Christian Schoenenberger, DNA strands could be used to build tiny electrical devices—if the strands could be made with an "on/off" switch to control the current flowing through them.

A DNA strand is much smaller and more regular than any metallic wire. A strand is 44/1000 of the diameter of the average human hair (or two billionths of a meter thick). What's more, it might be possible for DNA strands to wire themselves together. The researchers noted that the molecules at the end of DNA strands will attach themselves to some other molecules. That opens the possibility of creating a wiring grid by laying down those target molecules as terminals and letting the DNA strands attach themselves.

Meanwhile, a team at the National Institute of Standards and Technology (NIST) in Gaithersburg, Maryland, have invented a device that shoots streams of atoms in any direction, just as a laser sends out beams of light. Such an "atom laser" might be used in a new tool for making tiny computer chips, according to William D. Phillips, who headed the development team.

"An optical laser works by sending out a very narrow beam of photons," said Phillips. "An atom laser works like a light laser, except it is sending out atoms instead of photons."

The concept behind the atom laser is not new. In fact, it can be credited to Albert Einstein, who suggested 70 years ago that matter would reach a bizarre state if all the atomic motion in a cloud of atoms could be brought to a near standstill. The lack of motion causes the temperature of the matter to drop almost to absolute zero and the atoms to link up in a lock-stepped single unit. Work done four years ago in Colorado resulted in the development of a Bose-Einstein condensate, produced by using magnetic fields to still a cloud of atoms. In 1997, MIT researchers created an atom laser using a technique that allowed the atoms to spill downward in response to gravity. The MIT atom laser created a dripping mass of atoms instead of a single narrow beam.

The NIST team created a Bose-Einstein condensate out of sodium. They then used two pulsing lasers to hit the frozen cloud at slightly different frequencies, which caused the sodium atoms to escape and move outward in a coherent beam—the atom laser.

Phillips noted that the atom laser could be used to create precision measuring and navigation devices that could be up to ten times more accurate than those based on optical laser systems.

Busted!

Working on information supplied by the Motion Picture Association of America (MPAA), the NYPD raided the facilities used by a video counterfeiting ring this spring. Authorities estimate that the pirating operation grossed $15 million dollars a year and cost the industry $35 million in sales.

At the time, many of the videos seized by police—including *The Rugrats Movie* and *Saving Private Ryan*—had not yet been legitimately released on videotape, and one—*The Mod Squad*—hadn't even debuted in theaters yet.

The 22 suspects arrested in "Operation Rewind" face felony charges of trademark counterfeit and criminal possession of forged devices, among others. In raids of 15 locations in Manhattan, Queens, and the Bronx, more than 32,000 bootleg tapes, each with an estimated street price of $8, were confiscated. Police descriptions of the facilities painted a picture of dozens of slave VCRs duping copies simultaneously from one master tape. More than 1000 VCRs were also confiscated from nine illegal labs. The other locations that were raided included a dye cutting operation and a print shop where packaging materials were produced, as well as warehouses and distribution centers.

Major-Label MP3 Recordings

If you can't beat 'em, the recording industry figures, you might as well join 'em. By the holiday season, the recording industry will be offering MP3-encoded music files for sale over the Internet.

It's been estimated by Jupiter Communications Group that online music sales will grow this year from $200 million to $1.6 billion—but only 2% of that represents digitally distributed files. Two factors are seen as crucial to driving the developing market for downloadable online music: pricing of music files, and the availability of portable playback devices.

The popularity of MP3 music files has been soaring, leading to the introduction of portable MP3 players like Diamond Multimedia's Rio. Most of the music available in the format, however, is being distributed illegally, with no respect for copyrights. The recording industry is attempting to come up with a way to offer music that is copy-protected and "watermarked" so that copyrights are protected and the source of a file can be traced. The major labels have formed the Secure Digital Music Initiative (SDMI) to accomplish that goal.

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A Hands-on Electronics® REPORT

Sharp TelMail TM-20

Stay in touch via e-mail wherever you go, without lugging around an expensive and heavy laptop.

Travel a lot? Or, perhaps, are you simply on the go most days? If you've become dependent on the convenience of e-mail, yet find yourself away from your PC far too often, you might be wondering if there's a way to access messages while on the road. Sure, you could buy a handheld PC (HPC) or laptop, but these range from $500 for a typical HPC to thousands for a notebook computer. If all you want to do while traveling is just read and send e-mail, paying such exorbitant prices seems ridiculous.

Fortunately, there is a better, more economical way to stay in touch.

Mail in a Pocket. The folks at Sharp Electronics have come up with a handheld computing device that will give you easy access to e-mail at an affordable price. Called the *TelMail TM-20*, it's an 8.5-ounce digital companion that will fit in most any jacket pocket or purse, yet which packs a world of usability.

First there's the e-mail capability. With the TelMail, you don't need to find special payphones with RJ-11 jacks or carry special cables. The bottom of the device is a wonderfully innovative acoustic coupler, allowing you to press two adjustable transceivers against any telephone handset. A button on the other side will let you transmit and receive e-mails as the TelMail modulates the data acoustically. Essentially, this process is a modern version of the way the very first modems worked.

Who's on the other end of the phone? We'll deal with the service involved in the next section; for now, let's look some more at the device itself.

With TelMail, you can receive and compose and send messages of up to 4000 characters each. Averaging 700–800 words, the size of the messages is hardly what we'd call a limitation. While the small device

doesn't exactly have a touch-type-size keyboard, you'll be pleasantly surprised by how easy it is to deal with for e-mail and organizer tasks.

Speaking of organizer tasks, the TelMail TM-20 lets you bring more than just e-mail with you. You can store e-mail and street addresses and telephone numbers in the Address mode, and simple appointments in the Schedule. The Anniversary mode helps you remember important dates, and there's even a Memo function for keeping notes. Amazingly, the little device can even send faxes.

All these functions can be enjoyed on a 40 × 7-line screen, with a backlight that you can switch on for viewing in poor lighting conditions. Also to make reading easier, the TelMail's font size can be easily changed to a large size.

Because you may find yourself using the TelMail a lot, the folks at Sharp developed a PC transfer system to let you interface your acquired data with a computer. The cable and software are included in the box.

The TelMail will run for a long time, too. Without the backlight you can get about 50 hours from two AA batteries. Now, on to how you can make good use of that battery life.

Affordable Service. While wireless Internet-access accounts have high monthly rates and per minute (or message) charges, the Sharp TelMail TM-20 can be used with a truly economical wired service. If you can find a payphone and dial a toll-free number, you can connect to PocketMail.

When you first get your device, you have to call and activate an account with PocketMail. Then, you can dial an easy-to-remember 800 number to access the service from anywhere (you can even use a cell phone, though you'll be charged for the time by your wireless provider).

While the PocketMail service will provide you a new e-mail address (your_name@pocketmail.com), you can also access any preexisting POP3 or IMAP4 accounts you might already have. PocketMail has even devised a way for AOL and CompuServe users to get copies of e-mail. Corporate users may have to set their company accounts to auto forward messages while they are away.

The PocketMail service costs only $9.95 a month for unlimited service, and your first month is free. No matter how often you use the service, or how many messages you move back and forth, your monthly bill remains the same. The only additional charge is $0.25 for each fax you send.

The Sharp TelMail TM-20 retails for $150. Contact Sharp Electronics Corp., Sharp Plaza, Mahwah, NJ 07430-2135; Tel. 800-BE-SHARP; visit the company's Web site at *www.sharp-usa.com*; or circle 50 on the Free Information Card. ■

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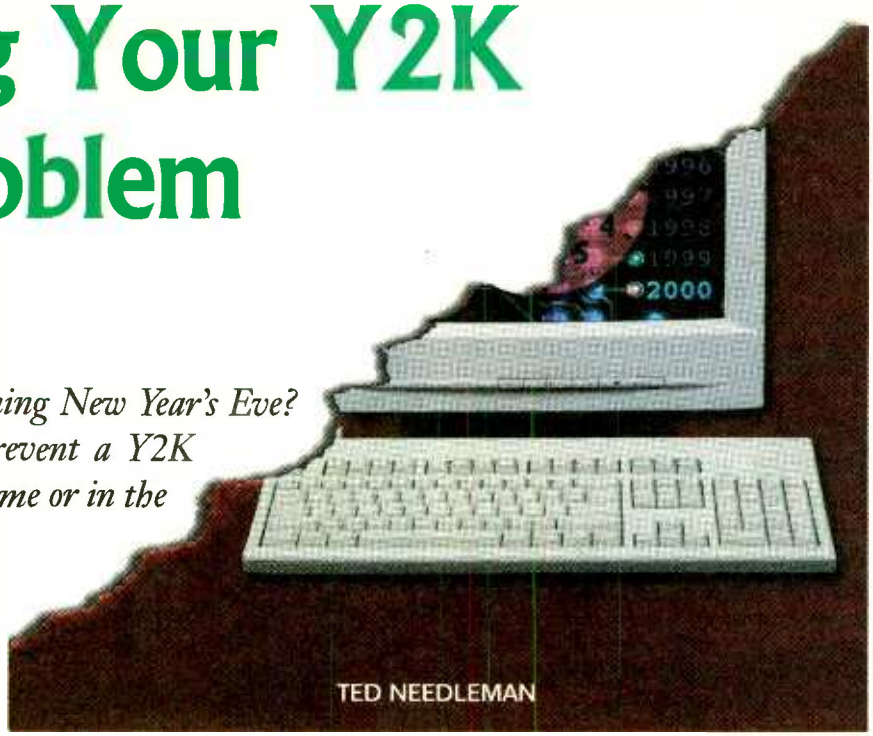
Solving Your Y2K Problem



Is your PC in danger this coming New Year's Eve? Learn what you can do to prevent a Y2K calamity from happening at home or in the office.

With the new millennium only months away, the big question among computer owners is: what will happen when the calendar flips over to January 1, 2000? There's been a lot in print and on television about the chaos that might erupt. While there's not much you can do about all of the potential problems we talk about in our "Will the Clocks Stop?" article in this issue, you can check your PC or laptop to see if it can handle the changeover to a new century. If it can't, there are a variety of products that may help alleviate the problem.

Not A Single Problem. Much of the talk in the press gives the impression that there is only a single "Y2K" problem. In reality, things are a bit more complex. There's the external Y2K problem, which affects the mainframes running many of the businesses and processes that surround us, and then there are the potential problems with the PCs in your home, office, or business. And even with "your" computers, the Y2K problem is more than just a single one. The external problem is one you'll have to leave to others to solve. However, you probably can solve many of the potential Y2K problems affecting your own systems, but even with some of these, you may have to rely on others to provide a fix.

That's because the problems we all face with the next millennium (of course, the real millennium doesn't begin until 2001, but to keep matters simple we'll refer to Y2K in such a way) are a result of how dates are handled by hardware and software. And it's not really a millennium problem, but one posed by going into a new century. When computers came on the scene about 50 years ago, no one had any idea of how pervasive they would become. And programming languages were optimized to make the most efficient use of very sparse computer memory. While 64 megabytes (MB) of random-access memory (RAM) is now commonplace, the first transistorized Philco and IBM computers had a meager 4 kilobytes (KB) of magnetic-core RAM. This memory was made up of fragile magnetic-ferrite rings, and difficult and expensive to manufacture, as well as requiring extensive circuitry to read and write.

Things didn't improve that much during the 60s, where 16KB of magnetic-core memory was considered enough. And even multi-user System 360s of the 1960s frequently made do with 64KB of main RAM. The advent of semiconductor memory helped a lot, but megabytes of RAM really didn't become common until well into the 1980s. And it wasn't until the last five years that 8MB or more of RAM started to become affordable to many users.

And lack of memory, more than anything else, is what got us all into this jam. With the need to be as efficient as possible, early computer languages and programmers took to using only the final two digits of the year, figuring the "19" part was inferred. Even with languages that allowed the year to be stored as a four-digit number, many programmers simply didn't bother. That attitude was carried forward into the system clocks and BIOS code of many of the PCs still inhabiting desks, especially with those BIOS chips produced before 1997. And some PCs have real-time clocks (RTCs) on the system board that will suffer a grim computing fate. When the clock strikes twelve on December 31st of this year, there will be lots of computers that don't correctly record the new date of January 1, 2000. Some will default to the earliest date contained in the BIOS chips, 1980 or so others will roll back the clock 100 years to 1900. And even if the BIOS handles

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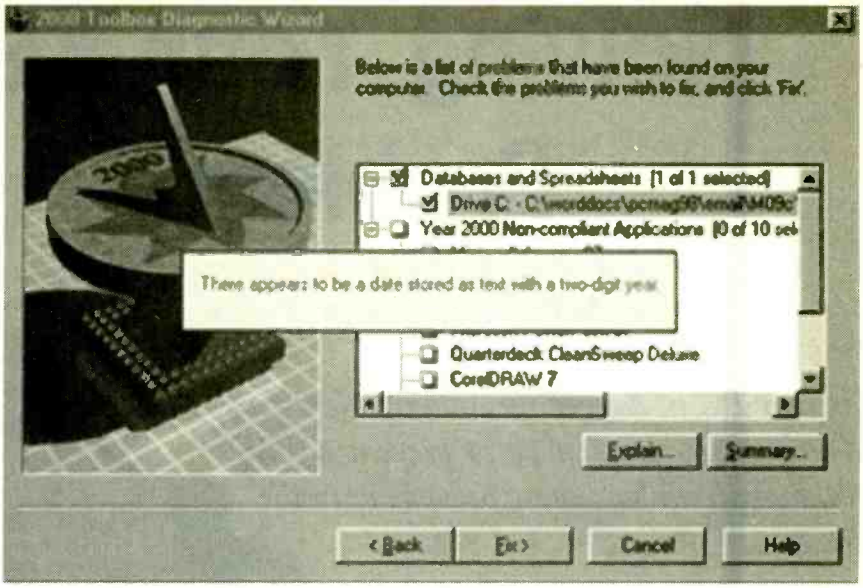
dates correctly, there's always the possibility that the RTC won't. Many newer PCs, however, will click over to the correct date just fine.

If yours is one of the latter, you're still not necessarily out of the woods. Even if your hardware is fine, you may have a problem with applications that incorrectly maintain the date. Popular applications such as some versions of Microsoft's *Access* database and Lotus *1-2-3 97*, are fine with some dates, but stumble with others. And even Microsoft's brand new Windows 98 operating system has a few Y2K bugs that have recently been uncovered. Any of these can sneak up on you, and you may not discover some of them for years. And even if all of your software appears to work perfectly, you can be sure that there is somewhere, in one of your applications, where you have defined a date as a two-digit, rather than a four-digit, year. You may not discover it until you load a predefined report format, but there will be few users entirely unaffected by the Y2K problem.



The reports that McAfee 2000 ToolBox *generates are a bit less comprehensive and useful than those provided by* Norton 2000.

Don't Panic Yet. Addressing the Year 2000-compliance question is a multiple-step process. The first step is to test the different aspects of your hardware, including its BIOS and realtime clock, to see how they handle the switchover. If there's a problem with either of these areas, you then need to see if (and how) they can be addressed. Some BIOS PROMs are flash upgradeable. If your PC is lucky enough to have one of these, and it's from one of the major BIOS providers, such as Award, AMI, or Phoenix, you will generally be able to download a BIOS fix over the Internet or from the vendors' Bulletin Board System. You can then "flash," or rewrite, some of the internal BIOS code that deals with how dates are maintained. If you have a non-upgradeable BIOS, or perhaps your BIOS vendor is out of business, there are a number of other solutions reviewed here that allow you to either patch the BIOS and/or realtime clock with new code that fixes the problem, or replace your system's BIOS with a new one, contained on a plug-in card.

Once that's been handled, step two is to check your applications for Y2K compliance. And if a problem is found here, to try to obtain a fix from the software vendor. There are a number of software utilities that claim to test applications for Y2K compliance. Another approach is to make a list of all of the software applications in your inventory, including the version number, and check the vendors' Web sites for notices and patches that correct the problems.

Finally, good back-up protocols become even more important with the potential for Y2K problems. These require both complete and incremental back-ups. And, with the possibility of file and data corruption pretty much at any time after January 1st, maintaining a copy of the complete backup on a weekly basis is probably a good idea. That way, you can go back a week, a month, or even before the first of the year, should it become necessary. If you don't already have a high-capacity backup device, such as a tape drive or CD-R/RW, now would be a good time to spring for one (we look at a CD-R/RW drive in this month's *Computer Bits*). And if you have multiple PCs that you'll need to back up in this manner, a parallel-port drive that you can move from PC to PC is a great idea.

To help you in your Y2K efforts, we examined a half-dozen products that offer various solutions to diagnosing and alleviating the date problems. Three of these are software only, the other three are combinations of hardware and software. Obviously, if you are testing a laptop, a hardware/software solution will be difficult to implement.

Keep in mind that some of these products are dedicated to uncovering a problem; others are oriented towards fixing problems that you've found. And many of the utilities and fixes are of limited use if you are primarily a DOS user or using early versions of Windows such as 3.1.

To be honest, however, none of the solutions detailed here is foolproof. Even if you replace both your BIOS and RTC with new hardware, and are able to catch the majority of your applications' date-handling foibles, there's no guarantee that you will have caught every problem that might arise. Realizing that possibility, maintaining good back-up procedures, and not getting overconfident provide the best assurance that you won't eventually get burned by the computer industry's shortsightedness.

Before We Proceed. The half-dozen cards and utilities detailed here all have one thing in common. They assume you have a problem with Y2K that needs to be adressed. Even the three software utilities are oriented towards repair,

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t the McAfee and Norton utilities also test your software applications for compliance.

But assume for a moment that you are not all that interested in finding out if you have a problem with applications. Perhaps you are more than happy to check on vendors' Web sites for potential problems. Do you then have to spend some bucks just to find out if your BIOS and RTC will correctly handle the century switchover?

Not if you have access to the Internet. All of the vendors detailed in this article provide free downloadable software that will test your hardware to see if it will handle the rollover. In fact, only one of the three hardware cards comes with a software test packed along, the other two vendors assume that you'll first download a diagnostic to see if there's a problem, before you spring the bucks for a solution that might not be needed.

It's probably a good idea to download a diagnostic or two, and run them on your hardware just to be sure. But keep in mind that the Y2K problem is not just a hardware one. Even if your free diagnostics indicate that your hardware is okay, you may still want to purchase a utility like those from McAfee or Norton that checks, and hopefully fixes, the date problems in your software applications.

Software-Only Solutions. The following are some solutions for Y2K that do not require you to open up your PC's case. For some, this is a good thing, but be sure to check out the hardware options that we look at later before you decide if software alone will handle your particular problem.

Network Associates
McAfee 2000 ToolBox
$29.95 (ESP)

The least expensive product we looked at, *McAfee 2000 ToolBox* is like a Swiss Army knife. It has Y2K diagnostics, and just so that you don't feel you paid too much, also includes a potpourri of additional utilities including VirusScan, WinGauge, McAfee Image, and Rescue Disk.

As with the Norton product, *McAfee 2000 ToolBox* is Wizard driven, so you don't need to even crack open the manual to use it effectively. The first option you are offered is to check whether any updates have been posted online; and to have the most complete application checking, it's advisable that you allow the product to download any available updates to itself. To do this, however, you will have to establish an Internet connection before running the update Wizard. Once this is done, the rest of the update process is automatic. The *2000 ToolBox* checked, found that a new version was available, and asked our permission to download it. The download took a fairly long time, in excess of a half-hour, but the process doesn't require any intervention, so you're free to work on other tasks.

The *McAfee 2000 ToolBox* installs from CD-ROM, and our box did not contain an offer for diskettes. This may present a problem for some older PCs without a CD-ROM drive. For those users, an electronic version of the product can be pur-

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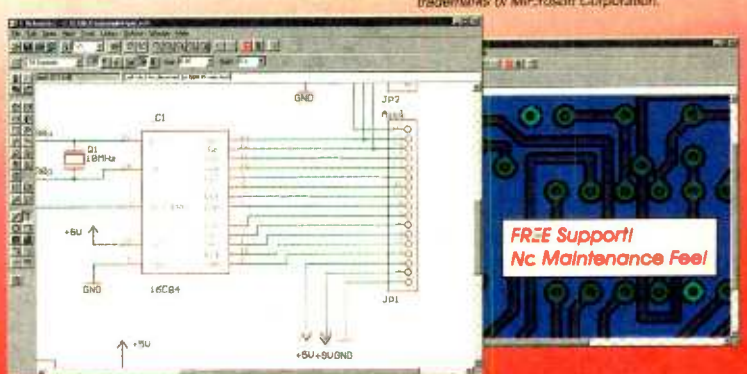

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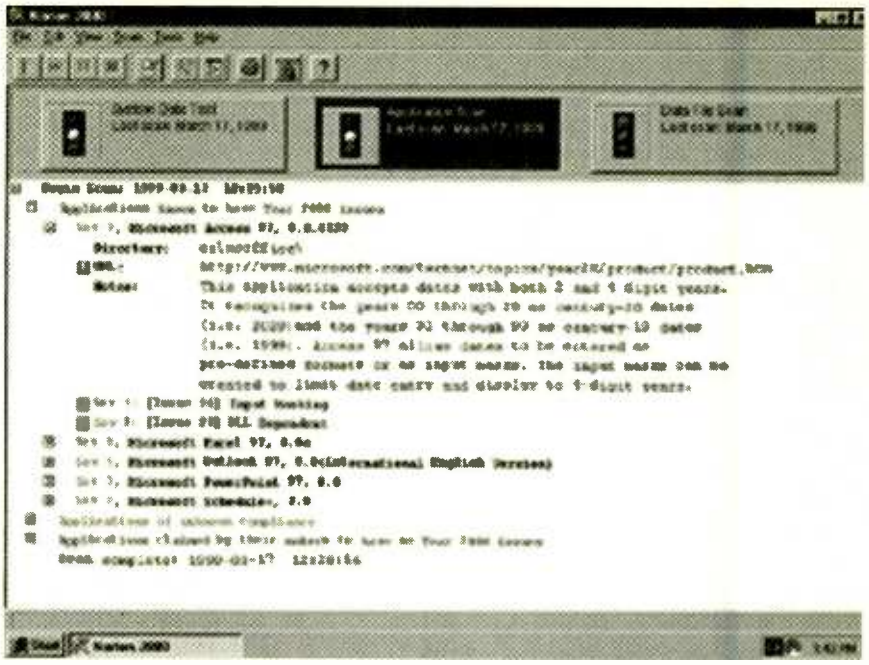
chased and downloaded from the vendor's Web site, bypassing the problem. And the utility is strictly for Windows 95 and 98 users; others need not apply. In our testing, *McAfee 2000 ToolBox* did find, and apparently fix, the BIOS problem in an older Pentium desktop and 486 laptop. It also provided a list of applications that might have a Y2K problem. In many cases, however, the only information on fixing the problem was to contact the vendor. Some problems, however, such as two-digit years in spreadsheets, can be fixed by the *2000 ToolBox*.

We also found the manual a bit on the sparse side, with just a few pages dedicated to each of the additional utilities included. That situation, however, is not at all uncommon. Most of the products we examined sport miniscule documentation, leaving the screen display to carry you through using the software.

Considering its inexpensive price, *McAfee 2000 ToolKit* is not a bad value. For serious Y2K diagnosis, however, we prefer the more detailed information provided by the *Norton 2000* utility. If we were just looking to fix our years-old laptop, however, the thirty-buck McAfee product would be our choice.



In addition to checking your hardware, Norton 2000 *checks your applications for Y2K problems.*

Symantec
Norton 2000 $49.96 (MSRP)

From the creators of the famous *Norton Utilities* and *Norton Antivirus, Norton 2000* is basically a diagnostic utility, able to check the system BIOS and realtime clock, as well as application software on your PC. It runs only on Windows 95/98 and Windows NT. If you are using an earlier version of Windows, or still running primarily on DOS, you won't be able to use most of the Y2K utilities. And *Norton 2000* is available only on CD-ROM. If you lack a CD-ROM drive, you will not be able to use this product.

Installation is quick and easy, and *Norton 2000* has Wizards that walk you through both installing and using the product. As part of the installation process, you are asked if you want to check for updates, and *Norton 2000* uses LiveUpdate to provide this capability. You can also choose whether to update through the Internet, or directly with the BBS that Symantec maintains for this purpose. We chose the BBS route, and the software found our modem, dialed the number, and downloaded the update and installed it. This was a long-distance call, but took less than 10 minutes to complete the process with no Net traffic slowing us down.

Norton 2000 is primarily a diagnostic product, but it also goes pretty far in helping you fix whatever problems it finds. There are three analysis engines, and you can use the Wizard, which goes through the entire process, or once you become familiar with *Norton 2000*, use the simple controls the software provides. One of the trio of analysis engines looks at your hardware, and if it finds a problem with the BIOS or RTC you can use an included patch routine to provide a software-based fix. For maximum safety and reliability, the *Norton 2000* utility lets you create a separate boot diskette to run this test from. In our testing, running this test both from Windows, and from the separate boot disk, indicated a BIOS and RTC clock problem on the older laptop we knew was affected.

Norton 2000 also provides two software analysis engines for testing a variety of applications, as well as data files used in spreadsheets and databases. Visual Basic code and Macros are also analyzed to determine Y2K compliance. A comprehensive report is generated from these tests with potential problem areas highlighted directly in the affected files, and *Norton 2000* will fix two-digit date use by recreating the file with a four-digit year, where you instruct it to do so.

Of the three software-oriented products, *Norton 2000* provides the most comprehensive Y2K problem reporting capability and appeared to fix the problems it uncovered on our test systems. We also liked the quick update, and the typical Norton quality.

The About Time Group
EZ Check 2000/PC Fix 2000
$74.95 (ESP)

Unlike the vendors that created the other two utilities covered here, The About Time Group was formed in 1998 specifically to produce software to deal with the Y2K problem on PCs. The result is *EZ Check 2000* and *PC Fix 2000*. The *EZ Check 2000* utility tests a PC for BIOS and RTC accuracy rolling over to a number of dates on and after 1/1/2000, while *PC Fix 2000* patches the hardware if a problem is uncovered. The About Time Group was offering the *EZ Check 2000* utility free on its Web

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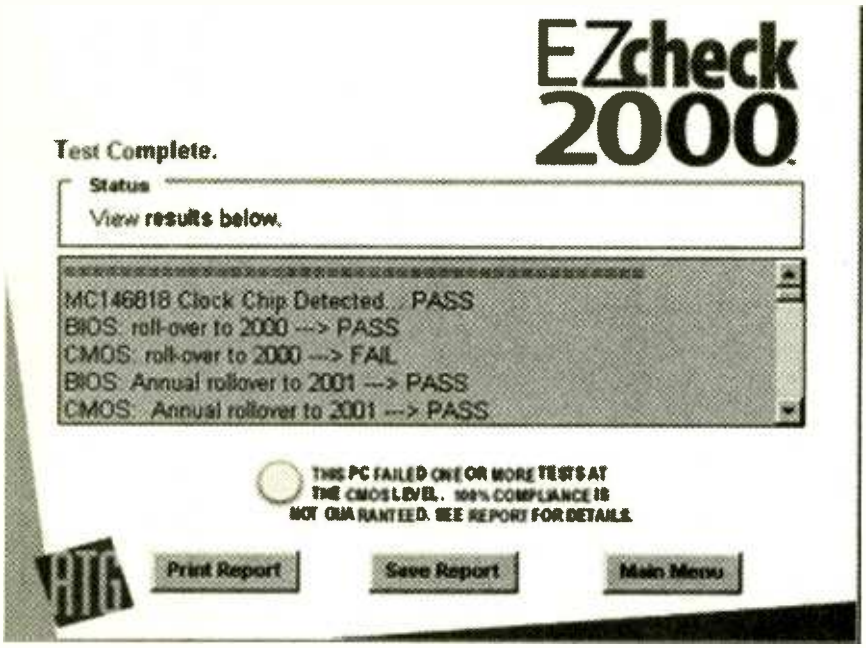
site as of the time of this writing, and was considering charging $14.95 for it after the end of March.

In some respects, the *EZ Check 2000* is much more limited than the other two utilities we tested. It looks only at the hardware and assumes that by fixing the RTC problem (if one exists), any software incompatibilities will no longer be an issue. Because of this, *EZ Check 2000* has no facilities for examining software incompatibilities in the manner of *McAfee 2000 ToolBox* or *Norton 2000*. And, in fact, while *EZ Check 2000* told us of a problem with the RTC on one test system rolling over to 1/1/2000 (the rest of the testing was fine), it did not pick up that we had the date format in Windows set to two digits. Both of the other utilities picked this right up.

Once *EZ Check 2000* uncovers a potential hardware problem, you can run the vendor's other utility, *PC Fix 2000*, to correct it. As with *EZ Check 2000*, *PC Fix 2000* can be downloaded from the vendor's Web site, so unlike the other two utilities we tested, you don't need a CD-ROM drive to install it. Running *PC Fix 2000* is easy; the utility requires no expertise to use, and "repair" of your hardware is quick. Once "fixed," our laptop was shown to be okay when we ran *EZ Check 2000* and the other two utilities.

EZ Check 2000 and *PC Fix 2000* do precisely what they claim to do. Our only worry is that there is really no way to know if a hardware-only fix is enough to completely safeguard you against a future Y2K-oriented disaster. And the hardware fixers in the other utilities also seemed to cure our BIOS and RTC problems. At $79.95, *PC Fix 2000* was the most expensive of the three software-oriented utilities, almost three times the price of the McAfee product. And while we weren't disappointed with it, we're also not certain that it's worth the extra cost.

Hardware Solutions. Now we get to the real hands-on approach to Y2K—a reason to pop the lid on your PC. While these plug-in cards are somewhat similar, we tried to point out the differences worth noting.



EZCheck 2000 *checks only your BIOS and realtime clock for Y2K problems.*

AMI2000
Year 2000 BIOS Enabler $74.95

AMI2000 is a division of popular BIOS and motherboard manufacturer AMI (American Megatrends). So the company has plenty of experience in knowing how the hardware handles Y2K issues. As with the other two hardware solutions, the Year 2000 BIOS Enabler is a small plug-in ISA card which, when installed, intercepts calls to the BIOS for a date and time, and substitutes the system's RTC data with the date and time generated by the clock on the Enabler. In this respect, it is almost identical to the other two cards we tested.

AMI2000's Year 2000 BIOS Enabler hung up our system initially. But we got it going with just a quick jumper change.

Unlike those cards, however, the AMI2000 Year 2000 BIOS Enabler hung up our system when first installed. The card has a set of jumpers to set the address space the card will reside at, but there is no diagnostic included to help you determine if the card's default (C8000h-CBFFFh) is actually available. The card does have a sparse manual, which suggests that you use *AMIDIAG* (a retail diagnostic package) to check this. We fortunately had a copy of SiSoft's *SANDRA* diagnostic, a shareware program that provides extensive address-usage information (among other system data), so we were able to find an empty address space to set the card to. After we did this, the card worked perfectly.

Micro2000's Centurion was the only card that came with a program to test your PC for a problem with the BIOS and RTC.

Not only does the BIOS Enabler

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VENDOR INFORMATION

Centurion
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800-864-8008
www.micro2000.com

McAfee 2000 ToolBox
Network Associates
3965 Freedom Circle
Santa Clara, CA 95054
800-332-3832
www.nai.com

Norton 2000
Symantec Corporation
10201 Torre Ave.
Cupertino, CA 95014
408-253-9600
www.symantec.com

EZ Check 2000/PC Fix 2000
The About Time Group
4151 Ashford Dunwoody Rd.,
Suite 515
Atlanta, GA 30319
404-255-2660
www.pcfix2000.com

Millenium/Pro
Unicore Software, Inc.
1538 Turnpike St.
North Andover, MA 01845
800-800-BIOS
www.unicore.com

Year 2000 BIOS Enabler
AMI2000 Corp.
6400 Regency Parkway
Norcross, GA 30071
800-892-6853
www.ami.com/y2k

come without diagnostic software, it also doesn't include a Y2K test program either. One is available for free download from AMI's Web site, or you can use one of the software utilities above, and if you find a BIOS/RTC problem, use the AMI2000 BIOS Enabler (or another card) to provide a comprehensive hardware/software solution.

As with all of the plug-in cards we looked at, the AMI2000 Year 2000 BIOS Enabler addresses only the hardware side of the problem. And it was a little more difficult to install than either of the other two cards. Still, AMI does have a lot of experience in BIOS creation (it is one of the major BIOS providers in the industry), so we feel pretty confident that the BIOS Enabler does truly correct the BIOS and RTC problem.

Micro2000
Centurion $69.95

All three hardware cards, including Micro2000's Centurion, effectively provide the same function, intercepting calls for the time and date, and supplying this information from a replacement clock on the add-in board. As with the other two, the Centurion is an ISA card that can be installed in any free slot on your system. There is a small set of jumpers on the card so that you can change the I/O and ROM memory addresses, but we found it unnecessary to do so in our testing. We simply plugged in the card, and booted up. All of our tests using both the included test program and several of the software utilities we tested indicated the older desktop system we used was now Y2K compliant, at least as far as the hardware was concerned.

The Micro2000 Centurion was the only card of the three to include a test program with the hardware, so you don't need to download it (though it is available on the vendor's Web site, so you can test your system before buying the card). And the manual, though only a few pages long, is enough, since installation and use is essentially just plug and go.

As with the other two cards, however, the Centurion is only a fix for the BIOS/RTC problem; it does not address the way application software, such as *Excel* and Lotus *1-2-3*, may handle dates internally. And, as with the other two cards, you may want to consider using the card as part of a more complete solution.

Unicore
Millennium/Pro $69.95

Like AMI2000, Unicore is also a division of a BIOS "biggie"—Award Software. As such, Unicore is in a good position to address the Y2K problems that result from old BIOS and RTC inadequacies. If you don't mind pulling a chip or two, Unicore can supply you with a brand new BIOS to replace that problem chip. But if you don't feel like getting

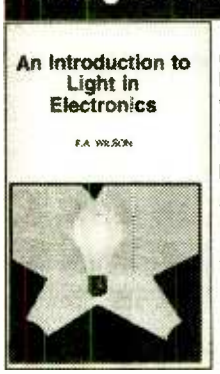
Unicore's Milliennium Pro simply plugs into any available ISA slot. There's no software to install.

quite that far into the guts of your PC, the Millennium/Pro is a much simpler way to update your system. As with the other cards, it intercepts date and time calls to the BIOS, and replaces them with the correct data.

As with the other two cards, the Millennium/Pro has a set of jumpers to set the address space. A tiny manual (actually, just a sheet of letter-sized paper folded over) explains how to reset the jumpers should your system not boot after plugging the card in an ISA slot. Our system booted just fine, so we didn't have to fiddle with the jumpers.

The Millennium/Pro also solved the BIOS problem our old desktop was suffering. But you'll have to use a downloaded test utility, or other means to find this out, as there is no software supplied with the board. And, just like all of the cards we tested, the Millennium/Pro solves only the BIOS/RTC problem, not incompatibilities in your applications. ■

An Introduction to Light in Electronics



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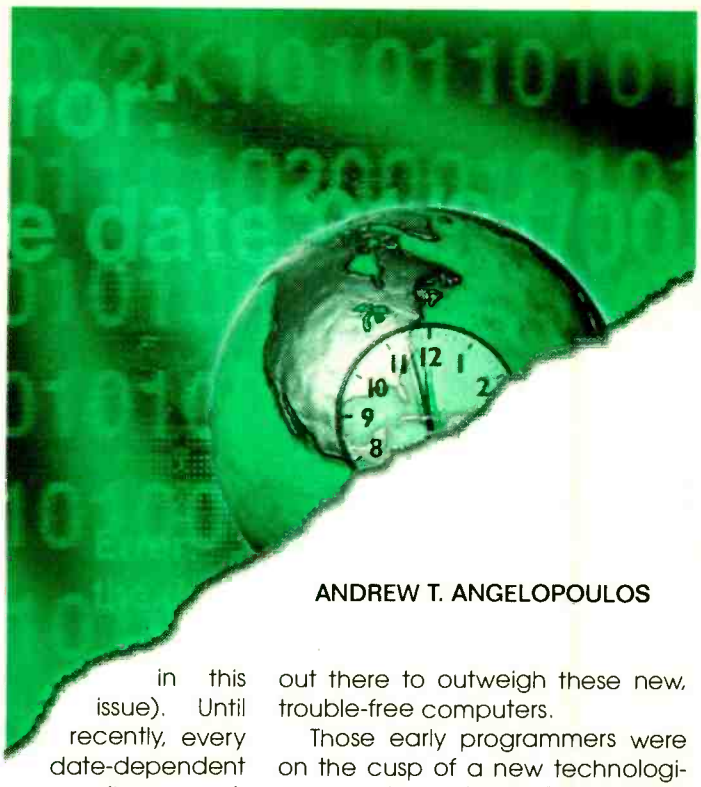
Will the Clocks Stop?

How will society handle the impending deadline? Find out if the experts think the world is ready for Y2K.



ANDREW T. ANGELOPOULOS

Trying to determine what life after Y2K will be like is a bit like talking about life after death—everyone has an opinion and no one can prove that he or she is right.

And that, perhaps, is the scariest aspect of our upcoming New Year, what President Clinton called, in September 1998, the "one deadline we cannot push back." While it seems that lots of people are finally talking about Y2K and actually trying to figure out how to best fix it, the following facts have become clear:

It sneaked up on us; we'll never be fully ready; and our lives will change, if even a little, as a consequence.

Most experts agree on two points: if we had done nothing, it would be catastrophic; and now that we are doing something, who can tell?

Y2K, to put it mildly, will forever be seen as humankind's greatest goof, an example of nearsightedness that would make the blind grin. If we survive it, history textbooks may have a chapter dedicated to the "Great Could've-Been Social and Economic Catastrophe of 2000."

The Problem. More than fifty years ago the first programmers took a shortcut and only used two digits, instead of four, to store the year. At the time it was a seemingly small issue, done to conserve precious memory (much more on this in our "Solving Your Y2K Problem" story in this issue). Until recently, every date-dependent computer language, software product, and motherboard-embedded chip had only two-digits.

Technology feeds on itself, and new advances tend to contain bits of earlier tech, kind of like we contain genes from our parents. And while a child never fully resembles its parents, it usually looks somewhat like them. The "little two-digit error" passed on from programmer to programmer in the same way, and was considered status-quo programming and design. Other things changed, but this little bit of "tech genetics" didn't. When the time comes to shift from 1999 to 2000, from 99 to 00, much software and hardware will, as a result of the passed-on archaic architecture, either reset, believing that the year is 1900, or return an error condition. Other devices will run, but not correctly, adding numbers incorrectly, returning the wrong information. Some Y2K-compliant machines will run just fine, but there are far more legacy machines with problems out there to outweigh these new, trouble-free computers.

> *"The machine does not isolate man from the great problems of nature but plunges him more deeply into them."*—Antoine de Saint-Exupéry (1900–1944), French aviator and author.

Those early programmers were on the cusp of a new technological age. If any of them thought that there would be a problem, they probably thought that "today's" amateurish efforts would be rectified by "tomorrow's" experts. In this case, we kept putting tomorrow off.

In the very early 1990s, maintenance engineers began to notice the problem, but solutions were put off because of various factors. A recession was going on, the trend to switch between mainframe and server-based systems was on, and there was an optimistic belief that new technology would solve the problem.

Decades worth of code and chips have collected with the Y2K error, and the glitch is everywhere: digital watches, VCRs, thermostats, answering machines, alarm clocks, telephone switchboards, personal computers, mainframes, banks, and governments. It even shows up in devices that aren't obviously tied to the calendar. And that's why, unfortunately, it can't all be fixed before the deadline that's fast approaching. We started too late and there is simply too much. In terms of repair costs alone, some estimates exceed $600 billion!

We know something will happen. The only question now is: How bad will it be?

Industrialized countries have

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come to depend on their computers as the means to running, maintaining, and managing *everything* that makes them what they are. So here's the problem: If our electronics shut down or don't know what day it is, if they simply don't work right, then nothing gets run, nothing gets maintained, and nothing gets managed.

Why the Fuss? World ecology has become increasingly complicated. It is a house of cards with each piece leaning against its neighbor, one set of cards dependent on cards nowhere near them for support. Knock one down and part of the structure may fall. Knock down the right one, or a few, and the whole thing will crumble onto the table. This holds true for both small- and big-ticket items, from apples to atomic power.

The small shopkeeper depends on his vendors for product and supplies, his electronics for inventory and accounting, his utility company for electricity and gas. These people and organizations, in turn, depend on other organizations, and they on others, and so on.

Two large examples of the world's interdependence were the Asian economic crisis of 1998 and the fall of the Mexican peso after the signing of the North American Free-Trade Agreement (NAFTA). These events threatened U.S. and world economies.

This interdependence structure is also referred to by Edward Yourdon, programmer, author, and co-author of *Time Bomb 2000: What the Year 2000 Computer Crisis Means to You*, as the "Domino Effect."

Basically, if enough small systems fail it will drastically affect the larger whole. Just because your PCs or company's systems are Y2K compatible doesn't mean you are OK, especially if you must depend on others, whose systems may not be free of the Y2K bug, to do what you do. The result is that organizations, consumers, and governments are drawing on fewer resources. There simply won't be enough of what they need when they need it to get the job done, whether that's generating power or making deliveries to the local supermarket.

Ed Yourdon, just one of the Y2K experts we spoke to, offers in his book and at his Web site his views on the possible problem.

"We're going to deal with technological disruptions throughout the year," said Yourdon, in a telephone interview from his home in New Mexico, "they'll peak January 1st and on February 29 (a leap year day that some systems may not roll over to properly)."

He has been a software engineer for 30 years, since the late 60s, and is a well-spoken, relaxed, congenial man.

"The consequence will be a serious economic decline," he said. "Companies that continue running will have reduced productivity and the U.S. will have a lower GNP." He predicts a decade-long recession.

When discussing just how bad it could be he cited Russia's traditional intransigence when admitting to anything wrong with their computer gear.

"Initially, they said their systems were different. Later, they came back with a letter and asked for $3 billion. Russian tax revenues are only $21 billion."

To emphasize how Russia's Y2K difficulties could affect others, Yourdon said that 40% of Germany's electricity (residential and industrial) was Russian supplied.

While he sees great progress in the U.S., it is the collective whole that worries him. With 11,000 banks and 7800 utilities here alone, he wonders how all of them could be fixed in time. Were such a feat to be accomplished, it "would defy 30 years of software engineering history." He did add "though, there is always a first time."

Yourdon expects short-term disruptions in 5% to 10% of U.S. utilities and banks. "It will be interesting to see how the Fed and the stock market react (later in 1999)," said Yourdon, who cashed in his holdings last year. "Hopefully, they'll force mergers (of non-compliant banks with compliant banks)." He also expects defections of large customer companies from other large provider companies when it is determined, or suspected, that the provider isn't compliant, like, say, a car manufacturer switching long-distance phone companies.

Though it looks like critical U.S. services will be ready, other kinds of service may not. The small businessperson and the large corporation might get left idling, their systems up-to-date and Y2K compliant, but unable to work because they are left waiting on a non-Y2K-compliant supplier's products or information.

This domino effect can take place anywhere along the computer-dependent food chain and across any border, and is what has some people very uncomfortable and concerned. For example, what happens to a non-compliant digital cash register's dated receipts in a neighborhood store? If you backdate the register to keep it working, the receipts are useless to you and your customers for tax or business purposes. After all, the receipt will say it's from last year, 1999, and not 2000.

While this example is easily fixed, using paper receipts as a contingency, it is an example of how pervasive and annoying the problem will be. The register will still add up totals, but unprepared shopkeepers, in effect, must step into the past until they buy a new register, assuming that there is no backlog in these devices due to high demand.

In an odd way, those few who do not use computers, let's say, those who use mechanical cash registers, are already Y2K compliant. Stepping ahead with the wrong "modern device," in this case, may mean taking a step back.

The Months Before. While some may want to blame Y2K on our fast lifestyle, we may also owe it our sal-

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vation. Since our current society works by planning things a year or more in advance, many of the industries most critical to our economic survival are discovering, and fixing, the problems now.

In February 1998, United Airlines completed its Y2K fix, at a cost of $70 million, so the company could issue tickets booked for 2000. As we approach January, forward-looking non-Y2K compliant systems will start to give errors as their programming crosses over the date threshold. As a result, problems will require fixing, ahead of the Year 2000 (otherwise, no software, no billing, no planning, no profit). Further, such trouble will highlight the need to others for preparedness.

On July 1, 1999 (a date not yet reached at the time of this writing, but perhaps by the time you read this), 46 states begin their fiscal year and must be able to use 2000 in their accounting. How they handle the transition will determine in part what they'll experience on January 1.

Since Y2K issues are foreseeable and rectifiable, it is expected that the insurance industry will declare Y2K a business risk and not a fortuity (*i.e.*, simply a question of chance). Translation: They won't pay for Y2K-related business problems because it was avoidable and it's a company's fault if it isn't prepared.

Dr. Bruce Gale, Ph.D., a clinical psychologist who specializes in anxiety disorders at Cedar-Sinai Hospital in Los Angeles, is author of *Introduction to Computers and Technology: A Guide for Mental Health Professionals* (Allyon & Bacon). Gale said that he expects that the Y2K crisis will most likely affect those already suffering from Generalized Anxiety and Obsessive-Compulsive Disorders. "I expect that I am going to see more anxiety patients, hopefully short-term," he said.

"From my perspective, I'm not seeing a whole lot of it yet. I gave a stress-reduction workshop recently and everyone wanted to know about St. John's Wart, but no Y2K.

"I think, if you look at the history of technological crises, like the Michaelangelo Virus, and if the best predictor of present behavior is past behavior, the Y2K crisis will be seen as minor and annoying (to most people)," he said.

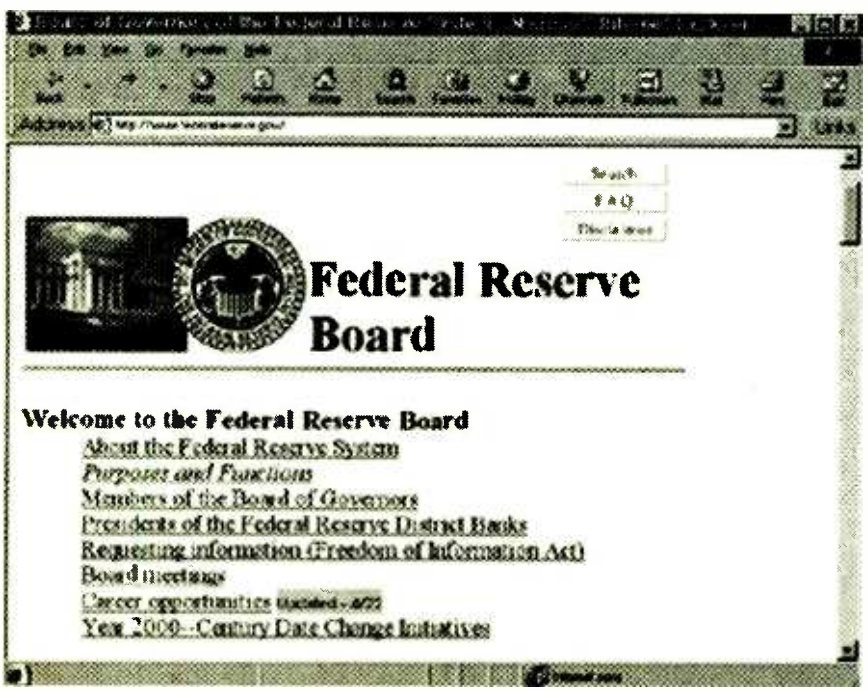
He believes that the confusion factor over Y2K, the uncertainty, and the hype will be primarily responsible for increased levels of anxiety. He cited a local telephone company's Y2K mailer, included with the monthly bill, suggesting that customers withdraw several hundred dollars from their bank accounts in preparation for New Year's Day. The phone company subsequently retracted its advice at the insistence of banks.

The belief that Y2K-related problems would impair or block access to cash has also generated a fear that a run on the banks could occur towards the end of the year, a disaster in itself.

The Federal Reserve, while stating that it anticipates no difficulty in accessing cash, has said it is prepared to request that the US Treasury print additional funds to supplement its $150 billion reserve, if needed. The Reserve requested $50 billion for domestic purposes and an additional $20 billion for international contingency purposes.

The President's Council on Year 2000 Conversion was formed in February 1998, by executive order, to coordinate federal Y2K efforts. Part of the council's mandate is to monitor the compliance of what it considers critical services: benefits payments, communications, electric power, emergency services, financial services, oil and gas, solid waste, transportation, and water supply. To be considered compliant, mission-critical systems, those necessary to do the job of an organization, must be repaired or replaced and, preferably, have a contingency plan also in place to work without them.

According to the Council, the federal government will remain intact when the clock strikes midnight this New Year's Eve. To other agencies and companies, the advice remains the same: good planning, information, and contingency plans will make the difference between a smooth transition or a rough one. Admitting that the real effect of Y2K is an unknown variable, spokesperson Jack Gribben said, "We're confident that the critical federal systems will be ready ... and there will be no nation-wide disruptions in key industries, like power." They expect to have 80% Y2K compliance of Federal agencies and divisions by March 1999, with 100%, or near it, by or before January.



Worried about your money as the deadline approaches? Check out what the U.S. Federal Reserve has to say about Y2K.

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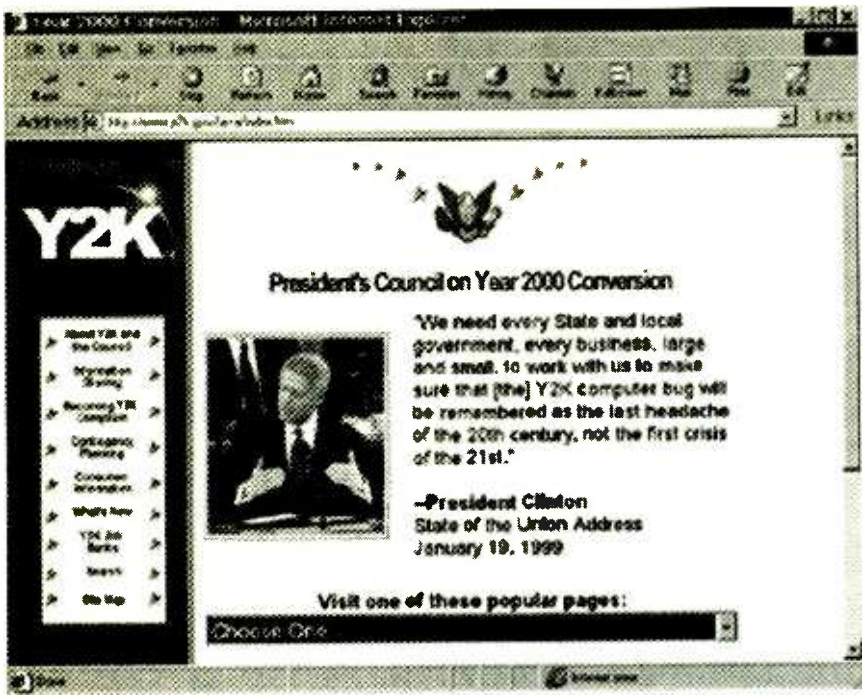

Either call 888-USA-4Y2K or visit the President's Council on Year 2000 Conversion to gain access to an information clearinghouse of government-collected Y2K information.

He added that of the critical US industries monitored, financial institutions were ahead of everyone else, with 96% Y2K compliance as of January 1999.

The President's Council, as other organizations concerned with Y2K, expect to have a clearer picture of the real problem as they head into the home stretch: end of summer, beginning of autumn.

What worries the Council is everybody and everything else—the systems that "the federal government doesn't control or operate," systems like small- and medium-sized businesses, associations, large corporations, counties, towns, cities, states, and other nations. Gribben added that most of the international concern centered on semi-industrialized nations.

There was both good and bad news in the Council's *First Quarterly Summary of Assessment Information*, January 7, 1999. The President's Council wrote that if any U.S. financial, power, or telecommunication Y2K disruptions occurred they would be localized, hence, manageable, if slightly inconvenient. The most disturbing part of the report concerned the efforts of other countries to meet Y2K. Simply stated, "International failures are likely ... a number of countries have done little to remediate critical systems."

This raises the specter of the domino effect again: when one system (or nation) fails, demands are placed on others to meet the need. In this case, demands would be placed on the international community and ignoring them, as demonstrated by previous economic crises, would be catastrophic for all.

John Koskienen, Chairman of the President's Council, testified before a House of Representative's subcommittee on January 20, 1999. While his testimony lauded the great Y2K progress that has been made at the Federal level, it also warned that more was needed from non-federal, private, and international entities. To help meet this end, the Council worked with the United Nations and organized a meeting with national Y2K coordinators on December 11, 1998 and unveiled the International Y2K Cooperation Center in February 1999.

Yourdon was at that December meeting in New York. His observations about the international situation and his criticisms of the President's Council are sobering.

"There were 120 countries there," he commented. The smaller nations, "don't have the money, the concern, or the expertise," to get compliant.

While pleased with the work of the President's Council, he is leery of government pronouncements.

"It is all self-reported data," he said, with no independent confirming authority. "And they keep eliminating systems that are considered mission-critical." Currently, 7000 systems are defined as mission-critical and 66,000 are not. He added that the advice they give businesses about contingency planning—stocking up on supplies and developing plans for working around Y2K—is the last thing they wanted individual consumers to do. It would drain banks and supermarket shelves.

Koskienen closed his congressional testimony by saying that while the Y2K issue was a serious problem, the continued efforts of all involved and public information was key. "Our strategy," he said of the Committee, "is based on the premise that the public has great common sense and will respond appropriately when they have the necessary information."

The average small-business owner or person on the street may already be encountering the frus-

Walk into your local K-Mart, Sears, or other major store and you might see signs of millennium fascination like Elegant Headwear's Countdown 2000 baseball cap, which ticks away the days, hours, minutes, and seconds to Y2K.

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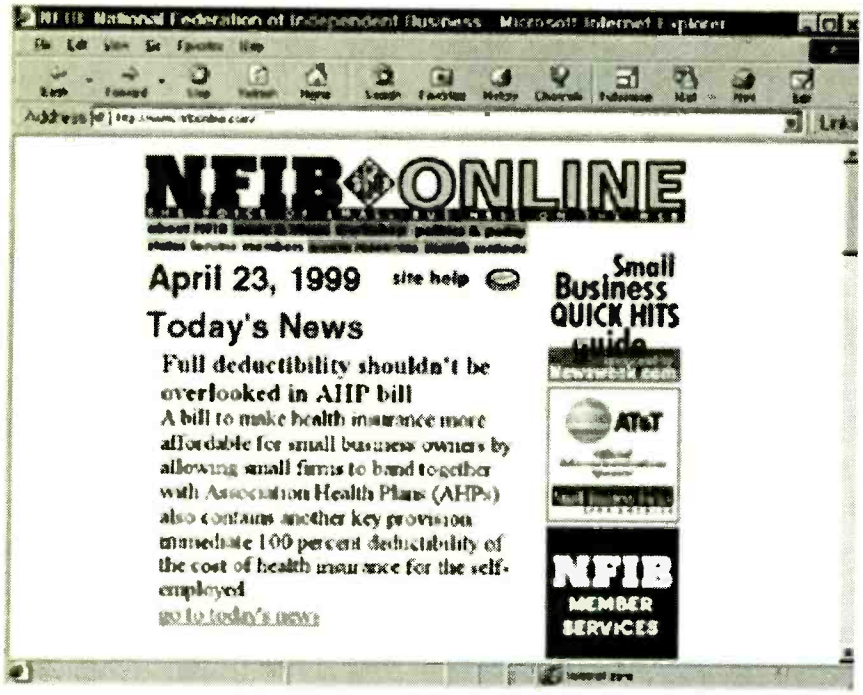


A great site for small businesses in general, the National Federation of Independent Business Web presence has Y2K information for the small businessperson.

trating effects of Y2K, at home, at work, or from those they deal with. Botched invoicing, delayed and handwritten checks, financial forecasts that return weird numbers, and problems scheduling events during 2000 are some of the ways it will manifest itself.

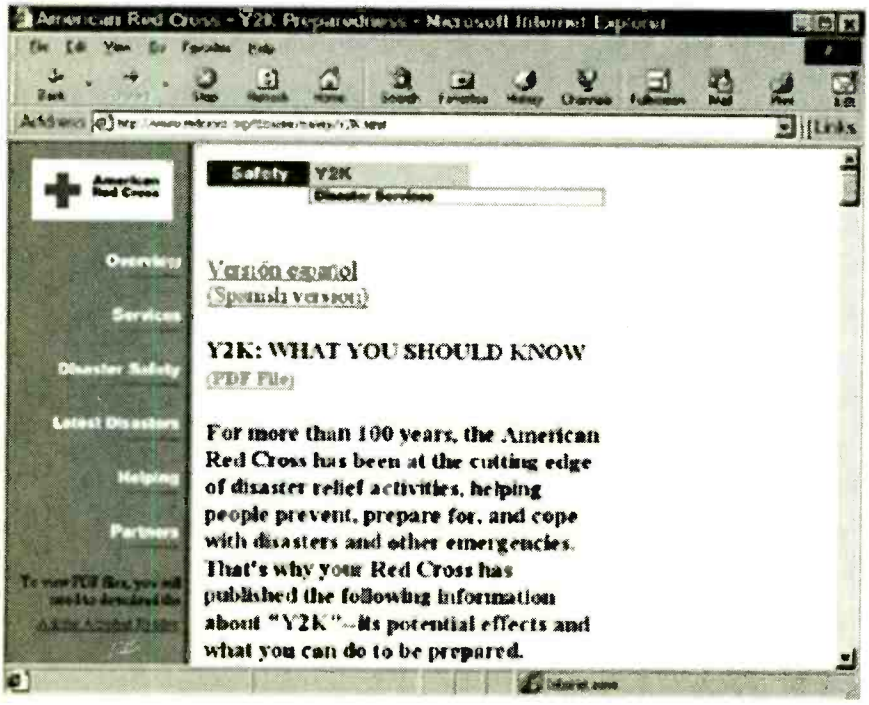
The National Federation of Independent Business (NFIB), while happy with recent progress, admits that 60% of small businesses remain vulnerable to Y2K, and that a third have no plans at all to fix the problem.

"It's hard to know," answered NFIB spokesperson Angela Jones when asked how Y2K would affect small businesses.

She added that even businesses that didn't use computers were at risk and that business people should ask their vendors if they are Y2K compliant. "It's the greater framework," she said referring to the interlocking relationships of businesses.

The American Red Cross, an organization that admittedly *must* plan for worst-case scenarios, has put Y2K survival recommendations on its Web site suggesting readers store some food, water, money, blankets, and gas up the car, just in case.

"Let me just say we think things will be fine," said Red Cross spokesperson Ann Stingle. "We just want people to approach this with common sense, to be prepared, and to anticipate what might go wrong. We want to put information out on what not to do," she said, adding that sometimes the greatest danger to life and property came from being ill prepared.



The American Red Cross, the famed disaster relief organization, has a Web site with information on what to do, and what not to do, during Y2K and other potentially harmful events.

The Day After: A Prognostication. The clocks won't stop. We live analog lives in spite of the digital trappings. The U.S. and the world will survive, but the first year, possibly two, will be a hairy roller coaster ride. One thing is certain: everybody is going to be inconvenienced and everybody is going to get annoyed.

January 1, 2000 is a Saturday morning. Those with non-compliant digital thermostats will wake to find their homes cold. Their thermostats have either shutdown in error, or think it is Monday, January 1, 1900, a workday, and that the house is empty. Others may wake up in the dark.

Digital watches that are returning errors must be reset to an earlier date. Owners of non-compliant digital watches that do rollover will find that today is a hundred years earlier than it was yesterday.

The same problems, over and over, will repeat with digital appliances and devices that use day, date, and year. A quick look around any home or office reveals how

(continued on page 44)

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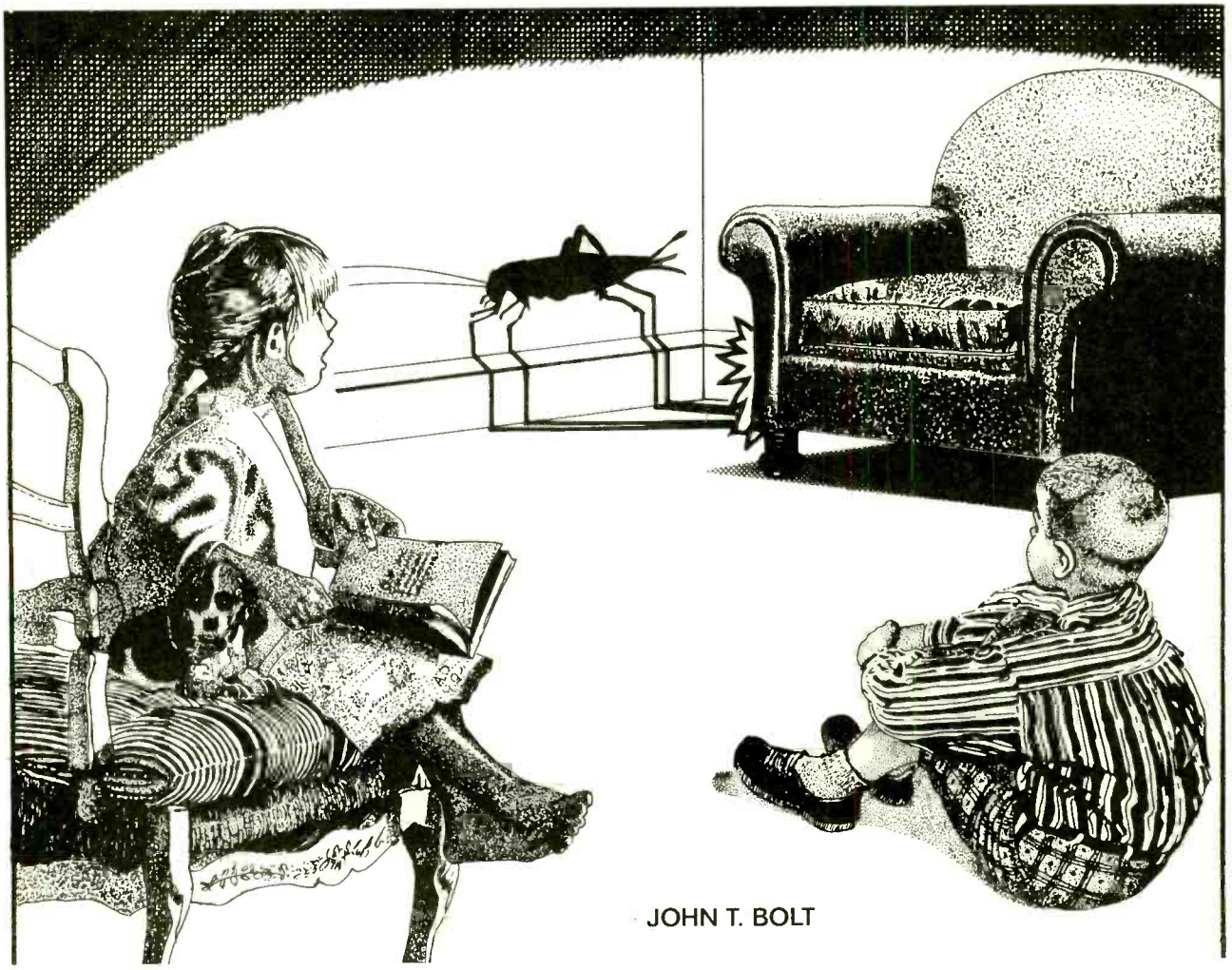
The Electronic Cricket:

A prankster's delight



JOHN T. BOLT

Imagine you've just spent an evening at a friend's house. Before leaving, you plant a devilish little circuit—the *Electronic Cricket*—that begins its annoying chirp, chirp, chirp as soon as the lights go out (say at bedtime). And it doesn't know when to quit. Your victim may stomp the floor or throw a shoe in the direction of the noise, but the chirping continues. Eventually, the victim, reaching the end of his or her rope, gets up in an attempt to locate the little devil. But just as soon as the lights go on, silence . . . nothing, *nada, zilch.*

It may not be a plague of locusts of biblical proportions, but it's sure to plague those who are unfortunate enough to be within hearing range of its intermittent chirp.

The Electronic Cricket is a light-sensitive circuit that turns on in the darkness or in dim light, but turns off when exposed to full room light. Use your imagination as to what happens when your victim finds it: You had better hope that this person can take a joke, or he/she may smash the bug, as well as the prankster.

Aside from its possible use in a harmless prank, the project is educational in that it demonstrates how a single IC can be used to form three oscillators (two compris-

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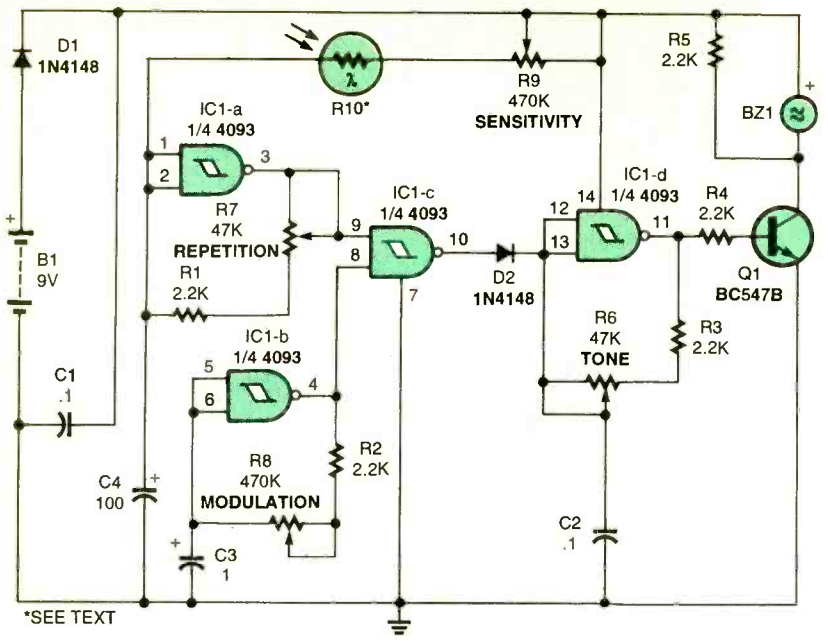

Fig. 1. The Electronic Cricket is little more than a single 4093 CMOS quad two-input NAND Schmitt trigger (IC1), whose individual gates comprise three oscillators and a gating (or mixing) circuit.

ing the circuit that makes the chirp and the third functioning as a timer to provide a pause between chirps) and gating circuit or switch.

How It Works. Figure 1 is a schematic diagram of the Electronic Cricket. Note that the circuit is little more than a single 4093 CMOS quad two-input NAND Schmitt trigger (IC1), configured as three oscillators that are strung together, with each controlling the operation of the one that follows. The fourth Schmitt trigger is used as a gating (or mixing) circuit.

The first oscillator (built around IC1-a) controls the Electronic Cricket's repetition rate. The frequency of that oscillator is determined by the values of C4, R1, and the setting of R7. Potentiometer R7 (REPETITION) is used to adjust the rate at which the chirping sound is produced.

A cadmium-sulfide photocell (R10)—also known as a light-dependent resistor or LDR, which, in this application, acts as a light-controlled switch—is connected in series with potentiometer R9 and capacitor C4, with the voltage developed at the junction formed by R10 and C4 applied across the inputs of IC1-a. Potentiometer R9 (SENSITIVITY) determines the light level at which circuit triggering takes place. The first oscillator, acting in conjunction with R10, activates the circuit when the light reaching the photo-resistive surface of R10 drops to the desired level.

The photocell is used to detect ambient room light. In total darkness, R10 has a resistance of about 100 ohms; under full light, it has a maximum resistance of about 500K. As the light level detected by R10 falls, the resistance across R8 begins to decrease, thereby increasing the voltage applied to the inputs of IC1-a. That forces the output of IC1-a low. The output of IC1-a, under the direct control of R10, remains low as long as the lights are turned off or at a low level, or until IC1-a's inputs are pulled high by some other force. The low output of IC1-a is divided along two paths. In one path, the output of IC1-a is routed back to its input, causing its output to toggle high. That high is fed back to the inputs of IC1-a (charging C4), once again forcing its output low.

That low is directed back to IC1-a's inputs, causing its output to once again go high. That sequence of events is repeated over and over as long as no light is radiated onto its photo-sensitive surface.

While that's going on, the output of IC1-a travels along the second path and is applied to one input of a gating circuit (built around IC1-c). The other input to IC1-c is fed from the output of a second oscillator, built around IC1-b. The operation of the second oscillator is identical to that of the first, except that its output alternates at a different frequency, which is determined by C3, R2, and the setting of R8 (a 470K potentiometer that serves as the circuit's MODULATION control).

The outputs of the two oscillators are mixed in IC1-c, producing a third signal frequency that is applied to the bridged inputs of IC1-d, which forms the third oscillator. The third oscillator determines the rate at which the chirping sound is produced. The output of the third oscillator is fed to the base of transistor Q1, which is used as a switch, turning it on and off at a rate determined by R3, R6, and C2. The signal generated due to the toggling of Q1 causes BZ1 to emit a

The buzzer used in the project is about 1 1/8 inches in diameter at its circular center and has red (positive) and black (negative) leads to identify their polarities.

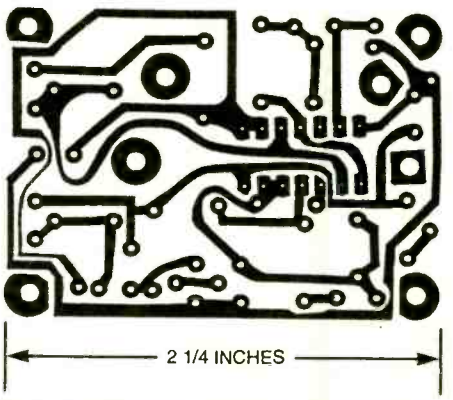

Fig. 2. The Electronic Cricket was assembled on a printed-circuit board measuring 2¼ by 1 10/16, a full-scale template of which is shown here.

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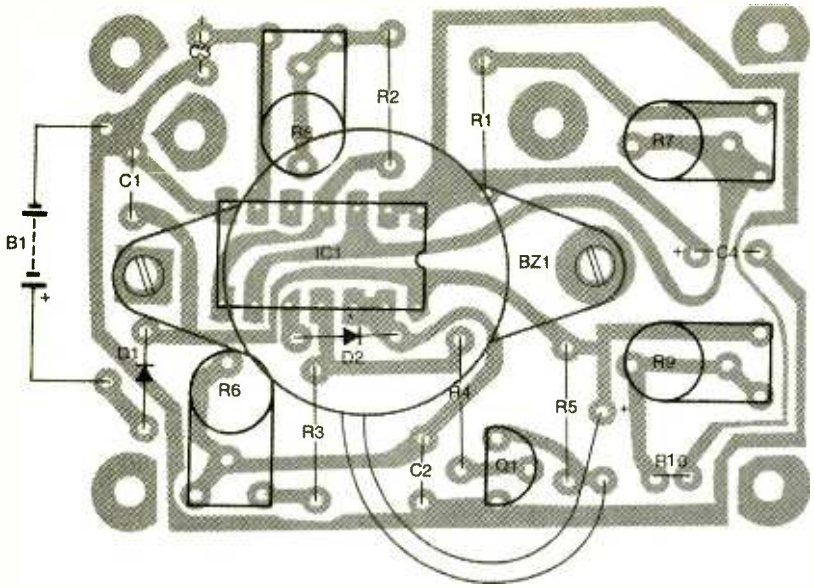


Fig. 3. Assemble the printed-circuit board guided by this parts-placement diagram. Note: The buzzer is mounted to the board using half-inch spacers so that it hovers over the previously mounted components as indicated.

PARTS LIST FOR THE ELECTRONIC CRICKET

SEMICONDUCTORS

IC1—4093 quad CMOS NAND Schmitt trigger, integrated circuit
Q1—BC547B NPN general-purpose silicon switching transistor
D1, D2—1N4148 general-purpose, small-signal, silicon diode

RESISTORS

(All fixed resistors are ¼-watt, 5% units, unless otherwise noted.)
R1–R5—2200-ohm
R6, R7—47,000-ohm trimmer potentiometer
R8, R9—470,000-ohm trimmer potentiometer
R10—Light-dependent resistor

CAPACITORS

C1, C2—0.1-μF, ceramic-disc
C3—1-μF, 16-WVDC, miniature electrolytic
C4—100-μF, 16-WVDC, miniature electrolytic

ADDITIONAL PARTS AND MATERIALS

BZ1—9-volt piezoelectric buzzer
B1—9-volt, transistor-radio battery
Printed-circuit materials, 9-volt battery connector, wire solder, hardware, *etc.*

Note: A complete kit of parts for the Electronic Cricket is available from Velleman Inc., 7415 Whitehall St., Suite 119, Fort Worth, TX 76118 for $12.29. Please allow 6 to 8 weeks for delivery.

chirping sound. Potentiometer R6 (TONE) is used to adjust the pitch of the output signal.

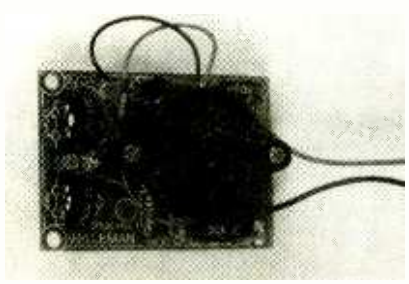
When the lights are turned on, photo-radiation striking the light-sensitive area of R10 causes its resistance to rise dramatically, deactivating the circuit, until the room is returned to a darkened condition.

Construction. There is nothing critical about the circuit, so any construction method can be used to assemble the project. However, it is recommended that the Cricket be assembled on a printed-circuit board. A full-scale template of the Electronic Cricket's printed-circuit layout, which measures 2¼ by 1 $^{10}/_{16}$ inches, is shown in Fig. 2. That pattern can be copied from the page and used to etch your own circuit board. Or, if you prefer, the board can be purchased as part of a complete kit of parts from the supplier listed in the Parts List. In any event, once you've gathered all the components listed in the Parts List, assemble the printed-circuit board guided by the parts-placement diagram shown in Fig. 3.

Start by installing an IC socket (but not the IC) for IC1 where indicated and then mount the photocell (R10). Next install potentiometers R6–R9 and the rest of the resistors, followed by the capacitors, making sure that the lone electrolytic unit, C4, is properly oriented. Follow that by installing the semiconductors (IC1, D1, D2, and Q1), double checking each component's orientation and placement prior to soldering it into position. Check that in soldering the tightly spaced components into position no solder is splattered across adjacent pads or traces (shorting them together). If such a splatter does occur, immediately correct the defect. Now, attach the battery connector to the printed-circuit board as indicated in the parts-placement diagram.

After that, mount the buzzer (BZ1) to the board (using half-inch spacers so that it hovers over the previously mounted components) as indicated by the parts-placement diagram (Fig. 3). The buzzer supplied with the kit is equipped with a pair of red and black insulated lead wires. When installing the buzzer, mount the unit first, clip the leads as short as possible, and then solder them to the appropriate foils, as you would with any other printed-circuit mounted component.

Finally, insert the IC into its socket, and check your work. There is very little that can go wrong with the circuit's construction—short of misorienting IC1, D1, D2, or C1 or reversing the battery's polarity—but it is always best to check the circuit before powering it up. Once you are satisfied that you've made no construction errors, attach the battery and see what happens.



Here is the assembled printed-circuit board for the Electronic Cricket. The Electronic Cricket can be housed in any suitable enclosure, or it can simply be tucked into some out-of-the-way location where it can sense the room's lighting condition.

Setup. The circuit should at least

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emit some sort of sound when the battery is first installed. If not, adjust the resistance of R9 (SENSITIVITY) until the circuit begins to emit a chirp or a beep. Once the circuit begins to emit some sort of sound, adjust R7 (REPETITION) to set the output rate (frequency). After setting the output rate, adjust R8 (modulation) to give the audio output the trill that's characteristic of the cricket's chirp. Then adjust R6 (TONE) until the sound emitted by the circuit most closely simulates the sound produced by the real thing.

With the Electronic Cricket emitting a trill sound at the right pitch and at the preferred rate, slowly adjust R9 (SENSITIVITY) under full room light until the chirping ceases. Turn out the light, and wait a second or two. If the circuit begins to chirp, turn on the lights to make sure that the chirping stops under full-lighting conditions. If the Cricket performs as expected, you are all set. If the circuit doesn't start chirping, adjust potentiometer R9 upward or downward until it does.

Once the circuit is operating properly, you are ready to have some fun. Just try not to be too big a "pest" with your new toy. ■

WILL THE CLOCK STOP?

(continued from page 40)

dependent we've become with embedded technology. Even some devices that are only a year or two old will fail. One suggestion for getting some devices to read the right day of the week and date, though not the year, is to set them to 1916, 1944, or 1972, if possible. They all started on a Saturday, and had a leap year. This, of course, is a short-term fix.

Back to our January 1 prediction. Morning newspapers and news programs will carry reports of the "localized disruptions" that have occurred during the night and will offer suggestions and information for those citizens who are affected. Major attention will be focused on the few international failures that have also occurred. Calls for calm will be made, and most likely heeded.

Luckily, January 1 is a Saturday, and all the financial markets will be closed. There probably wouldn't have been much action on Wall Street the week before, with investors confident and satisfied with the Street's Y2K efforts and press. Monday morning will be a great time to buy stock, thanks to the market not being open on "doomsday."

ON THE WEB—MORE INFORMATION

The American Red Cross
www.redcross.org

National Federation of Independent Business
www.nfibonline.com

The President's Council on Year 2000 Conversion
www.y2k.gov

The U.S. Federal Reserve
www.federalreserve.gov

Ed Yourdon's Site
www.yourdon.com

Of course, another round of Y2K-related problems, both at home and abroad, will begin as the full strength of the world goes back to work. The markets will not meltdown, but will be in a period of adjustment for the next 12-24 months as investor confidence dips with news of problems and rises when corporations and governments announce action.

Undeveloped countries, those that don't depend on computers yet, will wonder what all the fuss is about. The semi-industrialized, likely to have Y2K troubles with the majority of their second-hand or antiquated equipment, will need all the help they can get and that we can give.

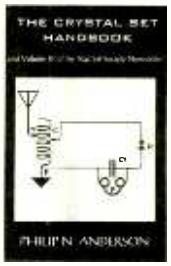
All the disquiet and economic distress will be followed by the biggest buying-boom since WW II, and some inflation as well, when every frustrated and annoyed consumer runs out to replace years worth of digital watches, VCRs, thermostats, answering machines, alarm clocks, PCs, anything and everything with the word digital in it that requires the right day and date....

What You Can Do—A Final Thought. Most importantly, educate yourself. Information will become clearer as we approach the deadline. A panic, like a run on the banks, can be worse than the event itself, and can make a bad situation much worse.

Call and write everybody that affects what is important to you—the cable company, state and county offices, your house-alarm service, your PC manufacturer, local emergency services, politicians, the people you do business with—and ask them what they have done for Y2K. Let them know that your knowing what they have done is important to you. If they have already fixed it, they will love telling you so. If they are already thinking about it, a reminder might push them into doing it. If they've done nothing, maybe it will convince them to get started.

In short, society will not end. If we all pay close attention to the final standing of our country in the last days before 2000, and heed any last-minute advice, January 1 might just be a nice day off from work with a few interesting news broadcasts at night. ■

INSIDE CRYSTAL SETS



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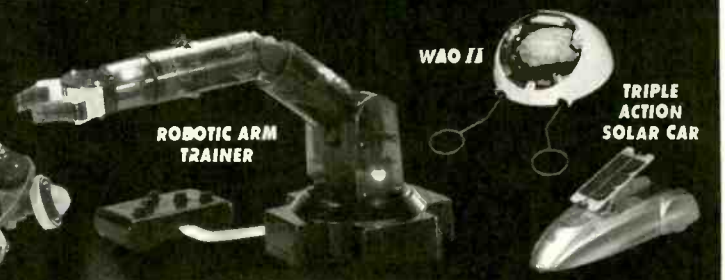

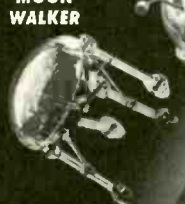

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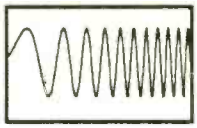
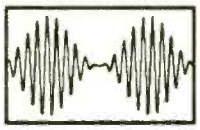
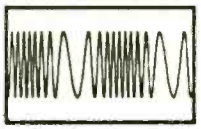
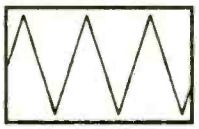
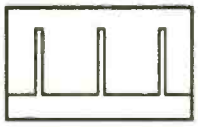

DC to 21.5 MHz linear and log sweeps

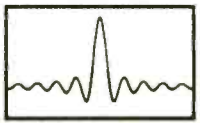

Int/Ext AM, SSB, Dualtone Gen.

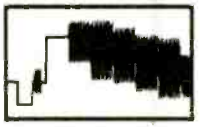

Int/Ext FM, PM, BPSK, Burst


Ramps, Triangles, Exponentials


Pulse Generator

Noise


Arbitrary Waveforms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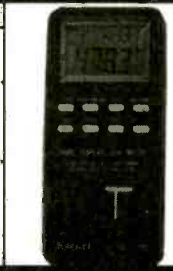

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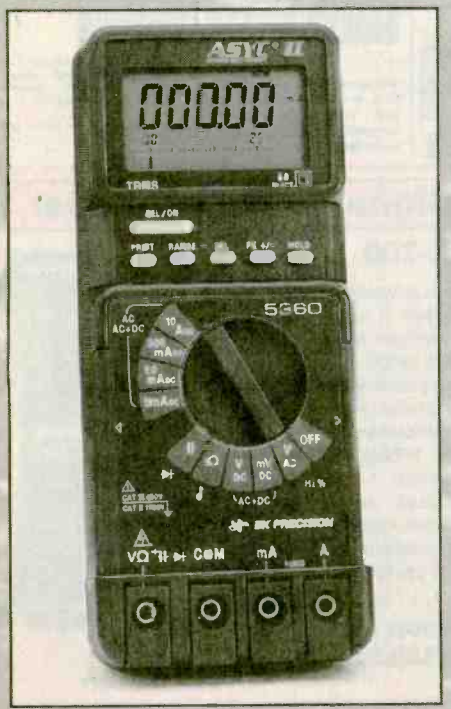

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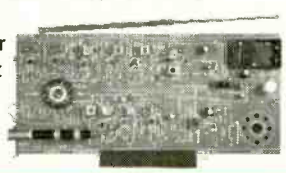

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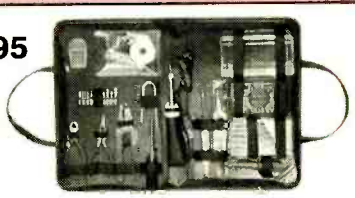

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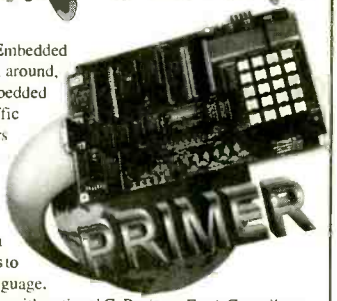

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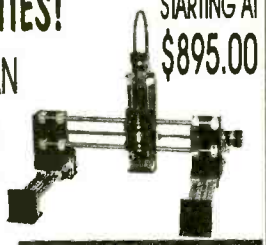

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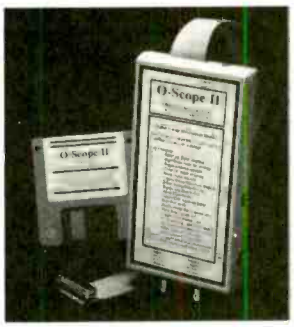

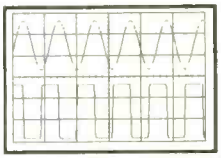

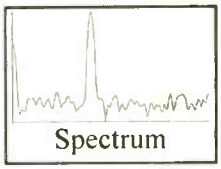

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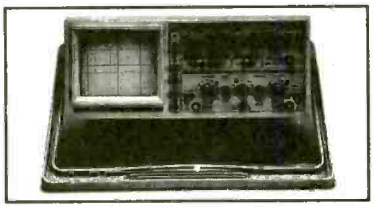

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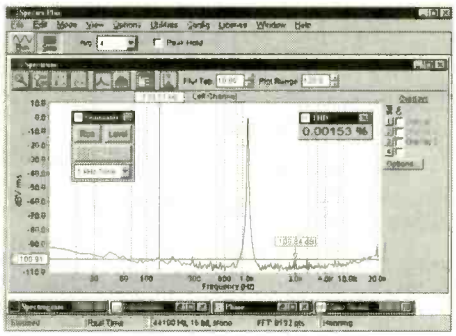

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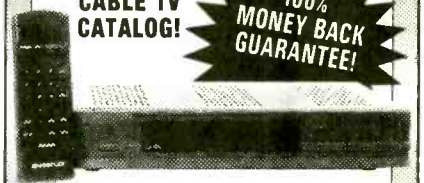

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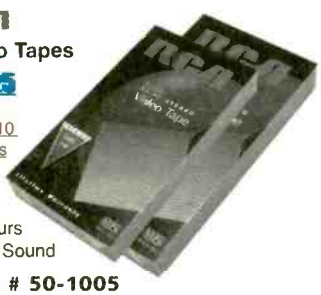

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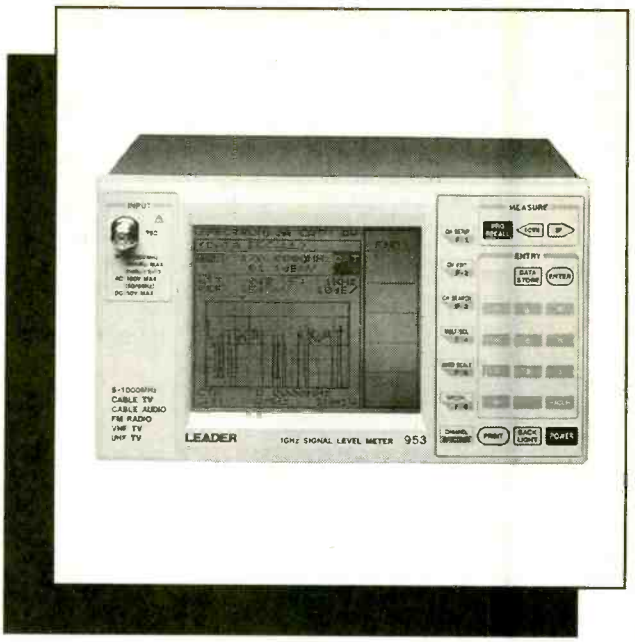

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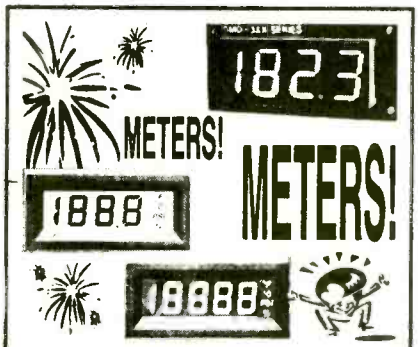

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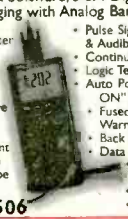

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Delay Sweep	YES	ALT-MAG	ALT-MAG	ALT-MAG
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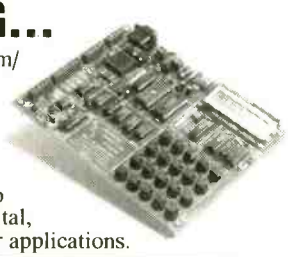

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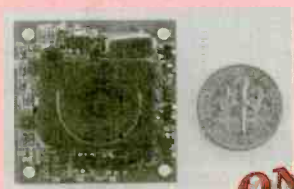

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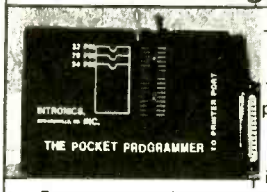

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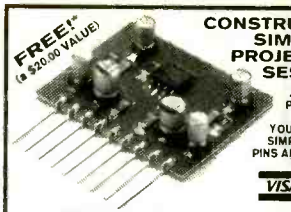

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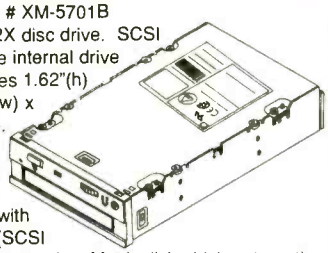
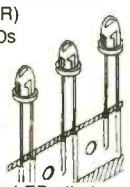


Toshiba # XM-5701B
New, 12X disc drive. SCSI interface internal drive measures 1.62"(h) x 5.69"(w) x 7.41"(d). For ease of set-up, comes with SCAM (SCSI Configuration AutoMagically) which automatically configures all aspects of the CD-ROM drive with the computer when connected through a SCSI port to a PC or Macintosh. Data transfer at 1800KB/s. 115ms average random seek time. 256K buffer.

$22.50 each

CAT # XM-5701B

3000 MCD ULTRA-BRIGHT RED LED



Everlight # 383URC-2/TR1-C(R) Red, "Ultra-bright" T 1 3/4 LEDs now at our lowest price ever. Due to a special purchase of "tape-and-reel" parts we are able to offer these LEDs at an incredibly low price when purchased on the reel. These are 5 mm diameter water-clear LEDs that light bright red at 20 ma.

CAT# LED-50

2 for $1.00

100 for $35.00
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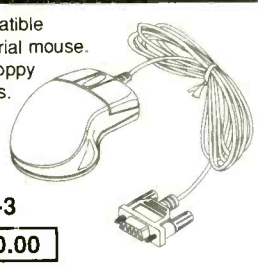
(25¢ each)

3 BUTTON Serial MOUSE



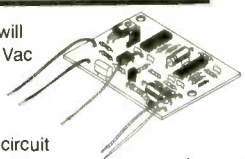
Windows compatible three button serial mouse. Includes 3.5" floppy disk with drivers.

$3.50 each

CAT #MSE-3

10 for $30.00

30 Minute Timer Board



Timer circuit board will operate 120 or 240 Vac devices. Originally designed to run a vibrating motor in a massage chair, the circuit automatically shuts-off a motor, lamp or other device after approximately 30 minutes. Shut-off time can be varied by replacing one of the resistors on the board with a pot or resistor of different value. Hook-up instructions included with the board explain how to make this modification. 1.9" x 2.5". **CAT# TMR-5**

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45 Amp Solid State Relay

Crouzet/Gordos # G240D45
Control Voltage: 3-32 Vdc
Load: 45 Amps, 24-280 Vac
Back-to-back (dual) SCR output for severe induction loads. False turn-on immunity and positive turn-off at high dv/dt. Standard "hockey-puck" 2.25" X 1.75" X 0.90". UL/CSA

CAT# SSRLY-45

$19.50 each

Surface Mount Momentary Pushbutton Switch

Panasonic # EQV PHV03T
S.P.S.T., normally open, surface mount pushbutton. 0.25" square x 0.13" high. Leads on 0.15" centers.

CAT # PB-85

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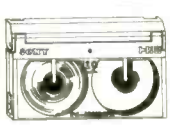
"HI-8" Video Cassette



SONY Hi-8 Top quality, metal particle 120 minute video cassettes. *Used for a short time, then bulk-erased.* Each cassette has its own plastic storage box.

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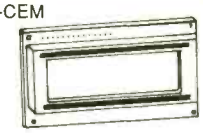
20 Character X 4 Line LCD



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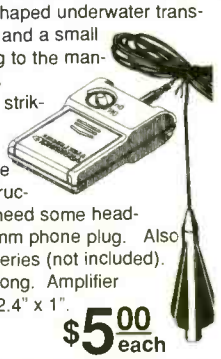
(PWB 20434-CEM)
5 x 8 dot format.
3" x 1" viewing area.
3.88" x 2.38" module.
Removed from new equipment. May have felt padding on metal bezel. 14 pin single row header is pre-attached. Spec/hook-up sheet included.

CAT# LCD-46

$7.00 each

10 for $60.00

Microphone For Fish



Consists of a dart-shaped underwater transducer on a 21' wire and a small amplifier. According to the manufacturer, it enables you to hear the fish striking your bait, thus allowing you to catch more fish. We don't have the instructions, and you will need some headphones with a 3.5 mm phone plug. Also requires 4 AAA batteries (not included). Transducer is 3.3" long. Amplifier assembly is 3.5" x 2.4" x 1".

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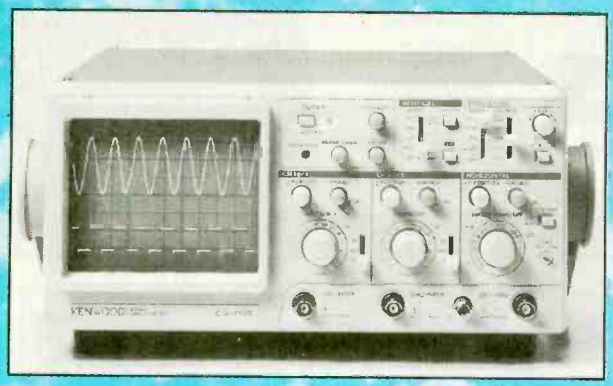

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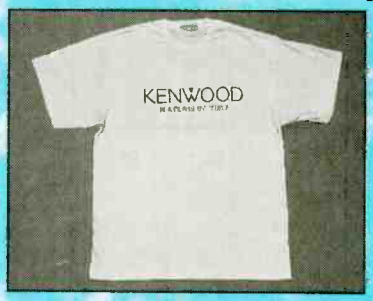

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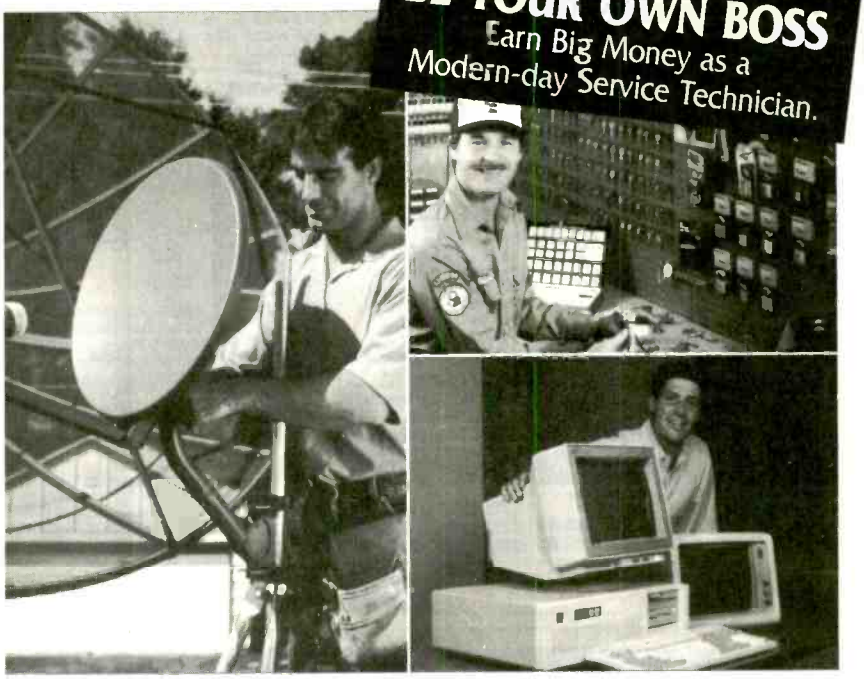

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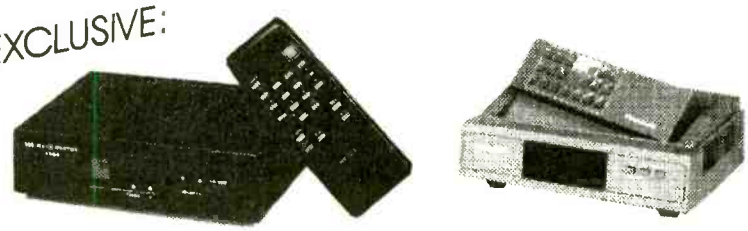

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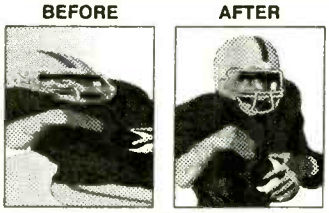

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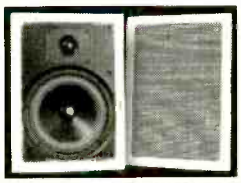
PARTS EXPRESS
ELECTRONICS & MORE

If you haven't received a copy of our current 260 page catalog ... have one added to your order or give us a call and we will send one out to you immediately.

6-1/2" Two Way System



This is our most popular in-wall. You won't believe how good these really sound. Big enough to produce great home theatre sound and still fit everyone's budget. Put a pair in every room of your house. Great for front or rear speakers in your surround system. The 6-1/2" polypropylene woofer and 1" textile dome tweeter were specially designed with home theatre in mind. The crossover network utilizes a mylar capacitor for crisp clean highs. 3 piece design make installation in new or existing walls a snap.
Specifications: ◆6-1/2" polypropylene cone woofer with poly foam surround ◆1" textile dome tweeter/midrange ◆8 ohm impedance ◆3 component L/C crossover network ◆Frequency response: 50-20,000 Hz ◆Power handling capability: 60 watts RMS/85 watts max ◆Sensitivity: 89 dB 1W/1m ◆Overall dimensions: 8-1/2" W x 12" L x 3-1/2" D ◆Hole size: 7-1/4" x 10-3/4" ◆Fits into standard 2" x 4" wall ◆Net weight: 12 lbs. per pair.

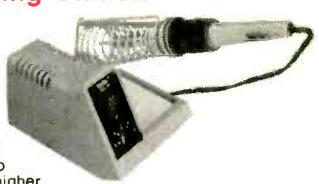
#300-036 ..... **$89.90**(1-3 PRS) **$79.50**(4 PRS-UP)

6-1/2" Round Coaxial System

Designed for the home and office, these 6-1/2" round in-walls are ideal for ceiling installations, or for use as rear channel surround speakers. Adding music to the kitchen, den, bath, or patio has never been easier! System features a weather resistant 6-1/2" treated paper cone with poly foam surround, coaxially mounted 1/2" polymer dome tweeter, and built-in crossover with a mylar capacitor in the tweeter feed. Retrofit design allows installation in both new and existing construction in just minutes. System includes removable steel mesh grills, built-in mounting bracket, hardware, and installation instructions.
Specifications: ◆Impedance: 8 ohms ◆Frequency response: 60-20,000 Hz ◆Power handling capability: 30 watts RMS/45 watts max. ◆Sensitivity: 89 dB 1W/1m ◆Dimensions: 9" round x 2-7/8" deep. ◆Net weight: 5 lbs. per pair.

#300-408 ..... **$69.95**(1-3 PRS) **$62.75**(4PRS-UP)

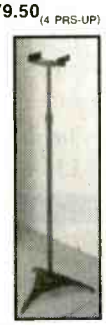
Weller WLC100 Soldering Station



The Weller WLC100 solder station is ideal for the professional, serious hobbyist, or kit builder who demands higher performance than usual of a standard iron, but without the high cost of an industrial unit. Power is adjustable from 5 to 40 watts. Includes 40 watt pencil iron. UL approved. Net weight: 1-3/4 lbs. Replacement sponge #372-119.

#372-120 ..... **$39.95**EACH

Satellite Speaker Stands



These quality speaker stands are perfect for mini or rear surround speakers. The heavy die cast base provides stability. Textured black satin finish blends in well with any decor. The height is adjustable from 26-1/2" to 47-1/2" and the speaker wire can be run inside the pole for a better appearance. The top base is adjustable from 4-1/8" to 7-1/2" to accommodate most mini speakers. Includes foam pads to prevent marring of speaker cabinet. Sold in pairs. Net weight: 12 lbs.

#240-762 ..... **$39.80**(1-3 PRS) **$35.50**(4 PRS-UP)

3 Amp Power Supply

This fully regulated power supply is perfect for powering CBs, car radios, and other 12 VDC devices that draw up to 3 amps. Heavy duty steel housing with front mounted switch and binding posts. Short circuit and overload protection!
Specifications: ◆Output Voltage: 13.8 VDC (fixed) ◆Output Current: 3A (cont), 5 amps (surge) ◆Ripple Voltage: Less than 3mV at rated output ◆Input Voltage: 120 VAC, 60Hz ◆Dimensions: 5-1/2" x 3-1/2" x 6-1/2" ◆Weight: 5 lbs.

#120-530 ..... **$19.95**(1-3) **$18.50**(4-UP)

"44" Solder

Kester "44" rosin core solder is designed for electronic and electrical work. It uses a fast acting, instant wetting, non-corrosive, and non-conductive flux for faster soldering and a strong, long lasting bond.

Part #	Alloy Lead/Tin	Spool	Dia.	Price (1-3)	Price (4-UP)
370-080	60/40	1 lb.	.031"	$8.50	$7.95
370-090	60/40	1 lb.	.050"	8.50	7.95
370-098	60/40	4 lb.	.031"	33.90	31.80
370-088	60/40	1/2 lb.	.020"	6.95	5.75
370-072	63/37	1 lb.	.020"	14.90	13.50
370-086	63/37	1/2 lb.	.031"	9.95	8.50
370-074	63/37	1 lb.	.031"	12.50	11.50
370-087	36/37	1/2 lb.	.031"	7.95	6.75

5 Function Remote

◆Operates five devices (TV, VCR, Cable, Satellite, A/V Receiver) ◆Lighted component keys which indicate what device is currently being used ◆Preprogrammed, 621 codes that work over 6,400 models ◆New ergonomic design features a contoured case, index finger grooves, and keys grouped in clusters for easy operation ◆Satellite cursor control is tailored for use with a Home Theatre system, keypad design allows movement through menus with ease ◆Retains codes when replacing batteries ◆New flat back design for easy operation ◆Money back guarantee ensures customer satisfaction ◆Toll free customer service number provides the customer with friendly, knowledgeable assistance ◆Requires 2 AAA batteries (#140-150 not included)

#180-806 ..... **$29.95**(1-3) **$26.95**(4-UP)

DMM and LCR Meter

In addition to functions found in regular DMM's, this meter can also measure inductance in 5 ranges (4mH, 40mH, 400mH, 4H, 40H), capacitance in 5 ranges (4nF, 40nF, 400nF, 4uF, 400uF), frequency in 4 ranges (4KHz, 40KHz, 400KHz, 4MHz), TTL logic test, diode test and transistor hFE test. 5 AC/DC ranges up to 1000V (AC750V), 3 AC/DC current ranges up to 20A and 7 resistance ranges up to 4000 M ohms. Includes test leads, battery, spare fuse, and manual. Net weight: 1 lb.

#390-513 ..... **$85.90**EACH

Pro Wick

Pro Wick's advanced fine braid design provides wicking action that is second to none.

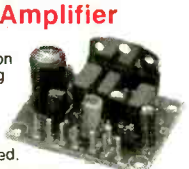
Part #	TS #	Size	Length	Price (1-9)	Price (10-UP)
341-415	1802-5	.06"	5'	$1.40	$1.25
341-416	1803-5	.08"	5'	1.45	1.30
341-417	1804-5	.10"	5'	1.60	1.45
341-424	1802-10	.06"	10'	2.75	2.50
341-425	1803-10	.08"	10'	2.80	2.55
341-426	1804-10	.10"	10'	2.95	2.70
341-440	1802-25F	.06"	25'	6.80	6.30
341-441	1803-25F	.08"	25'	6.85	6.35
341-442	1804-25F	.10"	25'	7.60	7.00
341-418	1802-100	.06"	100'	21.90	20.50
341-419	1803-100	.08"	100'	21.90	20.50
341-423	1804-100	.10"	100'	23.90	22.50

3M 3/4" Temflex™ 1700 Vinyl Electrical Tape

General purpose 7 mil electrical tape. UL listed and CSA approved. 3/4" x 60' rolls.

#350-052 ..... **75¢**(1-9) **59¢**(10-UP)

2.5W Mini Audio Amplifier



This amp contains both pre-amplifier and power amplifier on a super small board measuring only 1-5/8"x1-1/4". Maximum output power is 2.5W into 4 ohms with 12VDC input power. No adjustments required. Short circuit protected.

#320-215 ..... **$9.95**EACH

Gold Plated A/V Cables

A super quality, "siamesed" type cable. Two RCA cables for stereo (audio) signal from VCR to receiver/stereo TV and one low noise coaxial type cable for video.

Part #	Length	Price (1-9)	Price (10-UP)
180-120	3 ft.	$4.25	$3.95
180-118	6 ft.	4.90	4.50
180-121	12 ft.	8.95	7.95
180-124	20 ft.	12.75	11.50

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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. **Sorry, no discounts on credit-card orders. Boldface (not available as all caps),** add .40 per word additional. **Entire ad in boldface,** add 20%. **Tint screen behind entire ad,** add 25%. **Tint screen plus all boldface ad,** add 45%. **Expanded type ad,** add $2.25 per word.

General Information: A copy of your ad must be in our hands by the 13th of the fourth month preceding the date of issue (i.e. Sept issue copy must be received by May 13th). When normal closing date falls on Saturday, Sunday or Holiday, issue closes on preceding work day. Send for the classified brochure.

DEADLINES

Ads not received by our closing date will run in the next issue. For example, ads received by November 13 will appear in the March issue that is on sale January 17. POPULAR ELECTRONICS is published monthly. No cancellations permitted after the closing date. No copy changes can be made after we have typeset your ad. NO REFUNDS, advertising credit only. No phone orders.

CONTENT

All classified advertising in POPULAR ELECTRONICS is limited to electronics items only. All ads are subject to the publishers approval. WE RESERVE THE RIGHT TO REJECT OR EDIT ALL ADS.

AD RATES: $1.75 per word, Minimum $26.25

Send you ad payments to:
POPULAR ELECTRONICS 500 Bi-County Blvd, Farmingdale, NY 11735-3931

CATEGORIES

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

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
5 - $26.25	6 - $26.25	7 - $26.25	8 - $26.25
9 - $26.25	10 - $26.25	11 - $26.25	12 - $ 26.25
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
29 - $50.75	30 - $52.50	31 - $ 54.25	32 - $56.00
33 - $57.75	34 - $59.50	35 - $61.25	36 - $63.00
37 - $64.75	38 - $66.50	39 - $68.25	40- $70.00

Total words _____ $1.75 per word = $_____

Bold Face _____ $0.40 per word = $_____

Special Heading _____ $20.00 = $_____

Other_____ = $_____

Total classified ad payment $_____ **enclosed**

TOTAL COST OF AD $ _____

[ ] Check [ ] Mastercard [ ] Visa [ ] Discover Card # _____ Expiration Date __/__

Signature_____

Name _____ Phone _____

Address_____City State Zip _____

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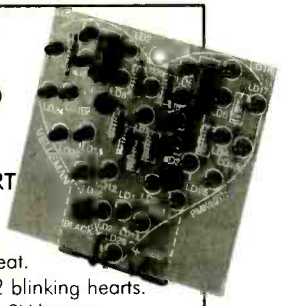
47pc•kit

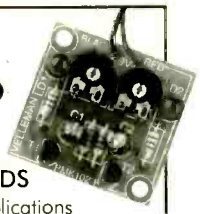
$12.95



MK101
SWEETHEART
Give him or her that special heartbeat.
28 leds form 2 blinking hearts.
Power supply : 9V battery

14pc•kit

$5.95



MK102
FLASHING LEDS
For different applications (such as model construction) and educational purposes.
Adjustable flashing speed.
Power supply : 9V battery

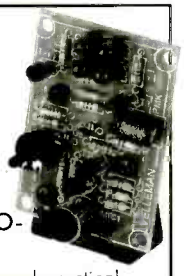
30pc•kit

$14.95

MK104
ELECTRONIC CRICKET
This cricket turns on when it gets dark.
Great as practical joke.
The tone and repetition between two crickets is adjustable.
Power supply : 9V battery

34pc•kit

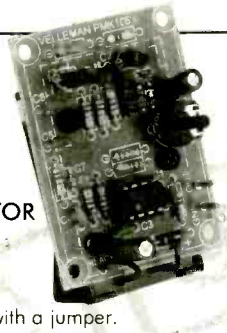
$9.95



MK103
LED SOUND-TO-LIGHT UNIT
For different funny and practical applications. 4 high-intensity leds light up and react simultaneously on every sound.
Power supply : 9V battery

36pc•kit

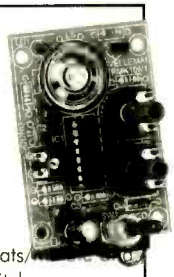
$10.95



MK105
SIGNAL GENERATOR
Several signal outputs : square wave, triangle, sine and integrator which are selectable with a jumper.
The signal frequency is about 1KHz (fixed)
Ideal to learn electronics!
Power supply : 9V battery

26pc•kit

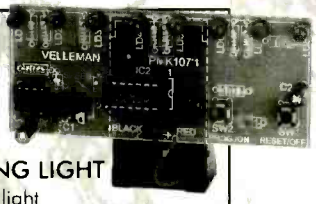
$14.95



MK106
METRONOME
The beats per minute are given by a built-in speaker and by a led.
Adjustable volume, beats/sound. With on/off switch.
Power supply : 9V battery

36pc•kit

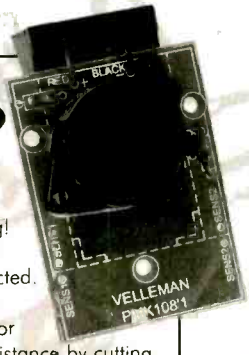
$12.95



MK107
LED RUNNING LIGHT
8 leds running light
Different running effects are selectable (by prog push button)
Adjustable effect speed.
Power supply stand-by by push button.
Power supply : 9V battery

8pc•kit

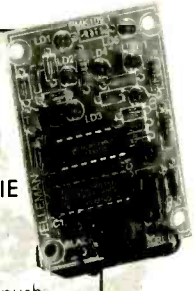
$7.95



MK108
WATER ALARM
Never let you surprise by flooding!
Gives alarm sound when water is detected.
Incorporated alarm buzzer. Water sensor can be placed at distance by cutting the board and using wires to connect the sensor. Power supply : 9V battery

35pc•kit

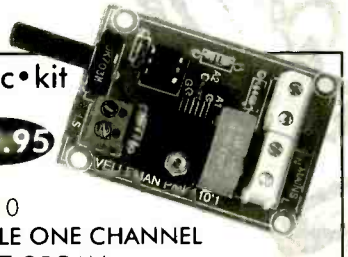
$9.95



MK109
ELECTRONIC DIE
No more cheating allowed ! The eyes of the die are leds
Rolls out when the push button is released.
Power supply : 9V battery

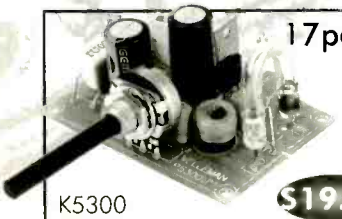
17pc•kit

$12.95



MK110
SIMPLE ONE CHANNEL LIGHT ORGAN
With loudspeaker input. The lamp flashes on the beat of the music. Optical isolated loudspeaker input with adjustable sensitivity : 2W to 60W.
Maximum load : 120W at 120Voc.

17pc•kit

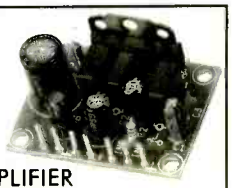


$19.95

K5300
STROBOSCOPE
Adjustable flash frequency : 5-15Hz
Power supply : 120Vac
Power consumption : 13W max.

21pc•kit

$12.49



K2637
SUPERMINI 2.5W AUDIO POWER AMPLIFIER
Superb audio amplifier with incredible tiny dimensions.
Integrated circuit has a pre- and power amplifier which can be used separately.
Max. output power : 2.5W @ 4ohm
Frequency characteristics : 60Hz to 15KHz
Power supply : 4.5V to 15Vdc / 400mA

Exists also as module : M2637 $17.49

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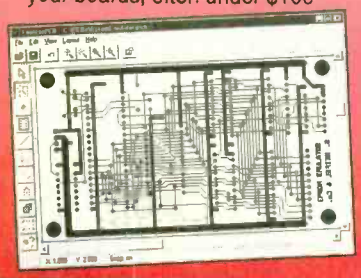

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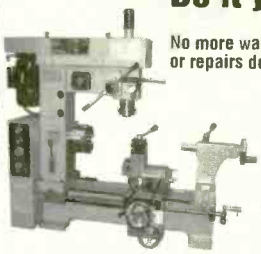

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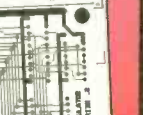
Our PIC Programmer kits of parts attach to the parallel port of a PC and contain the following: PCB, parts and instructions. Uses a straight through (25 pin) cable (not supplied). S&H: USA $4.95, Canada $7.95 Other $11.95



P16PRO PIC Programmer
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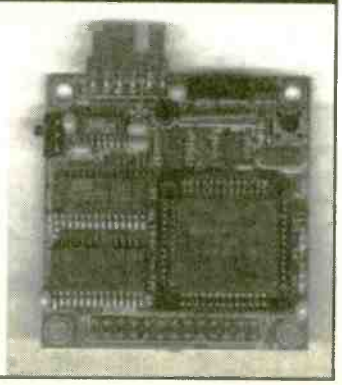

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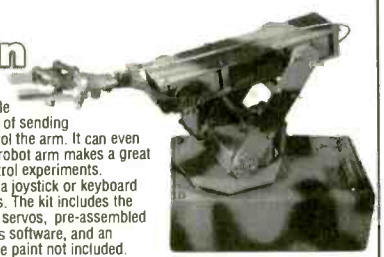

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▸**Complete example program with RS-232 I/O:**

```
#include <PIC16C56.h>
#fuses xt,protect
#use Delay(Clock=20000000)
#use RS232(Baud=9600,Xmit=pin_1,RCV=pin_2)
  main () {
     printf("Press any key to begin\n") ;
     getc();
     printf("1 khz signal activated\n") ;
     while (TRUE) {
          output_high(pin_0) ;
          delay_us(500) ;
          output_low(pin_0) ;
          delay_us(500) ;
     }
  }
```

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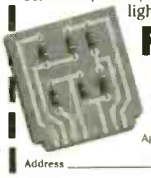

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AMAZING SCIENCE

Space Horticulture

JOHN IOVINE

Over the years, we at **Popular Electronics** have become aware of the vast number of hobbyists who like a little something extra with their electronics. And so, it is with that under-served segment of our readers in mind that we inaugurate *Amazing Science.* Each month we look at present experiments that push our hobby to its limits and are designed with the future in mind. So, without further fanfare, let's get right into the task at hand.

A LITTLE BACKGROUND

Our first experiment involves something that I'd been planning to check into for more than five years. Over that time period, I'd expected someone, presumably NASA, to hit upon the same idea, perform the experiment, and publish the results. Unfortunately, that did not happen, but we still have the chance to perform a wonderfully simple experiment that has the potential of impacting on future human space travel. The experiment grew out of thoughts of minimizing the power requirements for life-support systems during extended manned space voyages, say, to Mars and other planets.

It's been common knowledge for some time that for extended space flight, food and oxygen would need to be grown and recycled. The obvious answer to that dilemma is plants, which can serve as a food source, while recycling the byproduct of animal respiration (carbon dioxide) back into breathable oxygen. In addition, plants can be used to help purify wastewater back into potable drinking water. Nothing much new here, but let's continue stating the obvious for a little while longer (it's background).

Power generators take up precious space and weight on board the spacecraft. The more power needed for the life-support system, the greater the space and weight requirements of the power plant (power-generation equipment). Thus, it stands to reason that anything that can reduce power consumption can also improve the overall mission profile.

The first experiment is based on the hypothesis that a plant's photosynthesis cycle may not require continuous light (100% on) to achieve optimum growth. If that hypothesis is correct, it's reasonable to assume that a strobed light (a light that is rapidly switched on and off) can be used to effectively grow plants while conserving electrical energy. In our initial experiment, the light source used for plant growth is strobed on and off at a frequency of approximately 3 Hz with a duty cycle of 50%. The 50% duty-cycle means that the circuit consumes only half the amount of energy required for continuous operation.

INTENSITY VS. DURATION

It's possible that plants grown under a strobe light with a 50% duty cycle will grow as if exposed to half the illumination at 100% duty cycle. In other words, the plants average out the intensity of the light in relation to time. The plant-growth factor would be unity in such a case and show no appreciable gain. That's a critical point and bears repeating. If the average plant growth under the 50% duty cycle of the strobe equals the growth rate of plants under half light intensity at 100% duty cycle, then unity is reached and there is no appreciable gain.

On the other hand, if plants grown under the strobe light show increased growth over the control plants, then we have increased growth per unit of energy expended and the experiment is a resounding success.

TWO CONTROL GROUPS

In the initial experiment, two control groups were used—one illuminated by LEDs, and the other subjected to fluorescent light. The photo-period for all the groups was 12 hours of light followed by 12 hours of darkness. The LED control group used a nearly identical LED lighting module as the experimental group. By measuring each plant group's growth and leaf area over time, the experimenter should be able to ascertain how the plant's growth rate is affected (if at all) when exposed to a strobed LED source vs. 100% duty cycle LED illumination. Data gleaned from plants exposed to the two lighting arrangements can then be compared to that obtained from plants grown under fluorescent lighting.

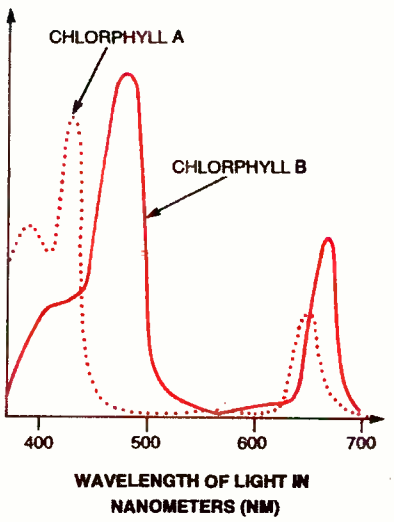

Fig. 1. The response of chlorophyll a and chlorophyll b to the visible light spectrum is graphically illustrated here. The graph indicates that the subject vegetation responds most favorably to light emanating predominantly in the blue and red range of visible light.

TABLE 1—AVERAGE LUMENS PER WATT

LIGHT SOURCE	LUMENS PER WATT
Edison Based Tungsten Lamp	14 Lumens per Watt
Fluorescent Lamps	72 Lumens per Watt
Super Bright LED	50–75 Lumens per Watt*

* Varies as to type and wavelength

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MEASURING PLANT GROWTH

The first experiment is impoverished, using only three groups of four plants each, two control groups and one experimental group. Statistically, the number of plants selected is insufficient to definitely form any conclusions. The in-group variance (natural growth rates) alone could undermine any results. However, in defense of using small groups, we're just beginning the experiment, and I want to get it off the ground. I plan on fine-tuning and expanding this experiment as I continue. The potential of this experiment is such that I plan to be re-running and improving it over the next couple of years.

For the time being, plant growth will be measured visually. If the results of the experiments justify the expense, provision will be made to measure the plants' biomass (leaf size or area), plus their wet and dry weights.

LIGHT SOURCES

When growing plants under artificial lights, fluorescent lamps are usually the lights of choice. Fluorescent lamps provide a broad spectrum of light and have good light efficiency (lumen output to watt). While it may be possible to strobe fluorescent lamps, it is doubtful that the energy saved by strobing fluorescent lamps would be worthwhile. Besides fluorescent lamps are fragile, not the type of device desired in space or for extended space flight. Incandescent lamps are too inefficient, low lumen output per watt consumed. In addition to the low efficiency, the light output of incandescent lamps is very much in the infrared and red portions of the spectrum.

Probably the best choice for lighting are super-bright LEDs. NASA has been growing plants under LED illumination for a number of years. While there have been reports of NASA's plant-grow chambers using LED illumination, hard data on the LED spectrum and lumen intensity used in their endeavor is difficult (if not impossible) to come by.

Note from Table 1 that LEDs provide an efficient light source that is comparable to fluorescent-light illumination and has the added benefit of being rugged, solid state, and suitable for the rigors of space flight. In the future, LED efficiency can only improve. Other super-bright LEDs can be used in place of those specified. If different LEDs are used, keep a record of the specific wavelength emitted by the LEDs and the voltage required. That's essential so that others can replicate your results if necessary. Also if the required voltage of the LED is different, the circuit can be modified as required.

INVERSE-SQUARE LAW AND ARTIFICIAL LIGHTS

Imagine taking a picture on a sunny day. To set the camera for the right exposure you use an external light meter to measure sunlight intensity. After taking the measurement at ground level, you shoot a picture. Then you and your friends decide to have lunch and take an elevator to the sixth floor of a building that has an outdoor restaurant on the roof. The view from the roof is so spectacular that you decide to take another picture. You take another measurement at the new location, only to discover that the meter reading indicates sunlight intensity is the same on the building roof (six floors up) as on the ground floor.

That's the major difference between sunlight illumination and artificial lights. The intensity of sunlight doesn't change appreciably as you move up or down a couple of hundred feet. With artificial light, movement toward or away from the light source changes light intensity dramatically. If a one-watt light source illuminates an area of one square centimeter at a distance of one meter, the intensity of light is 1 watt/sq.cm. If we move the screen back to a two-meter radius, the same light would be dispersed over four times the area, reducing the light intensity to 0.25 watt/sq.cm.

That's the *Inverse-Square Law*. The inverse-square law states that the intensity of radiation is inversely proportional to the square of the distance from its source. So a doubling of distance reduces the intensity by a quarter (1/4). Thus, a general rule to follow when growing plants under artificial illumination is to keep the plants as close to the light source as possible, but not so close that heat from the light source damages the plant.

LIGHT INTENSITY

Light intensity is measured two

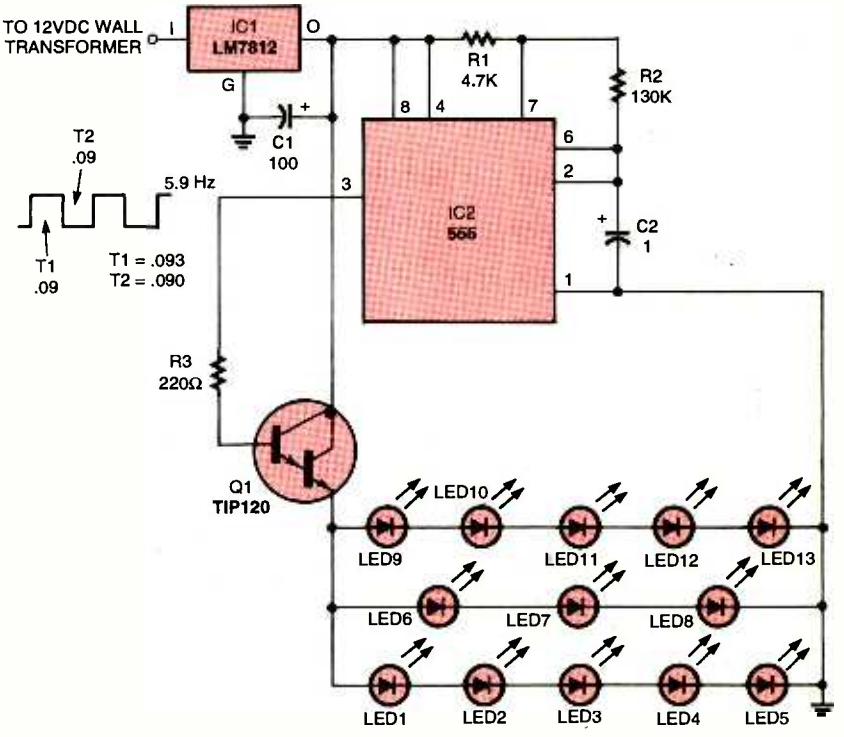

Fig. 2. This circuit, comprised of a 555 oscillator/timer and a TIP120 Darlington transistor, is designed to oscillate at 3 Hz and has a duty cycle of 50%. In this circuit, the Darlington, acting as a switch, toggles current to the strobe LED lighting module on and off in accordance with the output of the oscillator.

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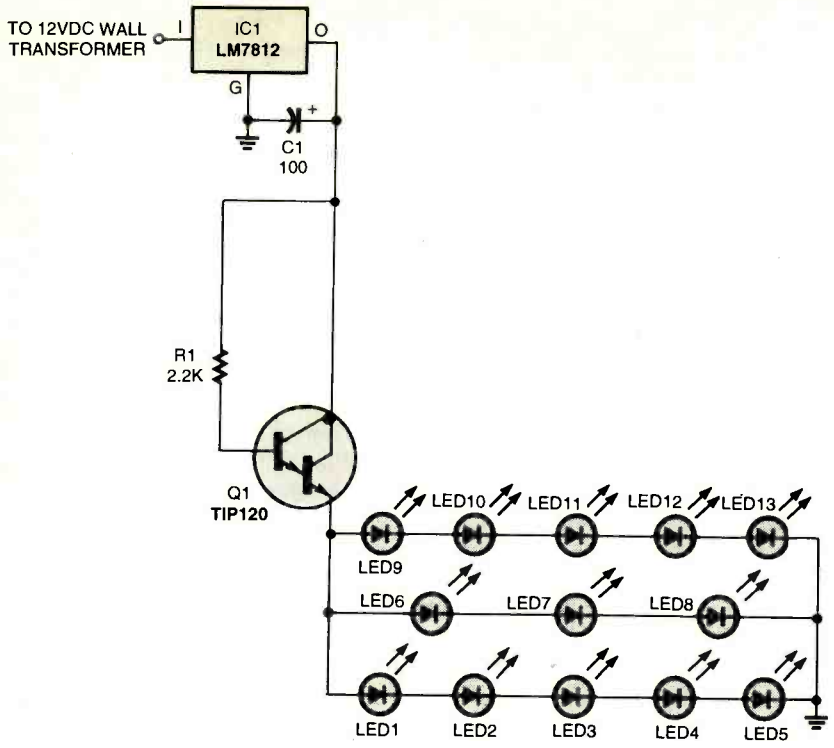

Fig. 3. This circuit is a slightly modified version of the circuit in Fig. 2. Here the oscillator has been eliminated, and the Darlington reconfigured to act as a regulator, so that the voltage applied to the LEDs in this circuit matches that applied to the array in Fig. 2.

ways, using either the *photometric* or the *radiometric* systems. The photometric system measures light based on the sensitivity of the human eye. The human eye, like other human senses, does not react in a linear fashion to the intensity of energy. The luminous intensity of light is measured in *candela*. A one-candela light source produces one lumen of light on an area of one square foot at a radius of one foot.

PARTS LIST FOR THE STROBED LED-LIGHTING SYSTEM (FIG. 2)

SEMICONDUCTORS
IC1—7812 positive 12-volt, 1-amp voltage regulator, integrated circuit
IC2—555 oscillator/timer, integrated circuit
Q1—TIP120 NPN Darlington transistor
LED1–LED13—Super-bright light-emitting diode (see text)

RESISTORS
(All resistors are ¼-watt 5% units.)
R1—4700-ohm
R2—130,000-ohm
R3—220-ohm

CAPACITORS
C1—100-µF, 25-WVDC, electrolytic
C2—1µF, 25-WVDC, electrolytic

ADDITIONAL PARTS AND MATERIALS
Protoboard, appliance timer (RadioShack 61-1068; $7.99), 1/8- or 3/16-inch phone plug, sockets, 12-volt DC wall trans former 500 mA.

PARTS LIST FOR THE NON-STROBED LED-LIGHTING SYSTEM (FIG. 3)

SEMICONDUCTORS
IC1—7812 positive 12-volt, 1-amp voltage regulator, integrated circuit
Q1—TIP120 NPN Darlington transistor
LED1–LED13—Super-bright light-emitting diode (see text)

ADDITIONAL PARTS AND MATERIALS
R1—4700-ohm, ¼-watt, 5% resistor
C1—100-µF, 25-WVDC, electrolytic capacitor
Protoboard, appliance timer (RadioShack 61-1068; $7.99), 1/8- or 3/16-inch phone plug, sockets, 12-volt DC wall trans former 500 mA

The radiometric system uses artificial detectors that accurately measure the intensity in terms of energy, which is expressed in watts. At the earth's surface, full sunlight is estimated at 1000 watts per square meter.

PHOTOSYNTHESIS GRAPH

Figure 1 shows the response of chlorophyll a and chlorophyll b to the visible light spectrum. In extrapolating the information in this graph we should provide plants with light that emanates predominantly in the blue and red wavelengths of visible light. Even so, in my preliminary experiment I decided to broaden the spectrum slightly by adding two more colors of light to the blue and red, namely, yellow and green. My reasoning for adding the other frequencies of light is that photosynthesis may operate more efficiently with a broader spectrum.

Note: While this experiment did not show that to be the case, it's wise to leave that option open when growing food stuffs, such as potatoes and wheat. Plants grown under a battery of mono-chromatic light sources must be checked (analyzed) to ensure that the plants produce proper (normal) carbohydrate and protein profiles when compared to growth under broad-spectrum lighting.

Incidentally, among all the plants and algae that are being considered by NASA for long-term space flight, the three most likely test subjects for future experimentation are potatoes, tomatoes, and wheat. Potatoes have already been to space and according to the published reports they grew well.

THE STROBED-LED LIGHTING SYSTEM

A schematic diagram of the strobed-LED lighting system, built around a pair of readily available ICs (IC1, an LM7812 fixed 12-volt regulator and IC2, a 555 oscillator/timer), is shown in Fig. 2. The optimum duty cycle and frequency for the oscillator (IC2) must be determined. In other words, we're flying blind in regard to optimum frequency and duty cycle. The circuit in Fig. 2 is configured to operate at a frequency of 3 Hz and has a 50% duty cycle. That circuit's operating frequency was chosen based on using a convenient 1-µF capacitor for

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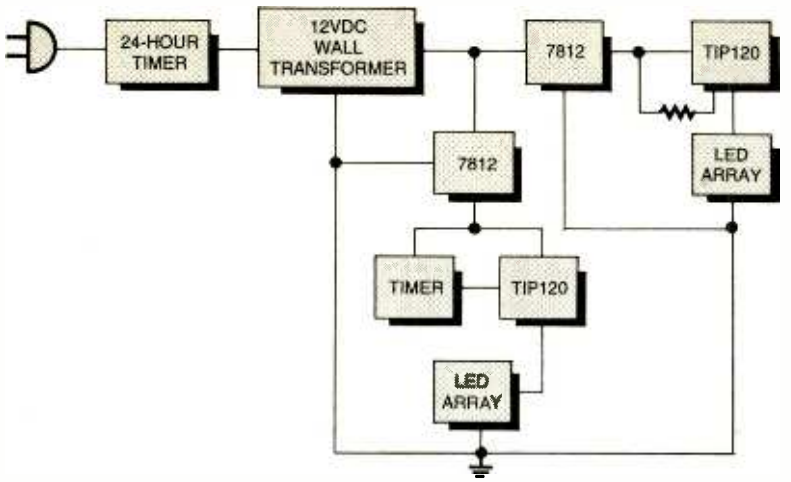

Fig. 4. Shown here is a functional block diagram of the overall circuit. Note that both LED modules are powered from the same 12-volt DC wall transformer, which plugs into an inexpensive AC appliance timer set for a 12-hour on period.

the 555 timer/oscillator. The output of the 555 (pin 3) is connected to the base of Q1, a TIP120 NPN Darlington transistor. The transistor, acting as a switch, toggles current to the strobed LED lighting module on and off in accordance with the output of the oscillator (IC2).

NON-STROBED LED LIGHTING SYSTEM

TABLE 2—STATISTICS FOR SUPER BRIGHT LEDS

COLOR	WAVELENGTH	V_F (VOLTS)	I (mA)	INTENSITY MCD
Red	630 nm	2.0	20	3000–6000
Yellow	588 nm	2.0	20	2000–3000
Green	525 nm	3.5	20	6000
Blue	470 nm	3.6	20	2000

The non-strobed LED lighting system shown in Fig. 3 is the circuit used to illuminate one of the two control groups used in our space-horticulture experiments. That circuit, while very similar to the strobed lighting system in Fig. 2, provides continuous illumination only. In order to ensure equal light among the plants placed under the two lighting systems, the voltage drop across the collector-emitter junction of Q1 in Fig. 2 must be considered. In order to ensure equal brightness from both LED modules, a dummy TIP120 transistor was placed in line with the LED array in Fig. 3 to match the voltage drop developed across Q1 in Fig. 2. The transistor (Q1) in Fig. 3 is forward biased (always on) as long as power is applied through R1 (2200-ohm resistor) to its base terminal. The voltage drop across Q1 is approximately 1.5 volts.

A functional block diagram of the overall circuit is shown in Fig. 4. The circuit (which is comprised of both LED modules) is powered from a 12-volt DC wall transformer that plugs into an inexpensive RadioShack AC appliance timer you should set for a 12-hour on period.

MAKING THE LED LIGHTING ARRAYS

Referring back to Fig. 3, note that the circuit is powered from a regulated 12-volt source comprised of IC1, a 7812 voltage regulator, and C1, a 100-µF electrolytic capacitor. The LEDs were arranged so that no current-limiting resistor is required. The voltage drop across the collector-emitter of the transistor is approximately 1.5 volts, so the voltage available to the LED array is about 10.5 volts.

With a 10.5-volt power source available to the LED array, five red or yellow LEDs can be placed in series. That

(Continued on page 77)

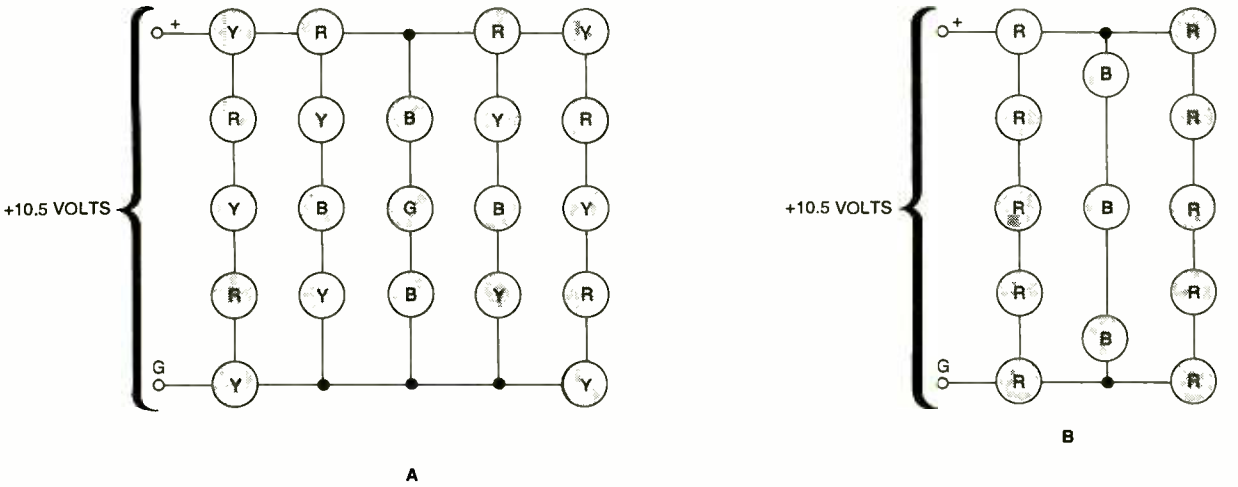

Fig. 5. Shown here are two LED arrangements. The one in A was used in the initial experiment, while the one in B is the preferred arrangement.

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Robotics Workshop

Vision Systems

GORDON MCCOMB

Of all the physical senses, sight is perhaps the most important to any living creature. After all, our eyes enable us to hunt and gather food, avoid dangers and enemies, aid in maneuvering around obstacles, *etc.* Endowing your robots with the gift of sight is perhaps the kindest thing you can do for your mechanical creations. On the other hand, it is one of the most difficult tasks in the robotics field.

Robotic-vision systems can run the gambit, from the very simple to the extremely complex, to match your requirements and your penchant for tinkering. Rudimentary "Cyclops" (one-eye) vision systems are used for nothing more than detecting the presence or absence of light. Such rudimentary arrangements are a worthwhile point of entry into the diverse realm of robotic-vision systems. More advanced vision systems might be able to decode relative light intensities and/or deduce shapes and patterns from the recorded scene.

But before we get into anything complicated, let's review some general concepts of robotic vision . . . from single-cell light detectors to more sophisticated image-mapping systems.

BASIC VISION: THE ONE-CELL CYCLOPS

A single light-sensitive photocell is all that is required to detect the presence or absence of light. The photocell—which was once called a "magic eye," but is today referred to as a *light-dependent resistor* (LDR) or *photoresistor*—is a resistive element that works much like a potentiometer, but has no control shaft. Instead, the photocell's resistance is varied by increasing or decreasing the intensity of light striking its light-sensitive detection area. With no light striking the cell's detection area, the unit exhibits a resistance in the megohm region. Radiating light onto the device causes its resistance to drop sharply to, perhaps, just a few thousand ohms.

In order to function properly in most applications, the photocell should be placed in series with a resistor and a voltage source, as shown in Fig. 1, with the output taken from the junction formed by the two devices. That arrangement allows the output of the photocell to be converted from resistance to voltage, the latter of which is easier to use in a practical circuit. **Note:** Although the value of R1 is specified as 3.3K, it is open to experimentation. The sensitivity of the cell can be varied by substituting a higher or lower value resistance for R1. For experimental purposes, a 50K potentiometer can be connected in place of R1 and the cell checked to determine the output voltage developed as a result of various settings of the potentiometer. The output of the Fig. 1 circuit can be monitored by connecting a volt-ohm meter (VOM) between the ground and output terminals.

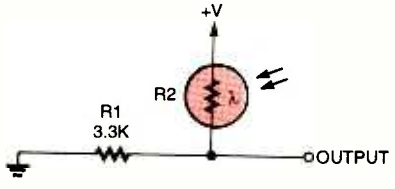

Fig. 1. In order to function properly in vision-system applications, the photocell should be placed in series with a resistor and a voltage source, as shown here, and the output taken from the junction formed by the two devices.

To make a practical circuit, the single-cell robotic eye can be interfaced to a computer. In order for the analog output of the single-cell robotic eye to be of any practical use in a computer-based system, it must first be converted to digital form—a task that can be handled by almost any analog-to-digital converter (ADC). A portion of a functional block diagram of a circuit based on an eight-bit multiplexed analog-to-digital converter (such as National Semiconductor's ADC0808 or some similar device) is shown in Fig. 2.

In that circuit, a series of eight photocells (only one of which is shown) is used to generate the input signals that are applied to the ADC. The outputs of the ADC form an 8-bit binary word that can vary in value from 0 (binary 00000000) to 255 (binary 11111111). Software running on the computer reads the instantaneous value of the ADC output, correlating the binary values into either brightness or darkness readings.

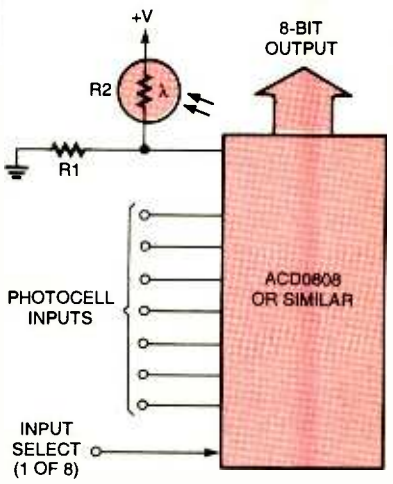

Fig. 2. In order to make a practical circuit, the single-cell robotic eye can be interfaced to a computer, which requires that the analog output of the single-cell robotic eye be converted to digital form—a task that can be handled by almost any analog-to-digital converter (ADC). A portion of a functional block diagram of a circuit based on an eight-bit multiplexed analog-to-digital converter is shown here.

Photocells are not the only devices that can be used to form robotic-vision systems. There are a variety of other light-sensitive devices that can be used in this application. For example, the phototransistor—which functions like a regular transistor, except that it is light activated—or the photodiode can substitute for the photocell. A solar cell is another option, though not as practical because of the greater surface area of the device. (**Note:** Nearly all semiconductor devices are light sensitive, particularly to light in the near-infrared region of the electromagnetic spectrum.)

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INTRODUCTION TO VIDEO VISION SYSTEMS

Single-cell vision systems are useful in detecting the presence or absence of light, but they cannot distinguish between the shapes of objects—a shortcoming that greatly limits the environment into which such a robot can be placed. With the ability to detect the shape of an object, a robot might be able to make intelligent assumptions as to its surroundings, perhaps maneuvering around obstacles, recognizing its "master," and more.

Even as recently as five years ago, video-vision systems for robots were expensive propositions for any experimenter. But that has changed dramatically. The advent of inexpensive "pinhole" cameras has made the hardware for machine vision affordable.

A robotic-vision system needn't be overly sophisticated. The resolution of the image can be as low as about 100 by 100 pixels (10,000 pixels total), although a resolution of no less than 300 by 200 pixels (60,000 pixels total) is preferred. The higher the resolution, the better the image, and therefore the greater the ability to discern shapes. A color camera is not mandatory, and in some cases, may even make it harder to write suitable video-interpolating software.

Video systems that provide a digital output are easier to work with than those that provide only an analog-video output. Digital-video systems can be connected directly to a PC through a serial, parallel, or USB port. Analog-video systems require a video capture card or other similar device attached to the PC. At about $80 retail, the Logitech QuickCam VC (*www.quickcam.com/*), which is a favorite among robot builders, connects to a PC via a parallel or USB port and sports a top resolution of 352 by 288 pixels. While the hardware for video vision is now affordable to most experimenters, the job of translating a visual image for use by a robot requires high-speed processing and complicated computer programming.

Giving robots the ability to recognize shapes has proven a difficult task. To understand the complexity of the task, consider, for example, the static image of a doorway. The human brain can easily comprehend the image and adapt to the angle at which the doorway is viewed; as well as the amount, direction, and contrast of the light falling on the doorway; the size and kind of frame used in the doorway; whether the door is opened or closed; and hundreds or even thousands of other variations. Robotic-vision systems require that each of those variations be analyzed. That's a job that requires computing and programming power beyond the means of most robot experimenters.

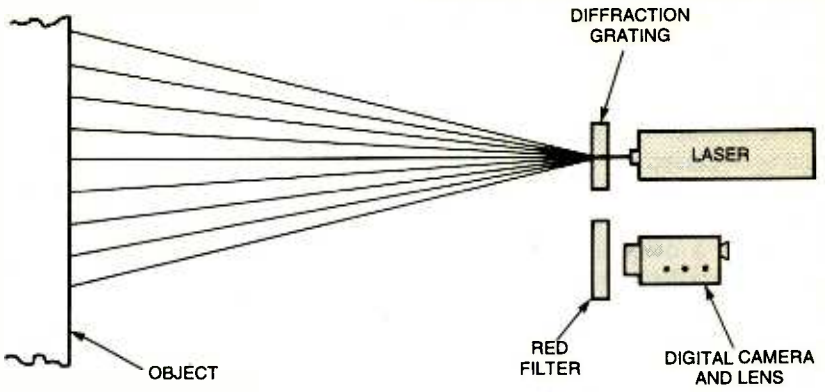

Fig. 3. In the diffraction-grating process, lines scribed into a piece of plastic on a single plane cause the laser beam to break up into several beams along the same plane. A penlight laser, diffraction grating, filter, and video camera can be used to create a low-cost machine-vision system.

VISION BY LASER LIGHT

Fortunately, there are some less complicated methods that can be tried in your quest for a better robotic-vision system. Here's a scheme—comprised of about $30 worth of parts (minus the video camera)—you might want to try that's built around a simple penlight laser, a red filter, and a small piece of diffraction grating (available from Edmund Scientific Company, see "Robotic-Vision Web Resources").

The system is based on a principle similar to the three-beam focusing scheme used in CD players. In a CD player, laser light is broken into "sub-beams" through the use of diffraction grating. In such a system, a single, strong (main) beam appears in the center, flanked by weaker beams on both sides. The three-beam CD focusing system uses the main beam and the two closest side beams, ignoring all others.

The beam spacing increases or decreases as the distance from the lens to the surface of the disc increases or decreases, respectively. Multi-celled photodetectors in CD players integrate the light reflected by the beams to determine whether the lens should be moved closer to or further away from the disc. (For history buffs, the fundamental basis of that focusing

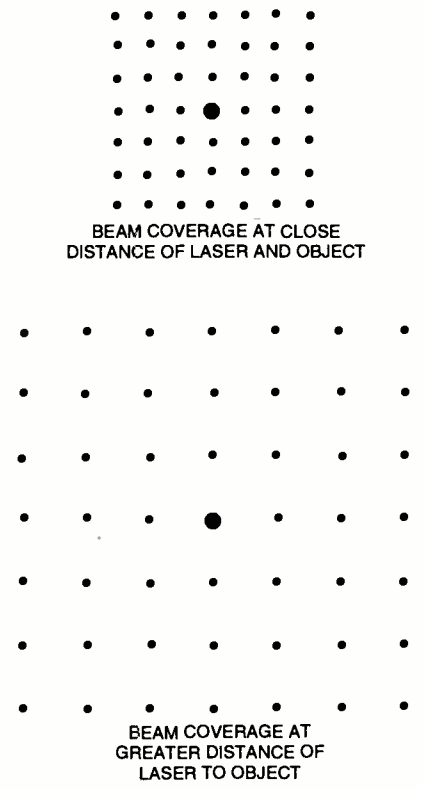

Fig. 4. In diffraction grating, lines scribed both vertically and horizontally cause the laser beam to split into multiple beams that form a "grid" when projected on a flat surface. The beams move closer together or further apart as the distance between the laser and surface is decreased or increased, as illustrated by the two dot patterns shown here.

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technique is over a hundred years old, pioneered by French physicist Jean Foucault.)

CD players use a diffraction-grating process wherein lines are scribed into a piece of plastic on a single plane. That causes the laser beam to break up into several beams along the same plane. With a diffraction grating that has lines scribed both vertically and horizontally, the laser beam is split up into multiple beams that form a "grid" when projected on a flat surface (see Figs. 3 and 4). The beams move closer together as the distance from the laser and surface is decreased; the beams move further apart as the distance from the laser and surface is increased. As you can guess, when the beams are projected onto a three-dimensional scene, they form a kind of topographical map, where they appear closer or further apart, depending on the distance of the object from the laser.

The red filter placed in front of the camera lens blocks out most of the light except for the red beams from the penlight laser. For best results, a high-quality, optical-notch filter that accepts only the precise wavelength of the diode laser, typically 635 or 650 nanometers, is recommended—check the specifications of the laser you are using so you can get the correct filter. Meredith Instruments and Midwest Laser Products provide a variety of penlight lasers and optical filters that can be used in your vision-system experiments.

The main benefit of the laser-diffraction system is that it's easier to write software that measures the distance between pixels than it is to write software that attempts to recognize shapes and patterns. For many machine-vision applications, it's not as important for the robot to recognize the actual shape of an object as it is for it to navigate around or manipulate the shape. As an example, a robot may "see" a chair in its path, but there is little practical need for it to recognize the chair as a late-1800s Queen Anne style two-seater settee. All it really needs to know is that something is there, and by moving left or right the object can be avoided.

BEYOND LIGHT-SENSITIVE VISION

Sight provides a fast and efficient way to determine surroundings. The eyes take in a wide field, and the brain processes what the eyes see to compose a "picture" of the immediate environment. Taking a cue from the special senses given to animals, however, visual eyesight is not the only way to "see." For instance, bats use high-pitched sound (sonar) to quickly and efficiently navigate through dark caves. So accurate is their "sonar" that bats can sense tiny insects flying a dozen or more feet away.

Similarly, robots don't always need light-sensitive vision systems. You may want to consider using an alternative system, either instead of or in addition to light-sensitive vision. Here are some affordable technologies that can be readily used:

Ultrasonics. Like a cave bat, your robot can use high-frequency sounds to navigate its surroundings. Ultrasonic transducers are common in Polaroid instant cameras, electronic tape-measuring devices, automotive backup alarms, and security systems. All work by sending out a high-frequency burst of sound, and then measuring the amount of time it takes to receive the reflected sound.

Ultrasonic systems are designed to determine the distance between the transducer and the object in front of it, as shown in Fig. 5. More accurate versions can "map" an area to create a type of topographical image, showing the relative distances of several nearby objects along a kind of 3-D plane. Such ultrasonic systems are regularly used in the medical field.

Some transducers are designed to be used in pairs—one transducer to emit a series of short ultrasonic bursts and another to receive the sound. Other transducers, such as the kind used on Polaroid cameras and electronic tape-measuring devices, combine the transmitter and receiver into a single unit. An important aspect of ultrasonic imagery is that high-frequency sounds disperse less readily than low-frequency ones. That is, the sound wave generated by a high-frequency source spreads out much less than the sound wave derived from a low-frequency source. That phenomenon improves the accuracy of ultrasonic systems. Both Digi-Key and All Electronics, among others, have been known to carry new and surplus ultrasonic components that are suitable for robotic experiments.

Radar. Radar systems work under the same principle as ultrasonics, but instead of high-frequency sound, radar uses a high-frequency radio wave. Most people are familiar with the high-powered radar equipment used in aviation, but few are aware of the lower-power versions commonly used in security systems, automatic-door openers, automotive-backup alarms, and of course, speed-measuring

ROBOT-VISION WEB RESOURCES

Video Cameras
Logitech QuickCam
www.quickcam.com

Laser and Optical Components
Meredith Instruments
commerce5.ba.best.com/~lasers/

Midwest Laser Products
www.midwest-laser.com

Edmund Scientific Company
www.edsci.com/

Ultrasonic Components
Ultrasonic Ranging Kit
www.qkits.com/public/qkits/qay60.htm

Digi-Key
www.digikey.com

All Electronics Corp.
www.allcorp.com

American Science and Surplus
www.sciplus.com

Additional Web Resources and Information
Ultrasonic Imaging Project
business.netcom.co.uk/iceni/usi_project/

Interfacing Polaroid Sonar Board
www.cs.umd.edu/users/musliner/sonar/

Structured Light Vision
www.cyberg8t.com/pendragn/actlite.htm

Analog-to-Digital Converter ICs
www.national.com

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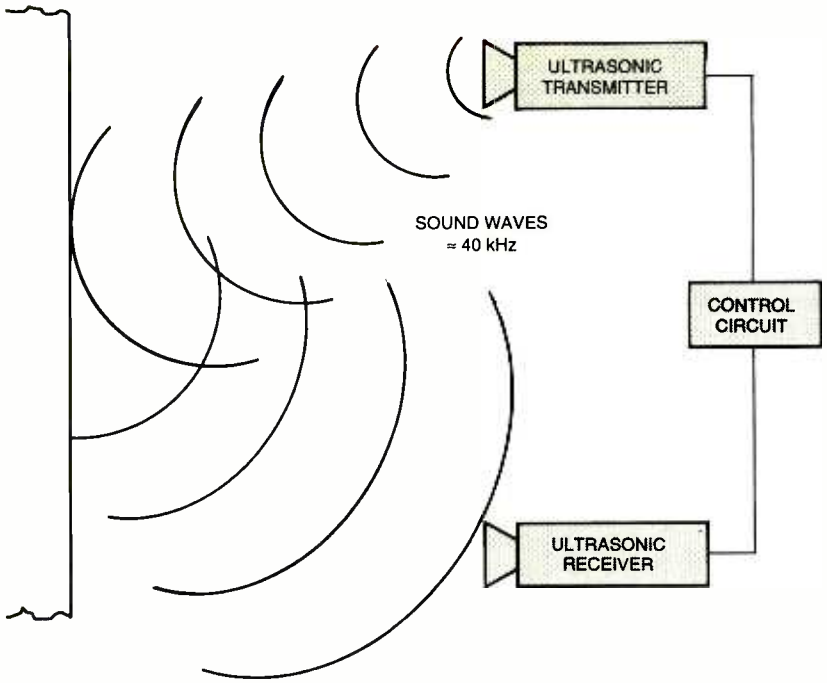

Fig. 5. Ultrasonic systems, like some of nature's creatures, use high-frequency sound to determine the distance between the transducer and the object in front of it. The time required for the sound to travel from its source to an object and back divided by two can be correlated into the distance from the transmitter to some object.

devices used by the police.

Radar is less often found in robotics systems because of its higher cost as opposed to ultrasonics. On the other hand, radar is less affected by wind, temperature, and distance (radar can be used up to several miles away, while ultrasonics is useful only up to about 10 or 20 meters) than ultrasonics.

Passive Infrared. A favorite in security and automatic-outdoor lighting systems, passive infrared (PIR) sensors detect the natural heat radiated by all objects. That heat is in the form of infrared radiation—a form of light that is beyond the limits of human vision. The most simple passive IR systems merely detect a rapid change in the heat reaching the sensor; such a change usually represents movement.

The typical PIR system uses a Fresnel lens to focus infrared light from a fairly wide area onto the pea-sized surface of the IR detector. In robotic-vision applications, the Fresnel lens can be replaced by a telephoto-lens arrangement, permitting the IR detector to view only a small area at a time. Mounted to a movable platform, the sensor could detect instantaneous variations in the infrared radiation of whatever objects are in front of the robot.

Tactile Feedback. Many robots can be effective navigators with little more than a switch or two to guide their way. Each switch on the robot acts as a kind of "touch sensor:" When a switch is depressed, the robot knows it has touched some object in front of it. Based on that information, the robot can stop and negotiate a different path to its destination.

To be useful, the touch sensors must be mounted to the robot in positions where they'll come into contact with the objects in its surroundings. For example, four switches can be mounted along the bottom periphery of a square-shaped robot so that contact with any object triggers a switch. Mechanical switches are triggered only by physical contact; other switches that use reflected infrared light or capacitance are triggered by the proximity of objects. Non-contact switches are useful if the robot might be damaged by running into an object, or *vice versa*.

Well, that's about it for this month, but be sure to join us for the next go round when we'll discuss robot control via a computer parallel port. Until we meet again, happy experimenting. ■

(continued from page 73)

would provide a voltage drop of 2.1 volts across each series-connected LED, which is well within the 1.7–2.4-volt range specified for the LED in the manufacturer's data sheets, as shown in Table 2.

Placing three blue LEDs in series with the 10.5-volt source produces a 3.5-volt drop (10.5 volts/3 LEDs = 3.5 volts) across each LED, which, again, is within the acceptable range specified for blue or green LEDs according to the data sheets.

Based on the forward-voltage-drop information, the LED array was laid out in series-parallel fashion to create the LED lighting module. In an attempt to create as diverse and even lighting as possible, the LEDs were laid out in a couple of configurations. The configuration in Fig. 5A is the one used in my experiment. The Fig. 5B circuit is the one you should use as it works much better.

The LED array was assembled on a section of protoboard (RadioShack 276-170).

COMING UP

Well, that's about all the space allotted to us for this go round, but be sure to join us here next month when we'll discuss building a basic growth chamber for the experimental plants and how to mount the lighting modules into the growth chamber. In the future, we look into adding an additional control group illuminated with half the light intensity of the experimental group, and use a computer to control all the lighting.

The computer will make it easy to control and vary the frequency as well as the duty cycle of the strobed LED lighting. Feedback sensors can also be incorporated to insure that the lights are on when they're supposed to be, and that they are glowing at the correct intensity.

If you are interested in hearing about the results of future experiments or wish to share the knowledge you observed while recreating this experiment at home, contact me at *Amazing Science* **Popular Electronics**, 500 Bi-County Blvd., Farmingdale, NY 11735. ■

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CIRCUIT CIRCUS

Model-Train Controller Circuits

CHARLES D. RAKES

The subject for this visit actually started on a brisk and cool Saturday morning back in early December 1954 at a local retail store. That day my father purchased our very first TV set—a 24-inch black-and-white Philco—and received as a bonus a Lionel "O" gage train set, which turned out to be my most treasured Christmas gift that year. I had always been fascinated by the life-like performance of the steam engines that passed through our area and grew to tolerate the new diesel trains. But actually having my very own steamer, even though it was only a toy, guaranteed a life-long interest in trains.

Today the model train hobby is filled with electronics. Engines come with computers that are comparable to the once popular 286 processor, which add truly realistic digital sounds. Gone is the old-fashioned, electromechanical type reversing system (replaced by electronic circuitry); even today's most modestly priced train sets come with electronically generated bells or whistles. At this point, you may be asking what possibly can the hobbyist build or add to such an already high-tech system? It may be true that in most cases necessity is the mother of invention, but in the real world cost is the main reason that new ideas and other ways of doing things come about. The cost of a really good power transformer and controller for a three-rail "O" gage train can run as high as $400. Low-end transformer/controllers cost much less, but the performance also suffers, especially in running a really big and heavy engine.

A LIFE-LONG FIXATION

My troubles started when I tried to run my newly acquired MTH RailKing Union Pacific "Big Boy" steam engine, which weighs about 12 pounds, with a 75-watt transformer/controller that came with a very nice, but less power-hungry train set. The lesser power system would move the "Big Boy" at a slow speed, but never generated enough torque to pull very many cars. Even when the system did manage to pull the load, the circuit breaker on the transformer would trip after a short time. The 75-watt transformer was certainly large enough to power the engine; but after looking at the voltage waveform across the tracks with an oscilloscope, it was easy to see why it wasn't doing the job. The controller wasn't allowing nearly enough output at full throttle to properly power the engine, while at the same time, the peak transformer current was high enough to pop the breaker. The electronic-control unit was removed from the system and the transformer's output connected directly to the train tracks. A variable 120-volt transformer was used to control the voltage applied to the power transformer. At only 80% throttle (or about 80 volt across T2), the engine ran at a respectable speed, pulling four cars. Everything was going fine, except that I had no way of blowing the engine's whistle. The power system/controller in Fig. 1 solved the problem.

Before getting into our first controller circuit, here's how the smart trains decode the signals from the controller to turn on the horn and whistle. The AC voltage supplying power to the train's motor also carries information that is fed to the engine's decoder circuitry. The AC voltage that is applied to the tracks for normal operation, which causes the train to run either forward

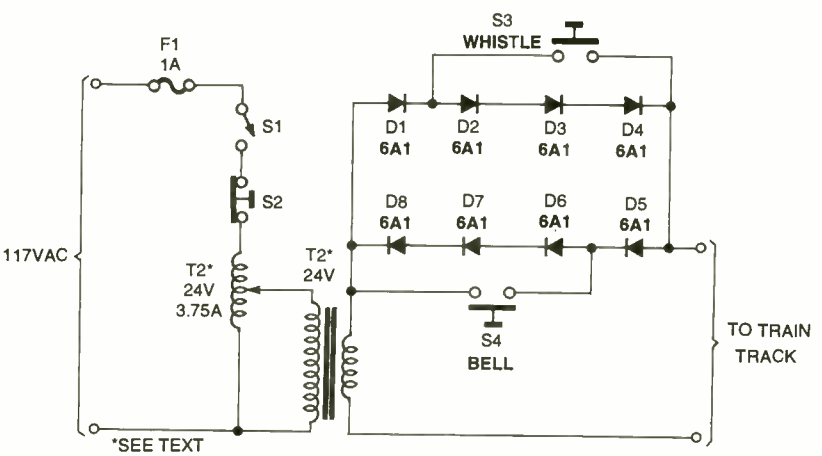

Fig. 1. The basic Electronic Train Controller circuit shown here is capable of operating most three-rail "O" gage engines and even sends out encoded signals that operate the unit's bell or whistle. Although power transformer T2 is a 24-volt 3.75-amp unit (which came with the train set) any 16-to-24-volt, 4-amp or more transformer can be used.

PARTS LIST FOR THE BASIC ELECTRONIC-TRAIN CONTROLLER (FIG. 1)

D1–D8—6A1 6-amp, 100-PIV silicon diode (Mouser 583-6A1 or similar)
T1—0–120/132-volt, 1.78-amp, variable transformer (Mouser 5874-171 or similar)
T2—24-volt, 3.75-amp transformer (see text)
S1—SPST toggle switch
S2—Normally closed pushbutton switch
S3, S4—Normally open, 5-amp contact, pushbutton switch
F1—1-amp fuse
Perfboard or printed-circuit materials, heatsink material, cabinet, wire, solder, hardware, *etc.*

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or reverse, is symmetrical in form . . . equal positive- and negative-going voltage excursions, as shown in Fig. 2A. The train's decoder circuitry is set up to look for an imbalance in the AC waveform. If the decoder detects an imbalance that is more positive than negative, the output will sound the train's whistle, and if the imbalance is more negative than positive the bell will chime. The waveform drawings in Figs. 2B and 2C show how the AC voltage feeding the track looks for each of the two encoded signals.

BASIC ELECTRONIC-TRAIN CONTROLLER

The circuit in Fig. 1 is an excellent working controller capable of operating most three-rail "O" gage engines and sending encoded signals to those engines equipped with a bell or whistle. The only drawback is the cost of the variable transformer, T1. If a brand-new, store-bought transformer is used, the cost could be as high as $60, but allowing ingenuity to enter into the mix, a suitable unit might be found at a local hamfest or ordered from a surplus-electronics, mail-order house for much less. I've seen them go for as little as $15 or so at hamfests.

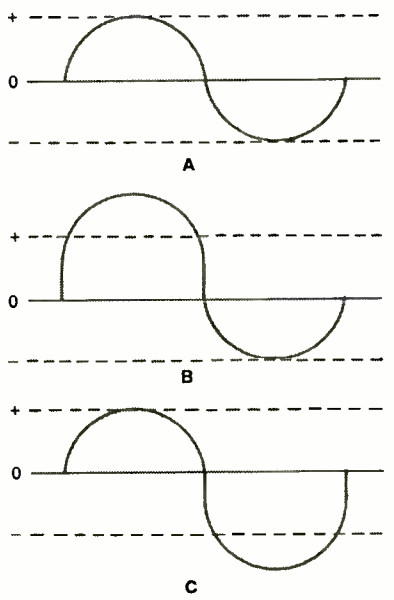

Fig. 2. Shown here are the waveforms produced by the control circuit under various switch settings. The circuit's output waveform with neither S3 or S4 activated is shown in A. Pressing S3 while the train is in motion causes the AC waveform to be offset in the positive direction, as shown in B, which caused the whistle to sound, while pressing S4 does the same with a negative offset (as shown in C) for the bell.

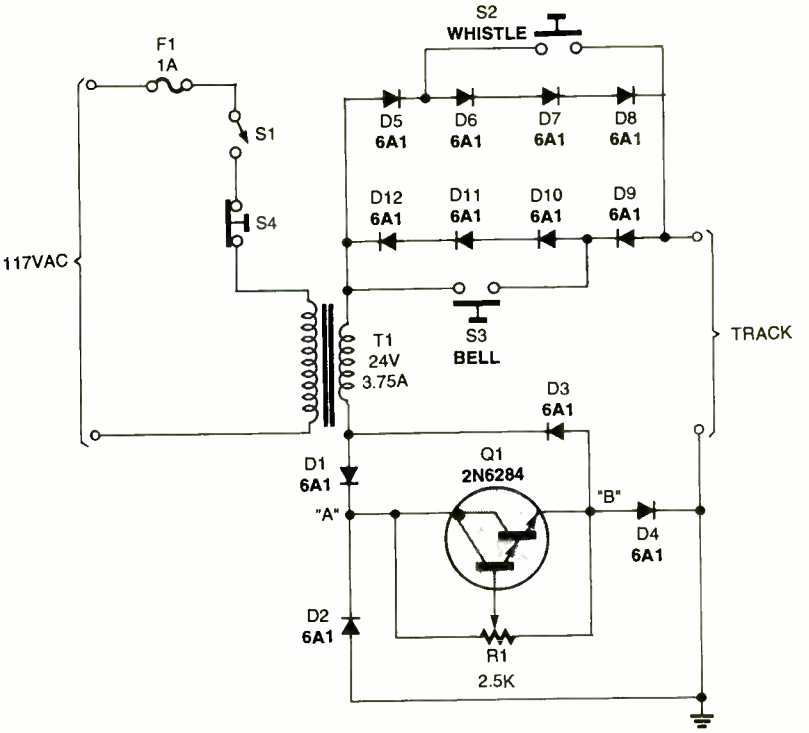

Fig. 3. This Modified Electronic Train Controller, while not offering the efficiency or smoothness of the previous circuit, is included in our discussion to illustrate an alternate method of controlling the train's speed.

PARTS LIST FOR THE MODIFIED ELECTRONIC-TRAIN CONTROLLER (FIG. 3)

Q1—2N6284 or similar NPN Darlington power transistor
D1–D12—6A1 6-amp, 100-PIV silicondiode (Mouser 583-6A1)
R1—2500-ohm linear potentiometer
T1—24-volt, 3.75-amp transformer (see text)
S1—SPST toggle switch
S2, S3—Normally open, 5-amp contact, pushbutton switch
S4—Normally closed pushbutton switch
F1—1-amp fuse
Perfboard or printed-circuit materials, heatsink material, cabinet, wire, solder, hardware, *etc.*

The power transformer (T2) illustrated in Fig. 1 is a 24-volt, 3.75-amp unit that came with the train set, but any 16- to 24-volt, 4-amp or more transformer can be used. The eight 6-amp diodes give the circuit the selective offset needed to activate the whistle or bell functions. The AC-output waveform with neither S3 nor S4 activated looks similar to the drawing in Fig. 2A. With the train in motion, pressing S3 causes the AC to be offset in the positive direction, sending out a whistle demand signal, while pressing S4 does the same with a negative offset for the bell. If, for some reason, both switches are closed at the same time, the train will speed up slightly and neither the bell nor whistle will sound because the two offset outputs cancel, resulting in a slightly increased AC-output voltage.

If the whistle and bell functions do not operate, or only operate in an intermittent fashion, it could be due to insufficient offset voltage for a particular make of engine that needs to be increased. That's easily accomplished by adding another diode in series with each diode string. Place a diode in series with D2 and D3, and a diode in series with D6 and D7. The offset will now be about 0.7-volt greater, which should be sufficient for most engines. Keeping the offset voltage as low as possible helps to keep the engine from picking up speed when the whistle or bell is activated.

Switch S2 serves as the train's directional control; it can also be used as an emergency stop switch. You'd

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be amazed at how smoothly this simple control circuit operates in comparison with the standard electronic controller that comes with many of the train sets sold today.

MODIFIED ELECTRONIC-TRAIN CONTROLLER

Our next controller circuit, see Fig. 3, is a workable design that will allow you to operate your train with the same functions as in our first circuit but not with the same smoothness or efficiency. This circuit is only included to illustrate an alternate method of controlling the train's speed. Diodes D1–D4 are 6-amp, 100-PIV units connected in a full-wave, bridge-rectifier circuit with a Darlington power transistor connected across its positive and negative outputs. The power transistor operates somewhat like a large variable power resistor. The whistle and horn circuits operate exactly like the ones in the previous circuit. Switch S4 serves as a direction-reversing control or can function as an emergency stop switch. With the speed control, R1, set to the emitter end of rotation, the output voltage is near zero and the transistor is cut off; little current flows between points "A" and "B." As R1 is rotated in the opposite direction (turned toward the collector end of Q1), current through the transistor increases, causing more AC voltage to be fed to the train's track.

The Darlington transistor must be mounted on a large heatsink, at least 12-inches square, to dissipate the heat generated while the train is running. If the temperature runs too hot, a small fan should be added. Since this circuit doesn't supply a constant voltage at any setting of R1, the train's speed will be more difficult to maintain. This is one excellent reason to look at our next controller circuit.

ENHANCED ELECTRONIC-TRAIN CONTROLLER

Our final controller, see Fig. 4, is the electronic equivalent of the controller circuit in Fig. 1. Note that the efficient but expensive variable transformer has been replaced by a pair of power diodes and a couple of complementary Darlington power transistors. The two Darlington transistors are connected in emitter follower circuits with their emitters tied together to form the circuit's output. The whistle and bell

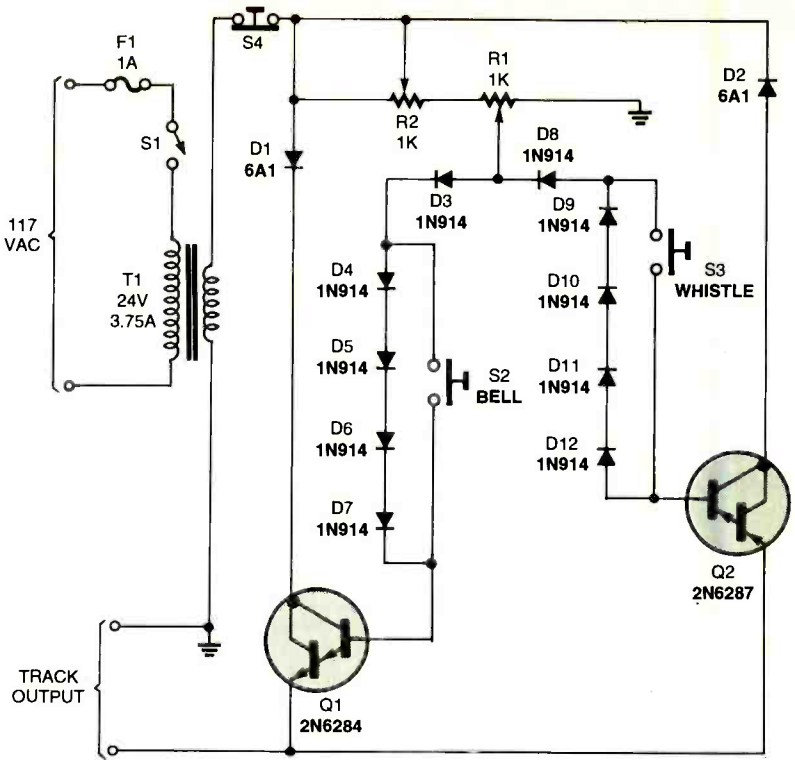

Fig. 4. This circuit, the electronic equivalent of our first controller circuit, replaces the expensive variable transformer with two power diodes and two power complementary Darlington transistors.

PARTS LIST FOR THE ENHANCED ELECTRONIC-TRAIN CONTROLLER (FIG. 4)

SEMICONDUCTORS
D1, D2—6A1 6-amp, 100-PIV silicon diode (Mouser 583-6A1)
D3–D12—1N914 silicon diode.
Q1—2N6284 NPN Darlington power transistor
Q2—2N6287 PNP Darlington power transistor

ADDITIONAL PARTS AND MATERIALS
R1, R2—1000-ohm linear potentiometer
T1—24-volt, 3.75-amp transformer (see text)
S1—SPST toggle switch
S2, S3—Normally open pushbutton switch
S4—Normally closed pushbutton switch with a current rating of 5-amps
F1—1-amp fuse
Perfboard or printed-circuit materials, heatsink material, cabinet, fan, wire, solder, hardware, *etc.*

encoding takes place in the base circuits of the two transistors. Potentiometer R1 serves as the throttle control, while R2 sets the maximum AC output voltage when R1 is set to full throttle.

The AC voltage at the wiper of R1, minus the accumulated voltage drop of the five series-connected diodes in the transistor's base circuit, appears at the track's output. During the positive half of the AC cycle, D1 directs the voltage to the collector of Q1. The voltage at R1's wiper, minus the accumulated diode voltage drop (D3–D7), appears at Q1's emitter, completing the positive half cycle of the AC output.

During the negative half cycle, D2 steers the negative voltage to the collector of Q2 and the negative voltage at R1's wiper, minus the accumulated diode voltage drop (D9–D12), appears at the emitter of Q2 to complete the negative half of the AC cycle. Operating S2 shorts out diodes D4–D7 increasing the positive voltage to the base of Q1, causing it to send out an encoded whistle signal. Closing S3 increases the negative half-cycle output to signal the bell to chime. On diesel engines, the whistle switch controls the engine's horn. Switch S4 serves as the reversal switch, which can also be used as an emergency

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SCANNER SCENE

Ship Ahoy!

MARC SAXON

As new technology becomes widely available, it gets incorporated into products that can be sold at popular prices. So it is with scanners. The RadioShack PRO-2048 is one such unit. Here's a desktop scanner that offers "smart search" and 200 memory channels (20 channels in 10 banks), plus ten additional temporary-storage monitor memory channels.

What's so smart about the PRO-2048? A feature we particularly like allows users to skip over any 20 frequencies they choose during a search, or they can also skip over data and open carriers. A push of a button turns on/off the key-press beep.

The PRO-2048 scans at 12 and 50 channels/second and can search from 50 to 300 frequencies/second. Users can select from three search or two scan speeds to suit their needs.

The frequency range is 29–54, 137–174, 406–512, and 806–956 MHz (minus the factory-blocked cellular bands, per FCC rules). It also covers the 108–137 MHz VHF aeronautical band. The weather band shows up with the press of a panel key. This is a triple-conversion scanner, thereby providing maximum protection from intermediate frequency (IF) image interference. The IF frequencies are 380.7 and 10.85 MHz, and 450 kHz.

The FM sensitivity at 20 dB S/N (±3 kHz) is 0.5 UV below 54 MHz, 0.6 UV from 137–512 MHz, and 0.8 UV above 806 MHz. In the VHF aeronautical band, it is 1.5 UV (20 dB S/N@60% modulation).

In all, quite a neat package, and it's listed in the $230 ballpark. That makes it the current mid-range unit in the line. For those who don't require the most advanced unit, but still need something far beyond basic, the PRO-2048 is definitely worth a look.

RIDING THE WAVES

With the sweltering weather upon us, now's the best time to own a boat. But even if you don't, you can still ride the waves using your scanner. Radio waves, that is. Though not often written about, the VHF maritime band will provide endless hours of monitoring fare for all who are within earshot of coastlines, harbors, inland waterways, navigable rivers, and larger lakes.

RadioShack's PRO-2048 is a triple-conversion desktop scanner that offers "smart search" and 200 memory channels.

The frequencies in the VHF marine band are designated for specific uses, and each is numbered. In our listing of available frequencies, we have included the channel number of each after the slash bar, as in 156.80/16, meaning frequency 156.80 MHz is Channel 16.

Distress/Calling: 156.80/16
Calling: 156.45/09
U.S. Coast Guard: 157.05/21, 157.075/81, 157.10/21, 157.15/23, 157.175/83
U.S. Coast Guard Auxiliary: 157.175/83
Intership safety: 156.03/06
Drawbridges & Navigational: 156.65/13
Commercial: 156.35/07, 156.45/09, 156.50/10, 156.55/11, 156.90/18, 156.95/19, 156.975/79, 157.025/80
Commercial Intership: 156.375/67, 156.40/08, 156.875/77
Yachts: 156.425/68, 156.475/69, 156.575/71, 156.925/78
Yachts Intership: 156.625/72
Major Ports (selected areas): 156.275/65, 156.325/66, 156.60/12, 156.675/73, 156.70/14, 156.725/74
State Control: 156.85/17

Some notes of interest about this information. The U.S. Coast Guard refers to many of the channels numbers as having the suffix letter "A" (as in Channel 21-Alpha). Technically, their designation is correct, but it's still the same frequency as without the suffix letter. In most areas, Channel 68 is the busiest yacht channel, the one used by many marinas, yacht clubs, and regatta and race committees.

Note that VHF marine operators may be assigned to use 161.80/24, 161.825/84, 161.85/25, 161.875/85, 161.90/26, 161.925/86, 161.95/27, 161.975/87, and/or 162.00/28 in various areas. These are coastal station semi-duplex output frequencies only. Such stations handle ship/shore phone calls, although many vessels now use cellulars instead. Some 161-MHz stations attempt to defeat eavesdropping by transmitting only one side of the conversation. In such instances, to hear both sides, it would also be necessary to monitor the vessels' frequency. The vessels' input frequencies are: 157.20/24, 157.225/84, 157.25/25, 157.275/85, 157.30/26, 157.325/86, 157.35/27, 157.375/87, and 157.40/28.

Since marine VHF handheld transceivers are inexpensive and easy to obtain, they have been in use for a wide variety of non-maritime purposes—with neither FCC license nor sanction. The FCC doesn't appear to monitor most of the channels, so pretty much anything gets by there. Given the limited range of handheld transceivers, you never know what you might hear, even 100 miles from the nearest waterway, One reader last year reported his local police department conducts surveillances on VHF Channels 67 and 72, where nobody would ever think to listen for them!

LONG LIVE CYCLE 23

Old-time scanner monitors have lived through one or more solar cycles. They last 8–12 years each and feature varying numbers of sunspots and high

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COMM LINKS

RF Shielding

JOSEPH J. CARR

It is almost an "article of religion" in electronics that shielding electronic circuits prevents EMI problems. A good shield can keep undesirable emissions of a transmitter or other forms of circuits inside in the case. All transmitters generate harmonics and other spurious signals. If they're radiated, then they'll interfere with other services. Signals that go out through the antenna terminal usually pass through either tuning or filtering networks that tend to clean up the emission. But if the circuits are not shielded, then direct radiation from the chassis can defeat the effects of the filtering.

The concept of shielding is good. Unfortunately, many shields are essentially useless. In some cases, they may even cause more problems than they cure. The problem is not isolated to transmitters or even just RF circuits in general, but is instead a dilemma confronted by *all* electronic circuits. I once worked with medical- and scientific-electronic instruments that rarely used frequencies above 1000 Hz; yet they were subject to severe EMI. Why? The 60-Hz powerline EMI!

SHIELDING MATERIALS AND METHODS

Figure 1 shows a "black box" circuit inside a metal enclosure. The term "black box" relates to any form of electronic circuit . . . and is used to universalize the discussion so that ideas are not associated with any specific class of circuit. What's inside the metal, shielded enclosure could be a transmitter, receiver, audio amplifier, or a medical electrocardiograph amplifier. It doesn't matter for our present purposes.

There are two basic approaches to shielding: *absorption* and *reflection*. Those mechanisms often operate together. Suppose a large external field is present. In the case of absorption, the field could penetrate the shield, but be greatly attenuated. In the case of reflection, the field is turned back by the metal shield. The absorptive method is mostly used at frequencies below 1 MHz for magnetic

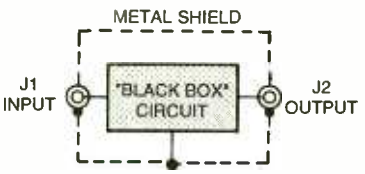

Fig. 1. Shown here is a "black box" circuit mounted inside a shielded metal enclosure, with the common line of the single-ended, internal circuit connected directly to the shield.

fields and is based on ferromagnetic materials such as steel and a special material used particularly for magnetic shields called "*mu-metal*" or μ-*metal*. At higher frequencies, especially where the electric field is of more importance than the magnetic field, better shielding materials—such as copper, brass, and aluminum—are required.

SKIN EFFECT AND SKIN DEPTH

Alternating current (AC) does not flow uniformly throughout the cross section of a conductor as is the case with direct current (DC). Due to the *skin effect*, AC currents flow only near the surface of the conductor. That creates a situation where the AC resistance of a conductor is higher than the DC resistance. If the current density from the surface to the center of a cylindrical conductor is graphed, it will show that the curve is a section of a parabola. The critical depth for a cylindrical conductor is the depth at which current density falls to 0.368 times surface current density. That's the current that is used to determine AC resistance.

TABLE 1—WIRE SIZE/K-FACTOR

WIRESIZE (AWG)	K-FACTOR
8	35
10	28
14	18
18	11
22	7

Sheets or plates of metal used for shielding also show a skin effect when currents flow in them. The *skin depth* (see Fig. 2) is analogous to the critical depth in cylindrical conductors. In both cases, 63.2% of the current flows in the area between the surface and the skin depth (δ). Skin depth is calculated from:

$$\delta = 2.602k/\sqrt{f_{HZ}}$$

where δ is the skin depth in inches; f_{Hz} is the frequency in hertz (Hz); and k is 1.00 for copper, 1.234 for aluminum, and 0.100 for steel.

Why is that important? In the case of absorptive loss, the attenuation is 8.7 dB/δ. For example, at 60 Hz, a steel shield has a skin depth of 0.034 inches. If $^1/_{16}$-inch stock is used, the total depth is equivalent to 1.84δ, so the attenuation for magnetic fields would be 8.7 dB $\times$ 1.84 = 16 dB.

To obtain maximum reflective loss at RF frequencies, the thickness of the shielding material should be ten times the skin depth. For example, at 10 MHz, aluminum has a skin depth of 0.001 inches, and copper has a skin depth of 0.0008 inches, so the shield thickness' should be 0.010 inches for aluminum and 0.008 inches or more for copper. Given that $^1/_{16}$-inch thick stock is 0.0625-inches thick, aluminum will be a bit marginal while copper would be more than sufficient. It's only fair to note, however, that some textbooks say a shield should be at least three times the skin depth . . . but that's for *minimal* shielding.

GENERAL RULE FOR SHIELDING

Shielding can be rendered ineffective if it is connected to the wrong spot in a circuit. The number one general rule for shielding is "The shield should be connected to the zero-signal reference point in a circuit (*e.g.*, 0 volts)."

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In the case of Fig. 1, the "black box" circuit is single-ended, so the common line of the internal circuit is connected directly to the shield. Figure 3 shows a slightly more complex situation. In that scenario, a "black box" circuit placed inside a shielded enclosure is used to supply an output signal that is fed to some sort of resistive load. A shielded signal source, V_{IN}, is connected to the

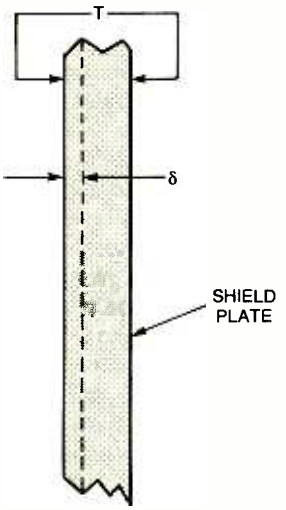

Fig. 2. Skin depth (δ) is analogous to the critical depth in cylindrical conductors, and is calculated from: $\delta = 2.602k/\sqrt{f_{HZ}}$; where δ is the skin depth in inches; f_{Hz} is the frequency in hertz (Hz); and k is 1.00 for copper, 1.234 for aluminum, and 0.100 for steel.

input of the "black box" through a length of shielded cable.

In that situation, there could be too many grounds. Suppose that the common signal point inside the main shielded compartment is connected to the shield and the shield is, in turn, grounded at "A." The signal source is also grounded, but to a different point, *i.e.*, "B." If a current (I) flows in the ground plane, then a voltage drop V_G will be developed across the resistance of the ground path. The current might be due to external circuits or it may be a result of the potential difference that exists between two points in the circuitry inside the shielding. Whatever the source, however, a potential difference between points "A" and "B" gives rise to a spurious signal voltage (V_G) that is effectively in series with the actual signal voltage (V_{IN}), producing a *ground loop* problem.

The key to solving the ground loop problem is to connect the shield to the ground plane at the signal end ("B"), and not at any other point(s). An application of Rule No. 1 might say: "The shield and common of the internal circuitry should be connected together at the point where the signal source is grounded." In other words, break the connection at point "A" and rely instead on the grounding established at point "B."

This sort of problem is representative of a class of problems in which a common impedance (in this case a resistance) couples two segments of a circuit. If a voltage drop appears across the common impedance, then a problem is sure to surface.

GROUND PLANES

The ground plane might be an actual earth ground, but in most electronics circuits it will be either a printed-circuit board or a chassis. In the case of printed-circuit boards, it's usually recommended in RF circuits to use a double-sided board with the top-side copper used as a ground plane and possibly to carry DC power-supply lines.

In RF circuits, it is not advisable to use small wires or printed-circuit tracks as ground lines. The AC resistance of cylindrical wire conductors is a function of both the wire diameter and the frequency. For any given wire size, the AC resistance = DC resistance × the square root of the frequency (MHz) × a constant (K). The value of the K factor, as shown by Table 1, depends on the wire size.

Thus, when #22 AWG solid hookup wire is used to carry a 1-MHz RF current, the AC resistance is seven times the DC resistance. If that wire is a ground and carries a current, the AC resistance of the wire might be considerable, creating a nasty ground-loop-voltage drop.

Even if the wire is large enough to reduce the effects of AC resistance at RF frequencies, the inductance might be a problem. The inductance of a straight length of #22 AWG wire is about 600 μH/1000 ft. A 1-ft run of wire will, therefore, have an inductance of about 0.6 μH. That inductance won't be noticed in an audio circuit or even many low-frequency RF circuits, but as the frequency climbs it becomes significant. In the upper HF and lower VHF regions, it is a significant portion of lumped inductances intentionally placed in the circuit.

If the wire is in a ground path, then it's a common impedance. Any RF voltage developed across its inductive reactance forms a valid signal, which can cause problems. The key to the problem is star grounding, *i.e.*, grounding all circuit elements to the same point. If the signal source is grounded, then its ground connection ought to be used as the overall grounding point.

HOLES IN SHIELDS

Ideally, a shield should contain no holes, but in practice that's impossible. There are always some connections (input, output, DC power) that must go in or out of a shielded enclosure. In other cases, the circuitry may generate considerable heat so some holes are provided to ventilate the interior. The holes must be very small compared to the wavelength of the highest-frequency signal being protected against.

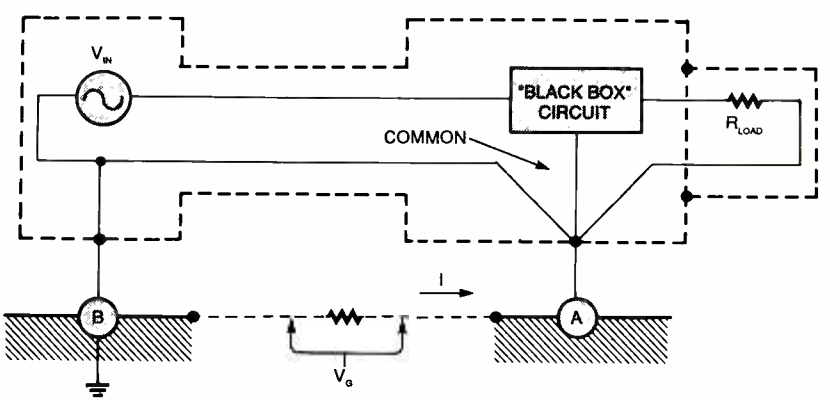

Fig. 3. Show here is a slightly more complex situation than is illustrated in Fig. 1. In this scenario, the "black box" circuit mounted inside the shielded enclosure is grounded at one point, while its shielded signal source, V_{IN}, is grounded to another, setting up a ground-current loop which gives rise to a spurious signal voltage.

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The general rule is that screw or mounting holes should be spaced *not more than* 1/20 wavelength (*i.e.,* 0.05λ) apart at the highest frequency of operation. At 1 MHz, this is not hard to meet, because 0.05λ > 49-feet. But at VHF and up, it might be a bit tricky because the wavelengths are much shorter. For example, spacing the screws that keep a shield firmly in place three inches apart may be sufficient for mechanical strength and will shield at lower frequencies. But 3 inches is 0.05λ at 197 MHz. Above 197 MHz, the shielding effect is therefore reduced.

The effects of wide mounting-screw spacing can be dramatic. I once saw a case where a mechanical engineer had "redesigned" the specification for an RF enclosure because she didn't understand the RF effects. But the electrical engineer designing the box showed her by taking a well shielded pulsed RF transmitter and connecting it to a dummy load. He then used a spectrum analyzer with a whip antenna on it to monitor the energy emitted from the RF box. He started by removing every other screw. As soon as the first screw was loosened, the harmonics and spurs showing on the spectrum analyzer display began to rise. He eventually reached the screw spacing recommended by the mechanical engineer . . . and at high frequencies the shielding was almost ineffective.

Be really wary of slots in shielding enclosures. They are relatively efficient radiators . . . so much so that some microwave antennas are little more than arrays of slot apertures. When the slot approaches 1/8 wavelength or longer, then it may radiate rather effectively. This could occur when connectors such as the "DB-x" type used for digital interfaces (*e.g.,* RS-232C) are mounted to the shielded enclosure.

Connectors are not the only form of "slot" found in some equipment. If covers or shell halves in aluminum project boxes are just butted together, then the lack of a tight fit might form a radiating slot. The best solution is to use boxes with an overlapping "lip" to join the halves together. Other accidental slots are created when internal-shielding panels are put in place to create multiple shielded compartments, and the mechanical fit is not good. One reason to use copper or brass to make enclosures is that a bead of solder can be used to ensure these panels are firmly anchored to ground with no "slotting" effects.

DOUBLE SHIELDING

If you delve into very sensitive equipment, such as receivers and scientific instruments, you will find certain critical circuits double-shielded. The reason is that each shield will produce a reduction of signal by 60 to 100 dB (although the latter requires very good shielding). Let's assume that the run-of-the-mill shield will provide 60 dB of attenuation. If two such shields are provided, one inside the other, then the total attenuation will be on the order of 120 dB. This is the reason why very sensitive or very high-gain instruments use double shielding, especially in their front-end circuitry.

SPRAY-ON SHIELDING

A lot of equipment today is built in plastic or other synthetic non-conducting forms of cabinet. Unfortunately, these cabinets are an EMI nightmare. In some cases, the manufacturer may apply a conductive coating to the inside of the plastic case to provide shielding. Copper, aluminum, and silver conductive sprays and paints are available for that purpose. However, they don't always provide a very good shield, so care must be taken. First, of course, make sure that the material selected is intended for making shielding. Not all silver, copper, or aluminum paints are truly conductive. And many such paints are not intended for shielding, so may produce a metal density and thickness that is insufficient. The best one can say about some products is that they are "better than nothing" ... but not by much.

I can be reached at PO Box 1099, Falls Church, VA, 22041, or by e-mail at *carrjj@aol.com.* ■

CIRCUIT CIRCUS

(continued from page 80)

stop switch.

This is the circuit to build if you want to electronically control your "O" gage trains without spending a bunch of money on a factory unit. The two power transistors should each be mounted on a heatsink at least 8-inches square; if the circuit is to be heavily used, adding a small fan wouldn't hurt.

Here's hoping that you'll have as much fun working with these train circuits as I have . . . please let me know how yours turns out.

Looks like our allotted time is about all used up for this round of circuitry, so until next month may all of your trains stay on track! ■

SCANNER SCENE

(continued from page 81)

er MUFs (maximum usable frequencies). This one is Cycle 23.

Cycle 23 began in May of 1997, and VHF low-band (30–50 MHz) fans started noticing the skip rolling in by late August of that year. The good news is that conditions will continue to improve and then peak about a year from now before slowly tapering off. But for now, it's going to get better and better, with outstanding DX to the world's most exotic places predicted.

Optimum results will (of course) be obtained if you use an antenna cut for these frequencies. I have excellent results with a MAX-46 Super Snooper mounted at a 45-degree angle. Others have done well with non-directional 6-meter ham band verticals and CB antennas.

Here are reliable "MUF marker" frequencies I always scan to learn DX conditions and the extent the MUF has reached. The 10-meter ham FM frequency of 29.60 MHz is my low end, next 30.16 MHz (a Spanish language station), and 30.45 MHz at the Ft. Hood Army Range, TX. Then midband 40.53 and 41.53 MHz, used in the Pacific Northwest for meteor scatter telemetry. At the top, I monitor 52.525 MHz, the 6-meter ham FM frequency. These show when/where to search for DX.

Let's hear from you! The direct e-mail address here is: *sigintt@aol.com.* Our postal address is: *Scanner Scene,* ***Popular Electronics***, 500 Bi-County Blvd., Farmingdale, NY 11735. ■

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NEW PRODUCTS

MINI-AIR IONIZER

A small, versatile air ionizer that can be used in confined or small spaces, the *Model 960 Mini Air Ionizer* is ideal for pinpoint coverage at the typical ESD workstation, inside or on top of production equipment, inside OEM equipment, and for pick-and-place and tape-and-reel equipment. It generates a well-balanced flow of ionized air particles, which neutralize any stray electrostatic buildup on a surface. Charges are dissipated in seconds, and the possibility of electrostatic discharge is minimized.

Features of the compact (3 by 4 by 2 inches) ionizer include steady-state DC ion emission and balanced shielded emitter points that need no adjustment. The unit includes the fan assembly, L-shaped mounting bracket/stand, and power cable. The 24V power needed can be supplied by 3M's 960X Wall Transformer.

The Model 960 Mini Air Ionizer costs $350 and the 960X Wall Transformer costs $40. For more information, contact 3M Electronic Handling & Protection Division, St. Paul, MN 55144-1000; Tel. 800-814-8709; Web: *www.3M.com*.

CIRCLE 110 ON FREE INFORMATION CARD

SOUND LEVEL METER

Designed to perform noise measurement, to identify noise-ordinance violations, and for use in such areas as theater acoustic studies and stereo balancing, the *Sound Level Meter*, analog Model 407706, measures from 54 to 126 dB in seven ranges with +3-dB accuracy. Readings are shown on a two-color analog display, which also provides a battery check. Users can lock in the highest reading on the display with the convenient front-panel MAX HOLD switch.

Ideal for field use, the meter, which measures only 2.7 × 7.1 × 1.4 inches and weighs just 5.1 ounces, is powered by a 9-volt battery and can be tripod mounted. It features selectable weighting (A or C) and response time (Fast or Slow). An analog output is available for connection to chart recorders and data loggers.

The Sound Level Meter, Model 407706, costs $59. For more information, contact Extech Instruments Corp., 335 Bear Hill Road, Waltham, MA 02451; Tel. 781-890-7440; Fax: 781-890-7864; Web: *www.extech.com*.

CIRCLE 111 ON FREE INFORMATION CARD

INFRARED THERMOMETER

The *Fluke 65 Infrared Thermometer*, a non-contact, laser-sighted, stand-alone thermometer, features a laser beam for easy aiming and is designed for measuring rotating, electrically live, dangerously hot, or hard-to-reach, objects. Created to meet the needs of electrical, process, plant maintenance, facility maintenance, HVAC/R, and automotive professionals, the thermometer effectively decreases troubleshooting time, with a temperature response time of less than one second.

The Fluke 65 provides highly repeatable temperature readings from 40ºC to 500ºC on an easy-to-read backlit display. The thermometer has a dual-display screen allowing for easy scrolling through the MIN/MAX variation measurements. Other features include temperature memory, any key wake-up, 0.1º resolution up to 200º, and 8:1 optical resolution. The small, light, rugged, and ergonomically designed instrument comes with a compact case that is surrounded by a protective holster.

The Fluke 65 Infrared Thermometer has a list price of $269. For more information, contact Fluke Corp., P.O. Box 9090, Everett, WA 98206; Tel. 888-492-7538; Fax: 425-356-5116; Web: *www.fluke.com*.

CIRCLE 112 ON FREE INFORMATION CARD

FIELD STRENGTH METER

This compact bipolar *Field Strength Meter* (*MFJ-802*), which measures 2⅝ × 4 × 1½, fits in the palm of your hand. Users can read relative field strength directly from their antennas, simply by holding the meter next to the antenna and adjusting the sensitivity.

The meter measures both antenna performance and the strength of the antenna field. Attach a receiving antenna—beam, duck, or dipole—to

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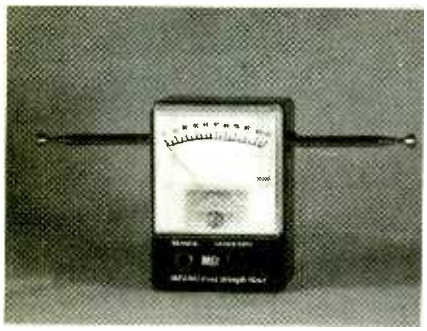


the Field Strength Meter or use the two telescoping whips or the included remote. Apply low power and transmitted RF will measure on the meter's scale. Moving the receiving antenna shows the radiation pattern of the antenna.

The Field Strength Meter (MFJ-802) costs $39.95. For more information, contact MFJ Enterprises, Inc., P.O. Box 494, Mississippi State, MS 39762; Tel. 800-647-1800 or 601-323-5869; Fax: 601-323-6551; Web: *www.mfjenterprises.com.*

CIRCLE 113 ON FREE INFORMATION CARD

LCR METER

Simplifying automated testing and sorting, the advanced design LCR meter, the Protek *Z9216*, measures resistors, inductors, and capacitors at a 20X-per-second rate, with .05% accuracy. Easy to use and calibrate, the unit (4.25 ×14.25 × 14.5 and weighing almost 13 pounds) stores and recalls nine instrument setups and has five test frequencies from 100 Hz

to 100 kHz. Measurement averaging is from 2 to 10.

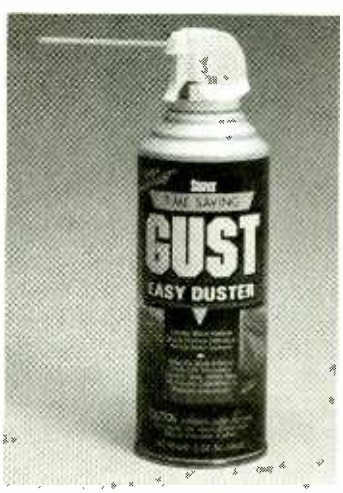
It displays component "Q" values and dissipation factors on the front-panel LCD readouts. Other important features include: open- and short-circuit compensation, accurate zeroing, built-in calibration procedures, and binding capabilities. The Z9216 operates on 120/220 AC Hz volts, 50/60 Hz frequency; consumes 20 watts power, and operates at 0 to 50ºC at <80% relative humidity. The unit accepts optional SMD tweezers, BNC fixture adapters, and Kelvin Clips. For remote operation, this instrument is equipped with RS-232, GBIB, and Handler Port Interfaces.

The Protek Z9216 LCR Meter costs $1750. For more information, contact HC Protek, 154 Veterans Drive, Northvale, NJ 07647; Tel. 201-767-7242; Fax: 201-767-7343; Web: *www.hcprotek.com.*

CIRCLE 114 ON FREE INFORMATION CARD

EQUIPMENT CLEANER

Using a clean, filtered, moisture-free, high-pressure propellant that is colorless, odorless, and non-ozone depleting, the *GUST-Air Duster* easily removes dust and dirt from glass, computers, tools, plastics, rubber, or appliances. The cleaner won't scratch or harm delicate surfaces.



GUST can help repair personal computers, stereos, TVs, and VCRs that break down due to dust build up. It can also be used to dust cameras, camcorders, computer keyboards, and other home or office equipment. Additional uses include removing sawdust and metal filings from saws, drills, and other tools. Each GUST Cleaning Kit includes three 15-ounce cans of GUST.

The GUST Cleaning Kit sells factory direct for $19.95 plus $4.50 S&H. For more information, contact Stoner, 1070 Robert Fulton Highway, P.O. Box 65, Quarryville, PA 17566; Tel. 888-STONERS;Web: *www.stonersolutions.com.*

CIRCLE 115 ON FREE INFORMATION CARD

SPEAKER PROBE AND TONE GENERATOR

Designed for moves, adds, and changes to telephones, LANs, security systems, and other audio/visual systems, the *542SP Inductive/Sensing Speaker Probe* and the *541TG Tone Generator/Sender* make it easy to perform cable identification and connector tracing. The devices are compatible with

each other, as well as with other similar devices sending or sensing tones.

The Model 542SP probe detects tones, providing both an audible signal and an LED lamp to indicate which wire carries the tone signal. A sensitivity-adjustment knob lowers or raises the tone level. The Model 541TG sends an alternating frequency "warble" signal for detection by the speaker probe. Its 3-position switch selects warble tone, off, or continuous output. An LED indicates continuity and warns of an active circuit. An RJ11 connector, datacom RJ45 jacks, and a pair of alligator clips are included with the tone generator.

The complete set is priced at $79.95, or $54.95 for the 542SP and $29.95 for the 541TG alone. For more information, contact Wavetek, Wandell & Goltermann, Inc., 9045 Balboa Avenue, San Diego, CA 92123; Tel. 619-279-2200; Fax: 619-565-9558; Web: *www.wavetek.com.*

CIRCLE 116 ON FREE INFORMATION CARD

SPECIALTY HAND TOOLS

Xuron *Ergonomic Specialty Hand Tools* are now available for use in a wide range of assembly, cable installation, and field service applications. The tools feature the patented Micro-Shear wire cutter, which produces a clean, square cut and comes with various

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head styles. Tools include Tweezer Nose pliers, which can hold wire under 1-ml thick; short- and long-nose pliers; a combination shear/plier; and several types of lead-forming tools.

Manufactured from alloyed steel, these tools are designed for comfort with broad, flat contact surfaces. The grip spread closed is under 2 inches, and the tools, which weigh only from 1.9 to 2.7 ounces, all incorporate return springs.

Xuron Ergonomic Specialty Hand Tools are priced from $13, depending on the model. For more information, contact Xuron Corp., 60 Industrial Park Road, Saco, ME 04072; Tel. 207-283-1401; Fax: 207-283-0594; Web: *www.xuron.com.*

CIRCLE 117 ON FREE INFORMATION CARD

ULTRASONIC INSPECTION SYSTEM

Designed for mechanical inspection, leak detection, steam traps & valves, and electrical inspection, the *Ultraprobe 9000 Digital Ultrasonic Inspection System* offers simplified airborne/structure borne ultrasound inspection and data logging. Its "Spin and Click" technology allows users to quickly

locate a desired inspection frequency, adjust headphone volume, store or download data, locate recorded data, and enter notes all with just two controls: a dial and a button. Heterodyned output enables users to record sound for analysis directly to tape recorders, vibration analyzers, and computers with sound cards.

Data is shown in two ways. The backlit panel displays numeric values of frequency and decibel. A 16-segment bar graph presents intensity swings and a peak-hold indication. Onboard memory enables frequency and decibel readings to be logged in as well as specialized notations in any of 400 memory locations.

The Ultraprobe 9000 Digital Ultrasonic Inspection System is priced from $46.95 to 59.95. For more information, contact UE Systems, Inc., 14 Hayes St., Elmsford, NY 10523; Tel. 914-592-1220; Fax: 914-347-2181.

CIRCLE 118 ON FREE INFORMATION CARD

DIGITAL WATTMETER

Ideal for industry, laboratories, electrical and electronic service shops, and schools and universities, the *Model 2000 Digital Wattmeter* is easy to use. Simply plug the unit under test into the

Model 2000 and read the consumption of wattage on the 3½-inch LCD display.

The meter evaluates the power consumption of power tools, computers, entertainment devices, and portable appliances. It reads true, not apparent, power, has a 200-watt range, an accuracy of ±1°+1D, and a resolution of 1 watt.

The Model 2000 Digital Wattmeter costs $189. For more information, contact Brunelle Instruments, P.O. Box 1223, Newport, VT 05855; Tel. 800-567-3506; Fax: 819-569-1408; Web: *brunelle.interlinx.qc.ca.*

CIRCLE 119 ON FREE INFORMATION CARD

DUCK ANTENNA

The *MFJ-1817 High-Gain HT Duck Antenna* is a dual-band antenna that combines telescopic and flexible features into a single antenna. This antenna extends to improve range, plus its flexibility allows it to bounce back after being bent or twisted. It is precisely tuned for a low SWR of less than 1.5 on

all bands and receives clear signals on 144/440 and 900 MHz.

The nine-inch antenna, which extends to 14½-inches, performs like a rubber duck antenna. On 2 meters, users have an efficient full-size antenna for full-size performance. On 440 MHz, it's a half-wave antenna that provides a 2.15-dBi gain.

The MFJ-817 antenna costs $24.95. For more information, contact MFJ Enterprises, Inc., P.O. Box 494, Mississippi State, MS 39762; Tel. 601-323-5869; Fax: 601-323-5869.

CIRCLE 120 ON FREE INFORMATION CARD ■

ELECTRONICS LIBRARY

(continued from page 18)

ing audio amplifiers of very high quality, the book goes on to tour the tubes offered by Philips and other manufacturers of the day. It culminates with a description of eight amplifier circuits, ranging from a single-ended 3-watt to a 100-watt Class B.

Valves for Audio Frequency Amplifiers costs $16.95 and is published by Audio Amateur Corp., P.O. Box 876, Peterborough, NH 03458-0876; Tel. 888-924-9465 or 603-924-9464. ■

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☐ **PCP119–Electronic Music and Midi Projects $12.95.** Save cash by building the MIDI gadgets you need. Want a MIDI THRU box, program change pedal. Metronome, analog echo unit, MIDI patchbay or switcher? Over 16 practical and very useful music and MIDI projects—all in this book! The projects are explained in detail with full instructions on assembly.

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☐ **BP411—A Practical Introduction to Surface Mount Devices $6.99.** This book takes you from the simplest possible starting point to a high level of competence in working with Surface Mount Devices (SMD's). Surface mount hobby-type construction is ideal for constructing small projects. Subjects such as PCB design, chip control, soldering techniques and specialist tools for SMD are fully explained. Some useful constructional projects are included.

☐ **BP136—25 Simple Indoor and Window Aerials $2.99.** Many people live in flats and apartments where outdoor antennas are prohibited. This does not mean you have to forgo shortwave listening, for even a 20-foot length of wire stretched out under a rug in a room can produce acceptable results. However, with experimentation and some tips, you may well be able to improve further your radio's reception. Included are 25 indoor and window antennas that are proven performers. Much information is also given on shortwave bands, antenna directivity, time zones, dimensions, etc. A must book for all amateur radio enthusiasts.

☐ **BP379—30 Simple IC Terminal Block Projects $6.99.** Here are 30 easy-to-build IC projects almost anyone can build. Requiring an IC and a few additional components, the book's 'black-box' building technique enables and encourages the constructor to progress to more advanced projects. Some of which are: timer projects, op-amp projects, counter projects, NAND-gate projects, and more.

☐ **BP401—Transistor Data Tables $7.99.** The tables in this book contain information about the package shape, pin connections and basic electrical data for each of the many thousands of transistors listed. The data includes maximum reverse voltage, forward current and power dissipation, current gain and forward transadmittance and resistance, cut-off frequency and details of applications.

☐ **ETT1—Wireless & Electrical Cyclopedia $4.99.** Step back to the 1920's with this reprinted catalog from the Electro Importing Company. Antiquity displayed on every page with items priced as low as 3 cents. Product descriptions include: Radio components, kits, motors and dynamos, Leyden jars, hot-wire meters, carbon mikes and more. The perfect gift for a radio antique collector.

☐ **BP93–Electronic Timer Projects $2.99.** This book covers many of the possible applications of timer circuits. These circuits may turn on or off at either some preset time or after an elapsed time. Some of the more complicated timer and clock circuits are made up from a number of simpler circuits that the author deals with individually. Also included are several special interest circuits such as cars windshield wiper delay unit, a darkroom timer, metronome, etc.

☐ **BP88–How To Use Op-Amps $5.99.** Written as a designer's guide covering many operational amplifiers, serving both as a source book of circuits and a reference book for design calculations. There are chapters on Meet the Operational Amplifier, Basic Circuits, Oscillators, Audio Circuits, Filters, Miscellaneous Circuits, Common Op Amps, Power Supplies and Construction Notes and Fault Finding.

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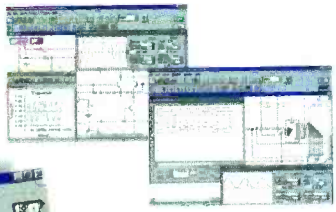

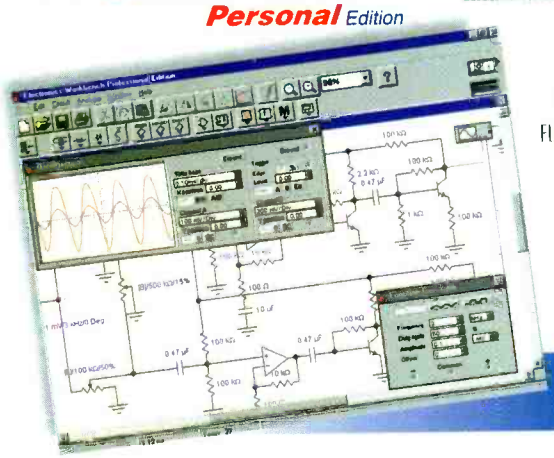

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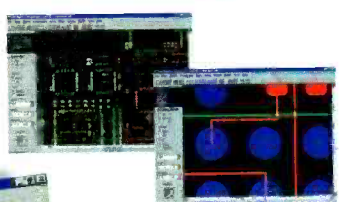

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