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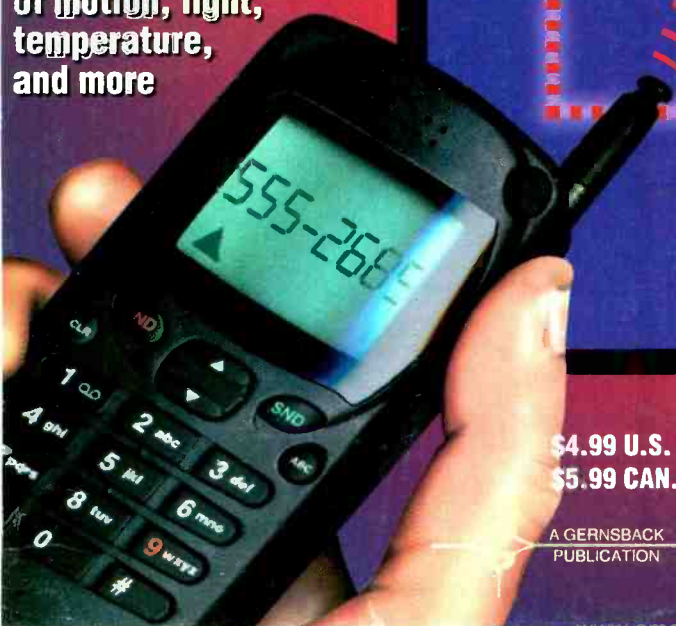
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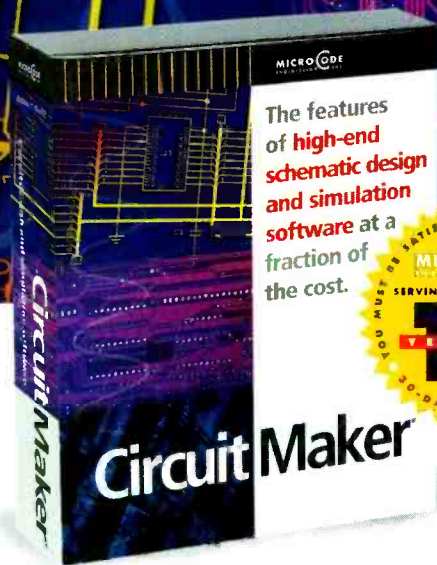
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EDITORIAL

The Home of the Future

It's been the setting for countless sci-fi tales, both in print and on film. The home of the future—an automated wonderland where you can control lighting, temperature, music, and any number of appliances. In various fictions or fleshed out on an engineer's drafting table, the concept of a home that runs itself is an enduring one.

No, we still haven't reached a point where we can walk around barking commands and having various artificially intelligent appliances do our bidding, but it's not all that far off. Voice recognition in computers is getting better every month it seems, and you often hear the big names in technology talking about how devices of all types will eventually have computer-like interfaces. The home of the future is not that far away.

For now, though, we'd like to evoke some of your dreams of a house you can control electronically and allow you to exercise your need to build gadgetry at the same time. In this home-automation special issue, you'll learn how to build innovative projects that let you take control of your house and give it some appearance of artificial life. Sure there are store-bought solutions for simple automation, but in keeping with the spirit of our do-it-yourself readers, we'd rather focus on how you can make such devices (thereby saving some money, too).

We start with the Tele-Computer Controller, a project that takes automation to a whole new level. Why only control appliances when you're home? Wherever you are you can use a touch-tone phone to call up the PC-interfacing device and enter in a command; then, hang up and know that whatever event you had set up occurred. Turn on the air conditioner in summer, reset a security system, even activate an electronic pet feeder—you choose the application. The story starts on page 29.

The projects continue with our Courtesy-Lamp Timer. Using a remote control, the easy-to-build gadget lets you light up your dark home as you approach it. Find out more on page 35.

Then turn to our Universal Sensor Interface, which makes it possible to monitor just about anything going on in your house. You choose the sensors; the advanced device does the rest. See page 39.

Also, on a do-it-yourself note, this month marks the return of *Computer Bits*, with new columnist Ted Needleman. Each month you can take a look over Ted's shoulder as he demonstrates, step by step, what you can accomplish with new computer-related products.



Konstantinos Karagiannis
Editor

A Stamp of Approval

With long-time *Computer Bits* columnist Jeff Holtzman off doing other things, we've taken the opportunity to take a more hands-on approach with the column. While **Popular Electronics** readers are among the most technically savvy around, the standard computer-product review fare doesn't always give a reader a good feel for what is actually involved in getting a specific task done. Detailing a list of features tells you what you can do, but not how to go about doing it.

Sure, you could figure it out on your own, but seeing exactly how to accomplish something in a step-by-step format is a good way to both familiarize yourself with a product and get a more precise idea of how to apply the product's capabilities. Let us hear from you how this new format works (or doesn't) for you, as well as any projects you'd like us to show in future columns.

FOILING PROJECTS

That out of the way, let's turn our attention to this month's project—"gold stamping." True gold stamping is an offshoot of engraving and uses a metal die to press gold leaf against a surface, resulting in the effect of printing with gold. Gold stamping is a popular effect on business cards and stationery where you want the appearance of lushness and formality. But it's not as common these days, simply because it's both expensive to do and

time consuming. In the fast-paced world of instant printing, gold stamping



Our foil stamping was done on an Alps MD-5000 printer. Note the cartridges inside—the print head picks up one of these at a time to lay down the individual colors or metallic foils that make up an image.

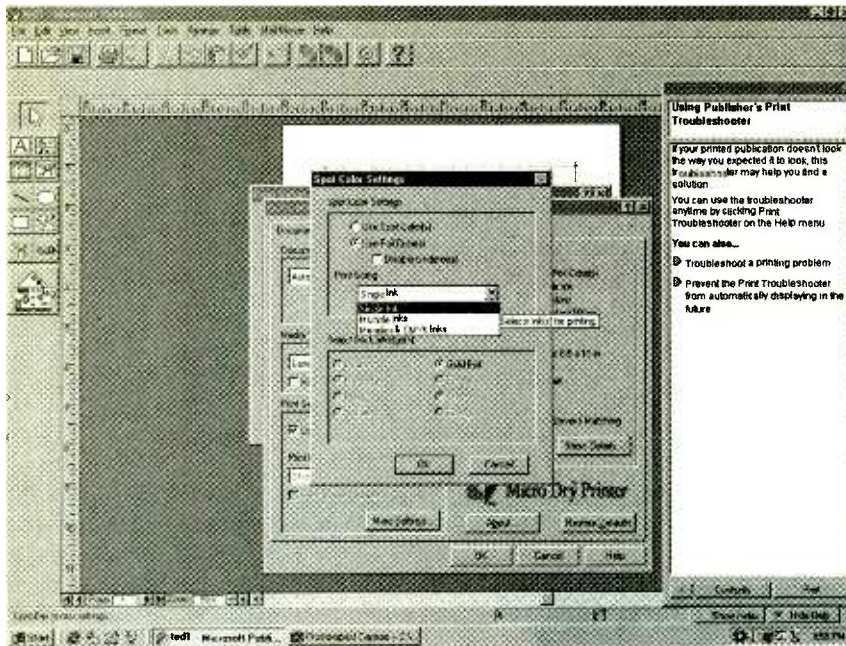
is a bit of an anachronism.

But it's not hard to do your own foil stamping. Imagine the impact a report will carry when it's presented with the recipient's name gold stamped on the cover or your company's name gold stamped in the corner. There are several ways to accomplish this.

The simplest and least expensive is with *LaserColor* foil (marketed by PaperDirect) or a similar product. Originally marketed in this country by Kroy as *KroyColor*, this type of product contains a color dye held on a plastic substrate. To use it, you first print a page or document with a laser printer, cut out a piece of the *LaserColor* foil to completely cover the area that you want

to color, fasten the foil down with the small adhesive dots included, and put it through your laser printer again, printing a blank page using your word processor. This causes the page to pass over the fuser assembly in the printer, and the heat partially melts the plastic laser toner already on the page. The melted toner then bonds to the color resin on the *LaserColor* foil, and when the page comes out of the printer and you peel back the foil, the toner that was covered by the foil has now picked up the color of the foil.

At least that's the way it was supposed to work. The original *KroyColor* system included a machine that applied both heat and pressure and had a temperature control that could be adjusted to supply more or less heat. And some users have had decent success using office laminators, some of which also let you adjust the heat. But the laser printer technique does not always result in good transfer of the colored material to the laser toner, especially if there's fine detail in what you've printed. Frequently, enough of the color does not transfer, producing highly visible and annoying black specs where the original laser toner is not covered. And precise application of color is not always possible when there's a lot of printing on the page. Finally, most laser printers don't handle heavy card stock or binder report covers well, which limits the use of the technique



The Alps printer driver has a pop-up box for Spot Color Settings. Check the Use Foil setting, and then Single Ink to print a simple foil project like a report cover (see text).

for these documents. On the plus side, this approach is very inexpensive, with foils available in some office supply stores for as little as \$10.

A much better approach to foil stamping is with a somewhat unique printer from Alps Electric. Alps makes a number of MD series models ranging from the \$299 MD-1000 to the \$599 MD-5000 we used for this column. The difference between the models is in features and capabilities, not the way in which each printer forms an image on the page. The MD or "Micro Dry" printer technology is a refinement of the thermal wax-transfer printers of the 80s and early 90s. Both use a thermal printhead to melt a dye from the ribbon onto the paper, but the MD printers have greatly refined the process. Older wax-transfer printers used a single ribbon that contained letter-sized panels of wax-based dye in each of the four process colors (cyan, yellow, magenta, and black, frequently called CMYK). To print a color page, the paper would be positioned, then the printer would move the ribbon so that the cyan panel was in place, and print the areas of the page that required cyan ink. The ribbon was then advanced to the next color panel, and the magenta colors were deposited on the page, then yellow, then black. This is exactly the way that color laser printers operate today, printing each page four times, once for each color.

The problem with this approach is that with a wax-transfer printer, even if no yellow is printed, the yellow panel is moved onto the discard roller. So it's not a very efficient way to print things with partial color. Alps' MD process replaces the wax-based dye with a resin-based one and puts each color into its own small cassette. As each color is needed, the cassette is picked up off of an internal rack by the print head, the areas of the page that need to be printed in that color are imaged on the paper, and the cassette is replaced. The process is repeated, with the paper repositioned to the top of the page each time, as many times as is necessary to get all of the pages printed.

What makes the Alps MD-5000, and its less expensive models, attractive to us are the optional ribbons that Alps makes available. For most normal printing tasks, you'll mount the CMYK ribbons. The MD-5000 lets you mount

up to seven ribbons, so you can have CMYK and metallics or foils. The lower-cost models of the MD series contain only four ribbon holders, though the cassettes themselves are bar-coded, and it doesn't matter in which order you mount them—the printer will always pick the one it needs. Alps also makes a variety of photo-oriented ribbons, as well as dye-sublimation ribbons and media. There's even a white ribbon, so you can create T-shirt transfers for dark-colored material or print on dark paper.

But the ribbons that we'll use to do our foil stamping are the metallic ribbons Alps offers. These come in metallic cyan, metallic magenta, metallic silver, and metallic gold, which can be used to add a nice accent if you're printing a greeting or business card. For the higher-resolution MD-5000 printer, Alps also offers silver and gold foil, which are a bit shinier and stand out more than the metallic silver and gold, and are priced at about \$12 each, \$2 more than the metallic gold and silver cassettes. For our stamping, we'll use the *Gold Foil* cassette, though the finished output from the metallic gold ribbon, with the less expensive MD-1000 printer is almost of the same quality.

GETTING DOWN TO IT

We'll tackle two easy foil-stamping projects. The first is to add a foil stamp to a report cover, the second is to add a foil accent to a business card. For purposes of example, we'll use Microsoft *Publisher* for both. You can use almost any graphics program or even a word processor for this purpose. It's just easier to format the text and foil effects exactly where you want them placed if you use a page-layout program.

Publisher has a large variety of already formatted templates, and we'll use one of these for the business cards. But for the report cover, it's easier to start with a blank page. When *Publisher* starts, it asks you if you want to choose a project from the Page Wizard selection. Instead, click on the Blank Page tab, select the Full Page icon, and click on the OK button.

Once the blank page is displayed, the next step, when using *Publisher*, is to draw a text frame. This is an area on the page that will be filled with text, rather than an image or clip art. To draw

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this frame, first click on the box with an "A" in it, then drag the cursor on the page to select an area where you'll type in the text you want to foil print (in our example, I made a report cover with my name and title). Once the text box is drawn, a cursor appears inside it. Select your typeface and text size from the drop-down lists, then move the cursor back to the text box and click with the right mouse button. A new menu will appear, and you can select the option to zoom in. Type what you want to foil stamp and leave it highlighted.

When the foil stamp is the only text printed on the page, there's no need to do anything special as far as assigning colors to the text. That's taken care of in setting the printer driver. First, insert the Gold Foil cassette into the printer. Under the Alps printer driver, there's a check box for Use Spot Color. Click on this, then on the Spot Colors button. A new box will pop up for Spot Color Settings. Check the Use Foil setting, and then Single Ink. Close everything up, and print your report cover. The text you entered will be gold stamped onto the cover. Using a darker colored

cover really works best, as the gold really stands out.

Making gold-accented business cards is a similar process. Choose a card design from the PageWizard collection that you like. Then enter the text you want on the cards, and highlight the text you want in gold. Mixed-color printing is a bit different from the preceding example. The first difference is that you need to use the Metallic Gold cassette, instead of the Gold Foil one. You also need to set the color of the area you are stamping so that the driver recognizes that it's supposed to use the metallic cassette. Make sure to insert the correct cassette, and then make the adjustments.

There's a table in the documentation that gives each color in terms of CYMK or RGB settings. *Publisher* used RGB values, and to get to the place where you can set them, you need to click on the icon on the main menu bar that has the letter "T" with a blue box. When this is clicked, it presents a palette of basic colors. There's also a button to select All Colors. When the latter option is selected, you

can enter the RGB values. For gold foil, these are 225 for the Red value, 160 for the Green value, and zero for the Blue value. Click on the Apply button, and you're almost ready to print.

As with the earlier project, you'll also have to make some settings in the printer driver. Go to the same Spot Color Settings screen we used before and click on the Use Spot Colors setting. From the pull-down Print Using menu, select Metallics and CYMK Inks. Click OK and you're ready to print your business cards. We used Avery blank cards for this project, which are widely available.

Once you get the hang of it, you'll be printing terrific-looking metallics and foils on everything. One word of caution, however. The directions for using metallic and foil inks aren't in Alps' hardcopy documentation. If you don't save this column, you'll have to look for them on the User's Manual on the CD-ROM disc provided with the printer.

That's it for this time. Feel free to e-mail me at tneedleman@aol.com with your comments and suggestions for future projects. ■

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MORE MEMORY

Get more RAM, get more Random Access Memory. It's the answer given for many computer problems and touted as a cure-all for computer-performance ills. And to some degree, it is. To be sure, more memory does usually mean better performance; and it is one of the cheapest upgrades available to users, costing between \$1.50 and \$2 per megabyte (MB). It is also simultaneously one of the easiest and hardest upgrades of all. Something that can take five minutes or something that needs a couple of hours of research and aggravation before the five-minute install, if it comes at all.

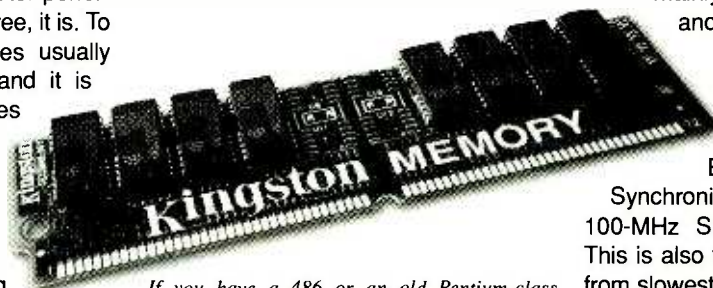
A TRIP DOWN MEMORY LANE

RAM, also called system memory, is the CPU's workspace. To use a tired but effective metaphor, think of an office with a desk and a file cabinet. The file cabinet represents storage (hard disk, CD-ROM, floppy, any external drive), the desk represents the system memory, and the person at the desk the CPU. The CPU pulls the information it needs to run a program from storage and drops a lot of what it needs into RAM. It saves a lot of time; the same way flipping through a file-folder already on a desk is a lot faster than rummaging around file cabinets. The larger your desk, the more you can spread out, and the more information to which you can have easy and fast access.

Though we won't be discussing how to upgrade it, cache RAM is an even more immediate form of memory. It's where the system stores data about to be used by a processor. In keeping with our current example, a piece of paper you hold in your hand

and read is similar to data stored in cache memory.

Even though processor specs may



If you have a 486 or an old Pentium-class machine, chances are it uses SIMM memory like the module shown here. Kingston and other vendors may be able to help you find the right RAM for your system.

remain conservative as new software is written, the memory specs still get higher—the file-folders are getting larger and the desk space needed to handle them efficiently increases as well. This is the top reason to upgrade your system memory and recover some performance lost to age, time, and more sophisticated software.

MEMORY TYPES

The system you have limits the kind and amount of memory you can use. It is an unfortunate fact of life: 386 and 486 machines can generally only use one type of memory, Pentium-class systems may have one of three types installed (though your motherboard may support one or all), and the latest Pentium IIs and AMD K6-2s have access to one.

Unfortunately, buying memory can be a confusing thing. What makes it confusing is that a majority of upgradeable systems are Pentium-class machines. And while memory can be bought easily, you must make sure that

the specs of the RAM you are buying match the specs of the RAM you have.

Five types of system memory are mainly in use today with desktop and laptop PCs: Fast-Page Memory (FPM RAM), Dynamic RAM (DRAM), Extended Data-Out DRAM (EDO RAM or EDO DRAM), 66-MHz Synchronized DRAM (SDRAM), and 100-MHz SDRAM (PC100 SDRAM). This is also their order of performance, from slowest to fastest.

While this list looks simple, it can get complicated rather quickly. There are different types of ratings and qualifications. In addition, there are more memory manufacturers than there are PC manufacturers, and very few thought to label their modules.

You'll find FPM RAM mainly in 486 machines. Some 486 systems also use DRAM and EDO DRAM, but these are more likely found in Pentium-class PCs. Pentium and faster machines use 66-MHz SDRAM, while 100-MHz SDRAM is for the latest Pentium II and AMD-K6-2 systems—those PIIIs with BX chipsets or K6-2s with Super 7 motherboards.

Chips are further qualified by the following set of consumer-important identifiers: SIMM, DIMM, SODIMM, ECC, ns, parity, and non-parity.

SIMMs (Single Inline Memory Modules) use older memory technologies, like FPM, DRAM, or EDO RAM. The modules have either 30 or 72 connecting pins. They are distinguished from other types of modules simply: They have memory chips on only one side and often have a notch in the middle of the pin array.

DIMMs (Dual Inline Memory Modules) were a great improvement

over SIMMs. They have 168 connector pins, are longer than SIMMs, have two notches, and contain memory chips on both sides. The modules support the latest memory improvements—SDRAM in both its speeds.

SODIMMS (Small Outline DIMMs) are DIMMs for notebooks. They have 144 connector pins and support 66-MHz SDRAM technology.

The ns designation simply refers to the access speed of the module for both reading and writing data. Lower is better (e.g., 50ns is a lot better than 70ns). If different-speed modules are installed in your system, the slowest one (highest number) wins.

ECC (Error-Correcting Code) is a kind of built-in error checking. As we'll get to in a moment, you have to buy modules to match your motherboard requirements.

Parity and non-parity refers to the presence or lack of a very basic error-correction method. Parity indicates that data is sent with a check bit that can be used to verify the data. Non-parity means that this method is not used. Again, your system's motherboard determines whether you get to use this method.

LONG- AND SHORT-TERM MEMORY

If you bought your system from a name-brand manufacturer, your life just got easier. If you purchased it directly through the mail, even better—these systems may have a premium attached to them when compared to a Mom-and-Pop-shop PC, but there are dividends in convenience sometimes.

Systems that are mass produced are produced the same way most of the time. A phone call to the manufacturer's help line, or a call to a RAM merchant, will get you the specs for the kind of memory you need. In some cases, one or two types of memory may have been used, and the representative you speak to can direct you to the best method of determining what was installed.

A direct PC manufacturer probably has your invoice, with the exact kind and amount of memory installed, on file in its sales database—even years later. The catch here is to decide whether you want to buy directly from them (read: *buy at a premium*), or look elsewhere, like the Web, for your discounts on RAM. With notebook RAM,

which is often proprietary, it's necessary to buy from the original manufacturer; desktop owners shouldn't have this problem.



Newer, superscalar PCs use DIMMs—168-pin, double-sided memory modules (top). When miniaturized for use in laptops, double-sided RAM has 144 pins and is called a SODIMM (bottom).

If you don't have a name-brand machine, finding out exactly what to install can be aggravating. The first place to look is in the manual that came with your system. It should indicate the kinds of memory that can be installed.

The next step would be to observe your POST (power-on self-test) and see if it indicates the kind of RAM—DRAM, EDO RAM, or SDRAM. If it doesn't, check your CMOS, which you can access during the POST. An access opportunity usually appears as a command at the bottom of your screen during bootup (e.g., "Press DEL for Setup"). If you see a logo instead of the POST, hit the ESC key; this usually clears it and presents you with a way to access the CMOS Setup. Once you enter Setup, scan through the options; one section may list the amount, kind, and type of RAM.

If you are still at a loss as to what kind of memory is installed inside your system, you will have to peek in and see. Turn off and unplug your system before removing the PC cover. Memory modules are installed on your motherboard in banks or small slots. Some banks will be filled; some may be empty. (If none are empty, you will need to remove your current RAM and replace it with higher-capacity modules—assuming higher-capacity modules of your particular type were made.) Once you find the RAM, you have two options for determining its type.

The first tack involves the installed memory modules, themselves. While unlikely, a memory module located in your system may have the specs on it. It will have a series of numbers fol-

lowed by an x8, x36, or x64, then a dash and a number. The xN number refers to the chip's bit depth. The number after the dash refers to the chip's speed in tens of ns (e.g.—7 represents a 70-ns module). These numbers and the specs of your system can help a RAM merchant determine the memory installed in your system. If you're really lucky, the chip will even say EDO or DRAM.

The second route involves identifying your motherboard's manufacturer and model number (usually silk-screened on one of the board's edges) and then checking with the manufacturer (through a support phone number or the Web) what kinds of memory the board can support.

With the module identified, getting

RAM VENDORS

Kingston Technology Company
17600 Newhope St.
Fountain Valley, CA 92708
800-337-8410
www.kingston.com

PNY Technologies, Inc.
299 Webro Road
Parsippany, NJ 07054
973-515-9700
www.pny.com

Viking Components
30200 Avenida de las Banderas
Rancho Santa Margarita, CA 92688
949-643-7255
www.vikingcomponents.com

more of the same type is a cinch. Like any vendor, memory manufacturers will be only too happy to assist you.

A query to make of your motherboard or system vendor is whether your system will accept faster memory than what was previously installed. Perhaps it is worth your trouble to upgrade from DRAM to EDO DRAM, or from 80-ns memory to, say, 70-ns RAM. If you do upgrade the type, you'll have to remove the older chips (another situation where you have to start from scratch to get more RAM).

INSTALLATION HINTS

As always, read the instructions. Most memory will come with some good tips that you should follow. The basics include shutting down your system (a given with just about any upgrade), and making sure you've discharged any static on your person.

Modules can easily be damaged.

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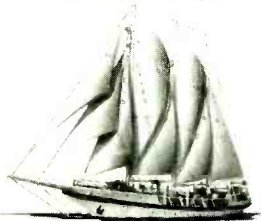


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Treat them with normal anti-static precautions. Be sure to hold them by the edges.

When it comes to orienting a module for installation, you have a built-in guide. Note how your old memory was installed and do the same.

When installing 30-pin SIMMs in 386 and 486 machines, you have to do so four at a time (for example, four 1MB modules). For 72-pin parity modules used in 486 machines, you can install one at a time. However, 72-pin non-parity SIMMs used in Pentium-class systems have to be installed in matched pairs; for instance, use two 8MB modules to get 16MB, but not one 8MB and one 16MB module for 24MB.

performance boost. Take Windows 95, for instance. With 16MB, the OS crawls through even simple tasks such as opening a word-processing document. Add just another 16MB, and it's like you're running the next generation of processor (at least it will feel that way).

OVER 64MB?

A warning is in order. Certain pre-440BX motherboards have chipsets that do not allow for the caching of more than 64MB of memory (Intel FX, VX, HX, and TX chipsets, in particular). Because of the way that Windows 95/98 uses "pages" or parts of RAM throughout the entire memory space, any time the OS accesses data stored

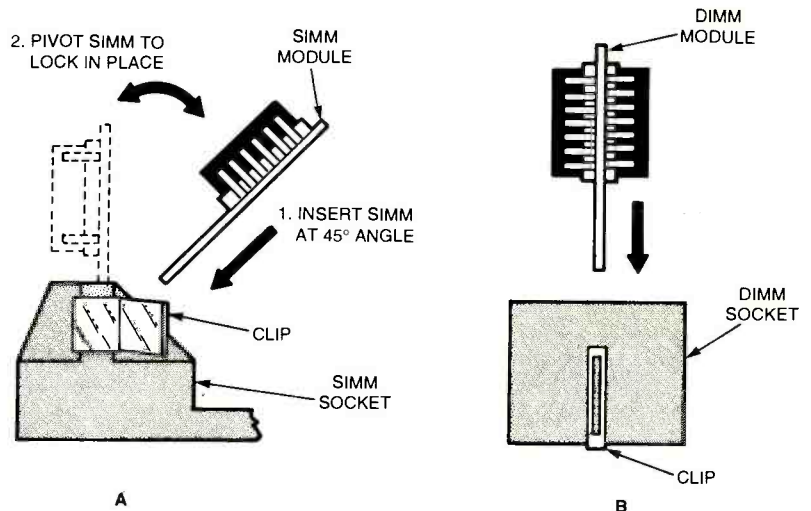


Fig. 1. When installing a SIMM, you need to slide the module in at a 45-degree angle, then rotate the entire assembly until it locks in place at a 90-degree angle (A). DIMM modules slide perpendicularly direct into their sockets (B).

Most SIMMs install at a 45-degree angle to the motherboard. Push such a module in gently, then pivot it in its socket assembly up until it clicks into position perpendicular to the motherboard (see Fig. 1A).

There are no limitations to installing DIMMs. You can add these one at a time, or in pairs, or in any number your board will house. These modules slide directly into sockets at 90-degree angles (see Fig. 1B).

When pushing a module in, make sure not to use excessive force. These little "cards" can easily be damaged. Just listen for the soft click.

Once you're done, reboot your computer. It should recognize the new memory and test it during the POST. If all's well, you may enjoy a significant

in that over-64MB region it will suffer sluggish performance. In other words, if you choose to upgrade to more than 64MB of memory, your system may suffer a speed hit. Unless you plan on keeping open several large graphics files and the like, you might find that your system's optimum performance will be at 64MB of RAM.

Check with your motherboard vendor to determine the real limit of useful memory you can add. Sure, you can physically add hundreds of megabytes of memory to certain systems, but Windows won't necessarily take advantage of it all when combined with the "wrong" chipset and too small a tag cache. Check before you spend money on adding memory past the 64MB barrier of certain older chipsets. ■

MULTIMEDIA WATCH

MARC SPIWAK
TECHNICAL EDITOR
COMPUTER RESELLER NEWS

CUTTING-EDGE A/V

Ever since I learned what an *Imagine 128* could do for benchmark scores a few years ago, I've been a fan of Number Nine graphics accelerators. And it wasn't just the power of the card, but also Number Nine's HawkEye display control.

Most graphics-card vendors bundle a utility that enhances Windows' own built-in utility, which isn't really that bad in the first place. If Windows detects a common graphics chipset, it'll usually be able to control it well. I find that plug and play sometimes gets in the way, depending on how fussy the graphics card, monitor, and system are, and it can be difficult to set the refresh rate. Otherwise, I'm content.

Sometimes a bundled graphics utility only makes things worse, and that's something I hate. But I really like Number Nine's HawkEye display control. It has been enhanced over the years, but never spoiled, and it has always made it easier to make display settings. Of course that's with a Number Nine card installed in the system.

Different graphics accelerators also create different-looking images. You can't really tell by using a single system, but when you work with dozens of systems a year, you see patterns. Number Nine cards always produce a deeper looking blue or green, depending on what you call the color of the standard Windows background. Pretty colors aside, Number Nine has always met its reputation for producing powerful graphics hardware at the high end, and the only thing that has changed today is that the high end has fallen through the floor.

That *Imagine 128* I mentioned before was a PCI card with eight megabytes of memory, and it cost

about \$700. That card was considered a prized feather in one's PC cap, so to speak. Today my *Revolution IV* graphics accelerator is a much better feath-



The Revolution IV is an AGP card with 32MB of SDRAM that costs only \$219. The Revolution IV is three to six times faster at OpenGL acceleration than anything in its price range.

er, but anybody can afford one. It costs only \$219.

Here's a bit of trivia for you: With most graphics cards having names that evoke fire-breathing dragons, warping spaceships, and racing cars, the names of Number Nine cards seem more conservative. But in case you didn't know it, and even if you don't care, Number Nine cards get their names from Beatles songs. "Number Nine," "Imagine," "Revolution" ... see the trend? In fact, there's always a Beatles phrase etched onto the PC board of a Number Nine graphics card. But that's not why I like the *Revolution IV*.

The *Revolution IV* is an AGP card (a PCI version's also available) with 32MB of SDRAM. Since last fall, this card has been selling for only \$219, or \$169 for a 16MB version. I've seen the 32MB version accelerate OpenGL graphics under Windows NT one fourth as fast as a professional card costing several thousand dollars. The

Revolution IV is three to six times faster at OpenGL acceleration than anything in its price range, though I'm sure all its memory has something to do with it. *Revolution IV* also does wonders for gaming and 2D graphics. Though most vendors will probably have 32MB cards for around \$200 by the time you read this, I doubt many of them will be as fast as *Revolution IV*.

Revolution IV is built around Number Nine's fourth-generation chip, Ticket To Ride. The card features a 250-MHz palette DAC fed by dual 128-bit-wide pipes. It supports resolutions up to 1920 × 1200 in 65,000 colors with a 77-Hz refresh rate, or 1600 × 1200 in true color at 92-Hz refresh. The 128-bit video engine allows full-screen MPEG playback at 1280 × 1024 in true color without dropping frames. The 3D rendering engine is coupled to a floating-point 3D rendering setup engine that runs at 430 MFLOPS (million floating-point operations per second). The latest HawkEye IV display control lets you double the size of the Windows desktop vertically or horizontally in a virtual mode, giving you more space to work. Hardware zooming works up to 8X.

Another contender in the graphics-card arena is one designed mainly with all-out 3D gaming in mind; it also holds its own with everyday compatibility. We're talking about the *3D Blaster Banshee* from Creative Labs. This graphics card not only has a 128-bit 2D graphics processor, but it also has a 3D engine based on 3Dfx Interactive's *Voodoo Banshee* processor. Along with that is a 250-MHz DAC, hardware assist for video playback, and 16MB of 100-MHz SDRAM. It supports resolutions up to 1920 × 1440 in

true color at 60-Hz refresh. Included are DirectX, Glide, and 3Dfx OpenGL drivers. The card costs under \$200.

FLAT SPEAKERS

I've seen countless sets of computer speakers over the years, most varying only by shape and size and, of course, power. But today, some computer speakers are taking a different shape. I'm talking about flat-panel speakers, which have nothing to do with flat-panel monitors as I've noticed is sometimes assumed.

Electrostatic speakers, also known as flat-panel speakers, do not use conventional cone-type drivers. Instead, two insulated metallic sheets are sandwiched together to form a highly resistive diaphragm. The audio input signal is stepped up and applied to the electrostatic diaphragm, which then vibrates and creates sound. Because heavy magnets aren't used, the lightweight diaphragm produces little distortion. Electrostatic speakers for home-entertainment systems are generally expensive.

Sonigistix' *Monsoon MM-1000* flat-panel speakers' for PCs use conventional electrostatic technology as far as I can tell. Sonigistix calls it Planar Focus technology and claims it directs sound at the listener better than conventional speaker designs. The dark-gray satellite speakers look like double-sided speaker grilles only, mounted on stands. They have plenty of power and are quite the conversation piece.

The *Monsoon* satellites house 4 × 8-inch dipole-radiating planar magnetic sheets with no real enclosures—just grilles on both sides. The system boasts a 25-watt subwoofer and 12.5 watts for each satellite. The subwoofer contains a 5.25-inch driver and measures 11 × 10 × 11 inches (HWD) and has controls for volume, bass volume, and bass punch with a 6-dB boost at 55 Hz. There's also a dongle for convenient desktop control of volume and mute.

Gallant Computer's *AudioStorm MT7F/X* speakers don't use electrostatic technology, but can certainly be called flat. The *MT7F/X* is a Dolby Pro Logic Surround Sound system with 5.1 channels—center, left and right front,

left and right rear, and the subwoofer. The powered subwoofer has an integrated center-channel speaker. There are also four flat-panel satellite speakers and a Dolby decoder unit.

Instead of conventional electrostatic technology, the *MT7F/X* flat-panel satellites have transducers mounted to thin panels that vibrate and create pretty good sound. The transducers basically consist of a magnet and voice coil with no speaker cone



Monsoon MM-1000 flat-panel speakers are powerful and look like they should be connected to a computer.

attached. The *MT7F/X* satellites are only 0.7-inch thick and light in weight. The satellites include stands, but they are also perfect for wall-mounting being so thin. Each satellite is 7 by 5 by 0.7 inches (HWD) and is driven by 3 watts. The center channel is also 3 watts, and the subwoofer is 12 watts. The components are relatively tiny: the subwoofer is about the size of a milk carton and the Dolby Pro Logic decoder is about the same size as a car stereo.

The *MT7F/X* delivers good sound, but the system is not as powerful as the previously mentioned *Monsoon* system. Gallant's 5.1-channel setup is perfect for Surround Sound, either for business presentations or entertainment. The entire package in its carrying-case-like box weighs less than 10 pounds. It's perfect for traveling with, especially now that notebook computers have DVD-ROM drives.

On a recent business trip, I just so happened to be demonstrating a VGA projector with an S-Video input and Gallant's *AudioStorm MT7F/X*, and I also had a DVD-equipped notebook with an S-Video output with me. Back in the hotel at night I enjoyed DVD movies projected on a strung-up, white table-

cloth (courtesy of room service), with 5.1-channel Dolby Pro Logic Surround Sound. The room-service waiter was hesitant to leave, seeing the near-movie-theater-quality setup in action. The *AudioStorm MT7F/X* flat-panel speaker system costs about \$150.

IMPRESSIVE IMAGING

I've raved about the *P-300* photo printer from Olympus, a 300 dpi, photo-quality dye-sublimation unit that makes beautiful album-sized prints directly from Olympus digital cameras.

It's a fantastic home-photography system that doesn't even require a computer. Then last month I discussed Canon's *CD-200* photo printer that's a bit different, but just as convenient. Canon's printer accepts CompactFlash memory modules that Canon's digital cameras also happen to use. The *CD-200* connects to a TV for previewing the images, and it can also capture images from video signals.

So you can also capture frames—from TV, videotape, DVD, or whatever—for printing.

I guess when Olympus caught wind of the *CD-200*, it quickly introduced a second photo printer, the *P-330*. Like the *P-300*, the *P-330* allows printing directly from Olympus cameras or from a computer. And like Canon's *CD-200*, it also allows photo viewing and printing through a TV set because it accepts the SmartMedia memory cards that Olympus cameras use. This is no-cable, no-computer digital photo printing at its best. Images viewed on a TV can be cropped and printed up to 30 copies. The *P-330* is also a video-capture printer, allowing the printing of frames from any video signal.

Dye-sublimation produces continuous color tones, so the *P-330*'s output is equivalent to a 2400-dpi ink-jet printer. It prints images on 4 × 5.5-inch glossy sheets at 1.5 minutes per page in true 24-bit color with 16.7 million colors. The glossy prints rival 35-millimeter prints. The *P-330* costs \$449, and packages of 30 glossy print sheets plus a new dye-sub ribbon cartridge cost about \$40.

Not willing to let its line of digital cameras stagnate for more than a few

weeks, Olympus has yet another new digital camera out, and this one is its new top of the line. The *D-620L* looks and feels just like the *D-500L* that I have admired so much, and its higher-resolution sibling, the *D-600L*. But the *D-620L* outdoes both.

The *D-620L* packs in a 1.4-megapixel high-resolution CCD, which generates 1280 × 1024 images. Also new with the *D-620L* are speed memory buffers that allow for nearly instant consecutive shots. A new burst mode can capture 3.3 frames per second at the highest resolution of nearly 1-megabyte per image. Quick focus settings help the camera respond to the shutter button more quickly. The *D-620L* also features an external flash connector so that third-party flashes can be used in addition to the *D-620L*'s built-in flash. The pop-up flash works up to 15.7 feet and provides six modes along with the external sync: auto low-light/back light, red-eye, fill-in, forced off, fill-in with external flash, and external flash only.

Like the *D-500L* and *D-600L*, the *D-620L* has a 3X zoom, all-glass f2.8 autofocus lens, and through-the-lens (TTL) single-lens-reflex (SLR) viewfinder. The lens has a focal length of 36 mm to 110 mm and macro capabilities. A macro focus mode provides close-ups from just under a foot away. A 1.8-inch smudge-resistant LCD allows image viewing and direct printing to the *P-300* and *P-330* printers. The camera has a serial port for connecting to computers and a parallel port for connecting directly to the *P-300* and *P-330* printers. It weighs 16.5 ounces and measures 4.5 by 3.25 by 5.1 inches (WHD). The camera comes with rechargeable nickel-metal hydride AA batteries, a charger, and an 8MB SmartMedia card (the type of memory it uses).

Adobe *PhotoDeluxe* image manipulation and creation software, and Enroute Imaging's *QuickStitch* panorama software, and a utility for downloading images from the camera to a computer, are included. The *D-620L* has a suggested retail price of \$1199.

PANEL PC

If you've never heard of panel PCs, you may be one of the people who needs one and doesn't even know it. A panel PC is basically a tiny system

with a built-in LCD screen. They are perfect for very cramped locations and for kiosk applications. Advantech's *PPC-140T* is a Pentium MMX-based computer with a 13.8-inch SVGA color LCD display. The display is touch-screen controllable, so you don't need a mouse—again good for kiosks. The unit has a hard disk drive, Sound Blaster-compatible audio, built-in stereo speakers, a CD-ROM drive, floppy drive, and PCMCIA slot. It also has a built-in 10/100Base-T network interface and an IrDA port.

The tiny system also sports four serial ports, two USB ports, a parallel port, and a game port. It has a microphone



Olympus' P-330 digital photo printer allows printing directly from Olympus cameras or from a computer. It also allows photo viewing and printing through a TV set because it accepts SmartMedia. It will also capture and print frames from any video signal.

input, speaker output, and line input for audio. Last but still important is a single ISA/PCI slot for expansion cards. Panel PCs can be wall, panel, swing-arm, or desk mounted. Depending on the configuration you choose, you'll spend around a couple grand on one of these.

BETTER NET TELEPHONY

The *Compro Ezfone*, from ACS Innovation, is an ISA card that lets you make calls over the Internet using a regular telephone while saving money on long-distance and international calls. It's intended for calls that are made frequently to the same locations, such as branch offices and relatives. *Ezfone* requires a quick card and software installation in a PC with Internet access and a regular telephone. The phone plugs into the card. The unit provides full-duplex audio compression and decompression and incorpo-

rates echo cancellation and noise filtering for distortion-free transmissions.

To reach someone without an *Ezfone*, you can subscribe to a worldwide network of H.323-compliant gateways that automatically connect you to the telephone network. You can still save money on international calls. You can even set up *Ezfone* to make calls over the Internet from regular telephones and cellular phones. One *Ezfone* costs \$149, and a starter kit containing two units costs \$249.

MOBILE ACCESSORIES

I happen to have a bunch of handy mobile accessories from two different companies this month, the first company being Teledapt. The *Mobile Connectivity Pocket Guide* helps the business traveler get connected with 76 pages of instructions in a pocket-sized book for \$14.95. The *TeleCord* eliminates tangled phone cords with 16 feet of retractable cable with RJ-11 connectors at each end—it works like a tape measure. For only \$15 the lockable unit takes up much less space than 16 feet of regular phone cable.

Other accessories from Teledapt include the *CoolPad*, which helps hot-running notebooks run cooler. The 360-degree pivoting base fits in the space of an owner's manual and lets notebooks run up to 20 degrees cooler. The pivoting base is also great for presentation use. It costs \$19.95. The *IBM Modem Saver*, available from Teledapt, plugs into any telephone jack and indicates whether the line is analog or digital. Most telephone systems in offices and hotels are digital, but the jacks look identical to regular analog lines. Digital lines will damage lots of modems. The *IBM Modem Saver* protects your modem for \$30. Digital lines are usable with analog modems with the *TeleSwitch Plus*, a device that converts digital lines to analog for \$150. A bundle, the *Digital Connection*, includes both the *TeleSwitch Plus* and the *IBM Modem Saver* for \$170.

If you travel to Europe a lot and often run into connectivity problems, you'll probably find the *Europe Access Pack*, from 1-800-BATTERIES, to be of assistance. This set includes 20 telephone adapters and six grounded power adapters, a modem saver, in-line coupler, modular Y adapter, line 1-

line 2 adapter, an 8-foot retractable RJ-11 phone cable, and a guide to mobile computing, all in a handy carrying case. The kit costs \$229 and covers your connectivity needs from Austria to Belgium, from Greece to Italy.

FORCE FEEDBACK

I've got two force-feedback input devices this month, both from American ANKO. The *Force Feedback Wheel* is a PC steering wheel for racing games, my favorite type of game. The steering wheel's force feedback conveys the bumps, twists, and turns of the road in a way that no joystick can. Whether it's off-road bumps or a brick wall, you'll feel more like you're driving a real car. The force-feedback wheel costs \$139. Also available is the *GC-2000B+* digital programmable joystick in USB form. This ultra-modern joystick costs \$59.00.

NEW SOFTWARE

3D Builder Pro from the 3D Construction Company is an amazing program. It lets you convert photos of objects into textured 3D models that can be exported to various rendering packages. *3D Builder* calculates X-Y-Z coordinates and displays the object as wireframe, a shaded rendering, or both, with texture maps applied directly from the photos. First you scan the photo, then you create a project and add the image files. You then locate points, lines, or faces of interest, correspond points between different pictures of the same object, and have *3D Builder* generate the 3D model and extract measurements. You can download a 30-day trial version of the software from the Web site, but the full version costs \$695.

If you like trains, and even if you don't, you'll probably like the multimedia software from Abracadata. *Master 3D Railroad* lets you set up virtual train sets with your own custom layouts, choice of railroad cars, and more. You can even put on the engineer's cap and drive your train. You can build trains over 100 cars long in any order you choose. There are different levels of difficulty, and you can even run multiple trains. Realistic controls, cargo loading and unloading, schedules, and more add to the experience. This CD-ROM costs \$59.99. *Train-Teasers: Jigsaw Puzzles* features hundreds of train-related pic-

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tures that can be turned into puzzles of varying difficulty. The number of pieces range from less than 100 to over 900. Pieces can be spread out randomly or placed in a grid. A second window lets you assemble or store certain pieces for later use. You can even add your own pictures to the program. This one costs only \$19.99.

Star Wars: Rogue Squadron from LucasArts puts you in a rebel pilot's shoes for battling the Galactic Empire in X-wings, Y-wings, A-wings, V-wing airspeeders, and snowspeeders. The

game is set in the period between *Star Wars: A New Hope* and *The Empire Strikes Back*. You'll lead twelve of the best pilots on dangerous new missions. This game costs \$49.95. ■

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ADVANCES IN E-COMMERCE

New sites appear every second on the Net—not exactly a breaking story by any means. Like anything else in the constantly changing realm of computing, the Web holds infinite possibilities. Netizens are virtually guaranteed to experience something new if they point and click from site to site.

But every once in a while a site manifests that pushes the technological envelope of the World Wide Web. A site that embodies not only cutting-edge features, but which promises only better things for the future. Wouldn't it be boring if Web pages were always text pages with a photo or two? Thank the HTML gurus for keeping the Net interesting.

This month's feature sites are linked to form a hot e-commerce spot with an interactive, visual edge that is refreshing. Join us for a look at My Ticketmaster.

PERSONALIZED AND INTERACTIVE

While Ticketmaster has had a Web presence for a while now, the company's new My Ticketmaster site is a whole new animal, featuring two key aspects that should set the precedent for better e-commerce in the future.

First, My Ticketmaster gives you personalization. Unlike most other sites that have you searching for what you want, this one pops up information related to your interests every time you log on.

If you're an avid concert goer or like attending just about any other type of live event, My Ticketmaster will let you



With the IPIX viewer installed in your browser, you can view the insides of 75 venues in the US, from any spot, to help you get a feel for where Ticketmaster will seat you.

choose what type of events you want to be notified about. When you first log on and create an account, you're presented with a series of menus that let you pick geographical areas of interest, as well as the types of events you'd like My Ticketmaster to inform you of.

I like to travel so I picked not only venues in the NYC area, but also in New Jersey, Connecticut, Massachusetts, and Pennsylvania. I then added some cities I'm likely to end up in, such as New Orleans, Las Vegas, and L.A. Then I chose my areas of interest, which included Alternative concerts, magic shows

(yeah, I'm still a bit of a kid at heart), and comedy.

Now, each time I log on, My Ticketmaster provides a list of events that would interest me. It's that simple. In fact, you don't even need to go to the site to get the latest info. Just download the nifty TM Event Ticker, which installs to your system tray (i.e. you'll find an icon for it on your Windows 95/98 Taskbar). When you're online, click on the lightning-bolt icon, and let the tiny applet pop up and show you what new shows are coming your way as well as provide you with a list of the top entertainment-story headlines of the day. For full news you'll have to go to the My Ticketmaster site.

The other key aspect—one of the neatest features of the site—is still in its infancy. Let's start with the good points of this virtual-view feature.

Not only can you buy tickets for shows from the site (a boon in itself, by the way—ever try to get through to Ticketmaster on the phone when a hot event goes on sale?), but you can get a feel for what your view of the stage or sporting event will look like. Having teamed up with Intel and Interactive Pictures Corporation, Ticketmaster now provides an immersive, interactive technology at its site. Once you download the IPIX viewer (it will install itself in most versions of IE and Communicator), you can virtually enter any of 75 venues around the country. Generated on the fly

(continued on page 78)

SCANNER SCENE

Unwanted Signals?

MARC SAXON

We go to great ends to find the best locations for our stations, obtain the antennas that will perform best and mount them as high as possible, use low-loss feedlines, and select the most sensitive scanners. All this in an effort to make certain we can monitor as much as possible. But it's ironic that a part of what we catch is not only unwanted, but actually undesirable. Like the fisherman who snags unwanted fish in his net and throws them back, it's best to waylay troublesome signals before they can muck things up for our monitoring.

Older scanners, like the BC-200XLT and PRO-43 (among others) didn't have protective diodes in their front ends. A very strong nearby signal source could permanently sizzle their front-end transistors. Most modern scanners are built with sufficient protection against such disasters. Yet, even the best modern scanners are usually prone to extremely annoying unwanted signal pickup.

That annoyance is the unrelenting and hated bleep-bleep interference from powerful local radiopaging transmitters. The signals are so strong they produce numerous phantom images of themselves within your scanner. This interference pops up all over the place, causing spurious signals and rendering wanted frequencies useless.

Radiopagers operate in the 152-, 158-, 454-, and 462-MHz bands. So, the interference comes from one (or more) strong pager(s) on one (or more) of these bands. Check local paging signals in those bands and compare them against your interference problem. You can probably spot the culprit causing headaches for your scanner. There is a solution!

Quiet monitoring may be effectively restored by installing a PAR filtering unit that attenuates the offending signal up to 35 dB. This precision filter quickly installs in-line, without tools, right at the scanner's antenna connector with M/F BNC connectors. You must specify whether the unit is to attenuate either 152-, 158-, 454-, or 462-MHz pagers.

There's minimal insertion loss. Units may be used in series to reduce interference coming from several pagers on different bands.

PAR filters are \$59.95 each, plus \$5 shipping (\$7 to Canada). NY State residents add \$5.36 tax. These are from CRB Research, PO Box 56, Commack, NY 11725; VISA/MC/Discover accepted; Tel. 516-543-9169; e-mail: sales@crbbooks.com; secure Web site: www.crbbooks.com.

TALK IS CHEAP

Of late, a variety of inexpensive handheld two-way radios have become more popular than ever. Frequencies that at one time had been rather quiet have recently become busy as the public increasingly uses these devices for business, security, law enforcement, recreation, and



Installing a PAR filtering unit like this one is easy to do and restores quiet monitoring.

many other purposes. This sudden popularity is a direct spin-off from the success of cellular and cordless phones. Some of these radios claim a range of several miles between units, with their short whip antennas, and at ground level. A base-station scanner with a high antenna can receive them from greater distances. You never know what you might hear, so give them a try!

RadioShack's two-way VHF business-band handheld is ready to go on 154.60 MHz, but can be changed to operate on 151.625, 151.70, 151.76, 151.82, 151.88, 151.94, 151.955, or 154.57 MHz. The UHF version is set up

on 464.55 MHz, but may be reconfigured for operation on 464.50, 467.7625, 467.8125, 467.85, 467.90, or 469.925 MHz. License forms are packed in with these radios, but you have to wonder how many users bother to fill them out and file them with the FCC.

The General Mobile Radio Service (GMRS) and the Family Radio Service (FRS) both operate on 452.5625, 462.5875, 462.6125, 462.6375, 462.6625, 462.6875, 462.7125, 467.5625, 467.5875, 467.6125, 467.6375, 467.6625, 467.6875, and 467.7125 MHz. GMRS licensees (base, mobile, handheld units) are permitted to use repeaters and simplex on the 462-MHz channels. In addition, GMRS also is assigned a repeater output frequency of 462.675 MHz (input: 467.675 MHz), which is designated for emergency and assistance purposes. FRS handhelds do not require licenses and are simplex on all channels, without access to repeaters.

FRS is growing at an amazing rate, with dozens of manufacturers producing the radios, and a heavy promotion of the service to the public. Several fire departments in my area now use FRS radios and one of the frequencies as a fireground mutual-aid channel. I've monitored them from more than five miles away.

Another place you'll want to monitor is the 49-MHz band, which has several frequencies set aside for those hands-free FM two-way radios. These radios clip to the belt, employing a headset. That makes them popular with store personnel, also groups of people riding bicycles, on construction sites, using them with surveillance activities, etc. The frequencies used are 49.83, 49.845, 49.86, 49.875, and 49.89 MHz. You may recognize that these include frequencies also used by cordless phone handsets and wireless room monitors. Some hands-free radios can operate on all five channels. The most popular frequency in hands-free two-way-radio use is 49.83 MHz. That's because 49.83 MHz is

(continued on page 78)

HAM Radio

Helical Antennas and RadioScience

JOSEPH J. CARR, K4IPV

This month we're going to focus on one of the more interesting forms of antenna, the helix, as well as look at some RadioScience Observing topics (a term I coined to cover topics such as whistlers, spherics, and radio astronomy).

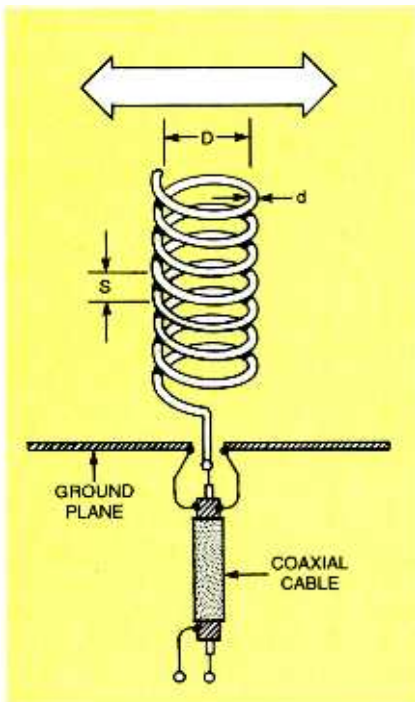


Fig. 1. Here is a normal-mode helical antenna. While somewhat inefficient, antennas like this are used in portable communications devices—an example being the “rubber ducky” antenna used on VHF/UHF two-way radios and scanners.

A helical antenna can transmit and receive with circular polarization, the orientation of which depends on the direction the antenna twists. There are two basic modes of operation for the helical antenna: normal and axial. Let's get right to the first one.

OMIDIRECTIONAL NORMAL-MODE HELIX

Sometimes nothing makes a point better than an image. Take a look at Fig. 1 to see a normal-mode helix

antenna. This device produces an omnidirectional pattern when the antenna is mounted vertically.

The diameter (D) of the helical coil should be one-tenth wavelength ($\lambda/10$ or 0.1λ), while the pitch (S—the distance between helix loops) is one-twentieth wavelength ($\lambda/20$ or 0.05λ). The tubing diameter (d) is about $3/16$ to $1/2$ inch.

As for the ground plane, it should be 0.8λ or higher for circular and 1.1λ or higher for square applications (the offset between the base of the helix and the ground plane is approximately 0.12λ).

Recall that the value for wavelength is $300/f_{\text{MHz}}$, so at 146 MHz:

$$S = 0.1 \text{ m} = 10 \text{ cm}$$

$$D = 0.2055 \text{ m} = 20.55 \text{ cm}$$

These antennas are inefficient, but have some uses in portable communications transmitters, receivers, and transceivers. An example of the normal-mode helix is the “rubber ducky” antenna used on VHF/UHF two-way radios and scanners.

AXIAL-MODE HELICAL ANTENNA

An axial-mode helical antenna is shown in Fig. 2. This antenna fires “off

the end” in the direction of the arrow.

The helix is mounted in the center of a ground plane that is at least 0.8λ across. For some UHF frequencies, builders have used aluminum pie pans for this purpose. The helix itself is made from either heavy copper wire (solid, not stranded) or copper or brass tubing (copper is the easier tubing to work with).

The dimensions of the axial-mode helix are calculated differently than with a normal-mode unit. In the axial configuration, D is approximately $\lambda/3$ and S is about $\lambda/4$. The length is approximately 1.44λ . At 146 MHz, these turn out to be about:

$$D = 0.685 \text{ m} = 68.5 \text{ cm}$$

$$S = 0.514 \text{ m} = 51.4 \text{ cm}$$

$$\text{length} = 2.96 \text{ m} = 296 \text{ cm}$$

A “rule of thumb” for the circumference is that maximum gain is obtained via:

$$C = 1.066 + ((N - 5) \times 0.003)$$

where C is the circumference and N is the number of turns in the helix.

The actual gain equation is a bit complicated, but can be calculated in antenna-modeling programs. However, a quickie approximation can be arrived

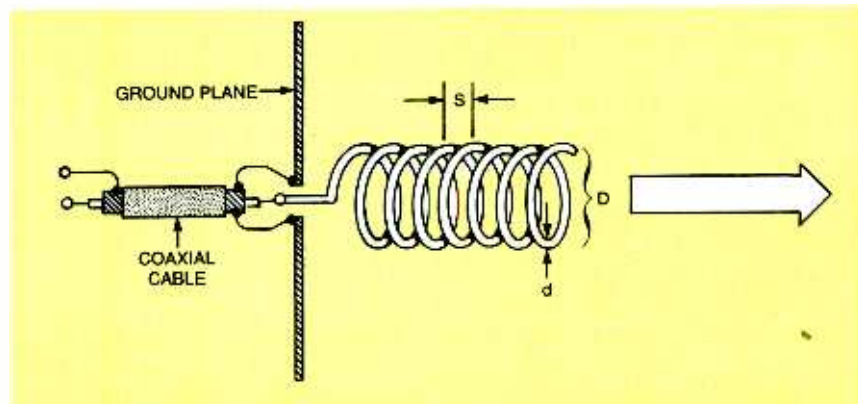


Fig. 2. Axial-mode helical antennas like this one fire “off the end” and are also designed with different formulas than normal-mode antennas (see text).

at from:

$$G = 11.8 + 10 \text{ LOG } (C^2NS)$$

Now for some interesting....

APPLICATIONS

Helical antennas are often used in RadioScience Observing because they have a wide bandwidth and are circularly polarized. For all applications, keep in mind that the feedpoint impedance of the single helical antenna is on the order of 125 ohms, so a 2:1 or 3:1 broadband RF transformer will make the impedance match to 50-ohm systems. Or if you use a 75-ohm transmission line, a 125-ohm imped-

wire or, more likely, small-diameter copper tubing. The soft copper tubing used by plumbers for things like humidifiers on furnaces seems ideal. It is easy to bend without kinking and will hold a shape once it is bent.

One reader in the United Kingdom wrote to me telling how he used a helical antenna on 151 MHz (a radio-astronomy band exists from 150–152 MHz) to monitor solar noise activity. He built a VHF downconverter to convert the 151-MHz signal to 29 MHz in the amateur-radio 10-meter band, so that he could use either his ham shack transceiver's receiver section or a good shortwave listener's receiver as a "variable IF strip." Note that 151 MHz

will be picked up. As the Sun begins to cross the horizon, the noise level will begin rising to a peak. My correspondent made recordings of the relative solar noise level and compared them to sunspot counts and radio-propagation effects and found some relationships that he intends to publish himself in the UK (which is why I don't report on them here).

SCIENCE-FAIR TIME?

While this is the June issue and hardly science-fair season, my opinion is that really top-notch science-fair entries get developed during summer vacation, and not when the science teacher advises it's time to get started. Because we are on the upswing of the sunspot cycle, perhaps some students might want to do a RadioScience Observing project of some sort. Something like the solar-flux monitor just described could be interesting. Heck, one young lady in Florida measured solar activity on the high-frequency shortwave bands by using a rectifier/integrator at the output of a receiver tuned to 15-MHz WWV (or WWVH if you are on the West Coast). The signal level varied diurnally with solar activity, and she was able to capture that effect on a strip chart recorder.

Of course, today you'd probably want to use one of those low-cost A/D converters that connect to either the serial or parallel (printer) port of a computer. It occurs to me that some of those A/D models have DOS-based programs, and that DOS computers are essentially little more than boat anchors and doorstops today. I've seen used MS-DOS computers with 286 or earlier processors on sale for \$10, and many are given away for free. One of those computers could be pressed into service as a RadioScience Observing monitor. This is preferred over your main computer because it can be dedicated to full-time use. Best of all, if a thunderstorm zaps the computer, you're only out ten bucks.

Figure 3 shows the circuit for a suitable rectifier/integrator. This circuit is based on a circuit created by Jeffrey Lichtman of Radio Astronomy Supplies (190 Jade Cove Dr., Roswell, GA 30075; e-mail: jmlras@juno.com). The jack (J1) for input voltage is connected to the headphone output of the

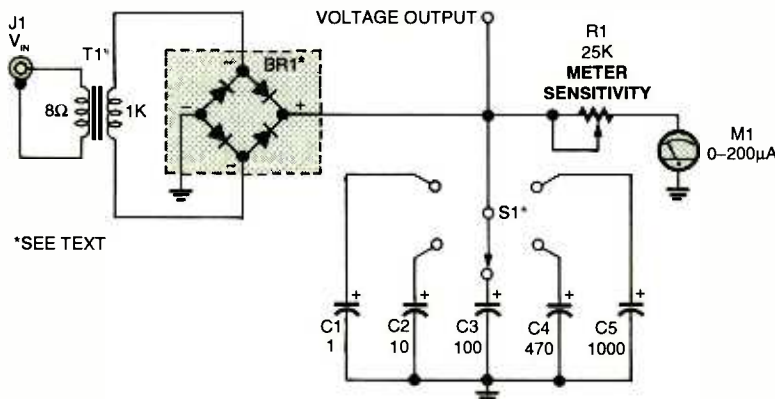


Fig. 3. This Lichtman integrator for RadioScience Observing systems can be used to monitor solar activity. To connect the circuit to an A/D converter, attach the latter to the voltage-output point.

ance results in a VSWR of 125/75 = 1.67:1.

If you are willing to restrict the bandwidth of the antenna because of a matching system, then you can make a quarter-wavelength matching harness. The impedance of the coaxial cable needed for a matching section is equal to the square root of the product of the two known impedances, or in the case of a 50-ohm system and a 125-ohm helical antenna, it is $\sqrt{(50 \times 125)} = 79$ ohms. Thus, 75-ohm coaxial cable can be used for this purpose.

When cutting coax, however, remember to discount the length by the velocity factor (VF) of the cable. For low-loss polyfoam dielectric coax, the VF is 0.82. The length in inches would be $2952V/f_{\text{MHz}}$, and in centimeters it is $7498V/f_{\text{MHz}}$. Thus, for our 146-MHz helical antenna using polyfoam coaxial cable, the lengths are 16.53 inches or 42 cm.

The helical antenna can be constructed using very heavy solid-copper

is close enough to the 2-meter ham band so that some of the 2-meter converters in older copies of the *ARRL Handbook* and *ARRL VHF Manual* will work nicely.

The solar-flux monitor built by this reader in the UK uses a rectifier and integrator (15-second time constant) at the earphone output of the receiver in order to produce a DC level proportional to the noise level. This DC level can be recorded on a strip chart recorder, X-T or X-Y paper chart recorder, or in a computer using an A/D converter.

During the early morning hours before dawn, the noise level is at a minimum, being only terrestrial and galactic in origin. Even this noise can be considerable, by the way. During World War II, British radar operators noticed that their radar sets would be a lot less sensitive to detecting in-bound German bombers whenever the Milky Way was above the horizon! With the antenna pointed east, the solar noise

receiver (using a cable with appropriate connectors). The signal level is indicated on DC-meter M1, and by the voltage appearing at the voltage-output point, which can be used as a connection to an A/D converter.

Transformer T1 in the circuit is an 8-ohm/1000-ohm audio unit (available from RadioShack and other sources). Bridge rectifier BR1 can be of any type, but keep in mind that the standard 1000-PIV/1-ampere versions are easily obtained for a low price. As for the capacitors connected to S1, they can either be switched in and out of the circuit as shown here, or you can replace the switch and array with a single appropriate value capacitor (start at 100 μ F when experimenting to find the right value for your recording setup).

Now, let's get back to science fairs. These events use judges from the community to examine the projects. If you are an engineer or scientist or have any training in those fields, then you might want to volunteer at the local high school or middle school (they are usually chronically short of judges).

If you are a student, then you might want to give some consideration to doing some form of RadioScience Observing project. It would be different and a lot better than some of the run-of-the-mill projects I've seen in fifteen years of judging!

Join us next month for an interesting change of pace. This column will be expanding to cover not only ham radio, but more aspects of the wireless world. Check out my new *Comm Links*, beginning in the July issue of **Popular Electronics**.

Until then, I can be reached by snail mail at P.O. Box 1099, Falls Church, VA 22041, or by e-mail at carrjj@aol.com. ■

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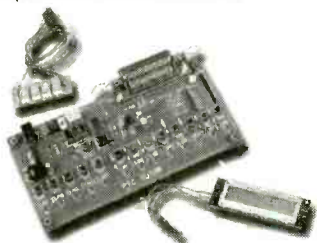
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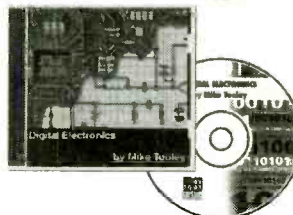
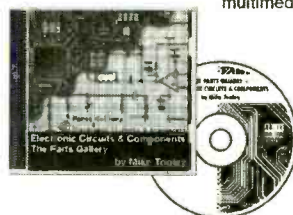
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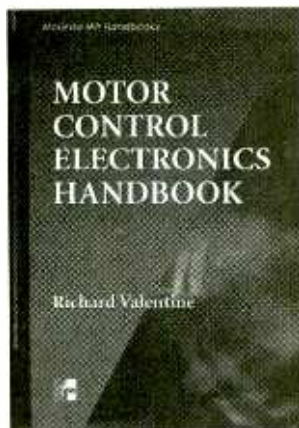
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ELECTRONICS LIBRARY

MOTOR CONTROL ELECTRONICS HANDBOOK

by Richard Valentine

With this insider's guide to electronic control technology, builders will be able to make very efficient motors. Featuring the latest in electronics technology from experts in the field, the guide provides everything from funda-



mentals to cutting edge-design tips, including real-life examples with software code.

The handbook explains how to implement microcontrollers, linear ICs, optocouplers, sensors, and power devices. EMI, RFI, and effective circuit-board layout are also covered. Techniques to network motor control systems and minimize electronic noise are discussed in detail.

Motor Control Electronics Handbook costs \$79.50 and is published by McGraw-Hill, 1221 Avenue of the Americas, New York, NY 10020; Tel. 800-2MCGRAW; Fax: 212-337-4091; Web: ee.mcgraw-hill.com.

CIRCLE 110 ON FREE INFORMATION CARD

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Also included in the catalog are application information, a glossary, and a selection guide. The current measurement selection chart helps users find the probe they need. In addition, the introductory selection guide gives pointers on how probes work, in theory and practice.

The Measurement Catalog is free upon request from AEMC Instruments, 99 Chauncy Street, Boston, MA 02111; Tel. 617-451-0227; Fax: 617-423-2952; Web: www.aemc.com.

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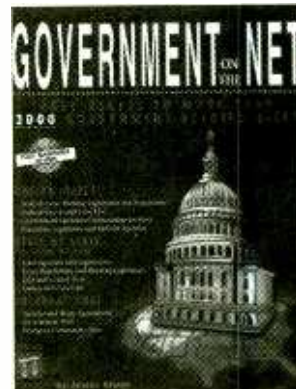
The 1999 EEM CD-ROM for Windows costs \$99 and is published by Hearst Business Communications, Inc./UTP Division, 645 Stewart Avenue, Garden City, NY 11530; Tel. 516-227-1314; Fax: 516-227-1453; Web: eemonline.com.

CIRCLE 112 ON FREE INFORMATION CARD

GOVERNMENT ON THE NET

by James Evans

This comprehensive guide to government resources available on the Internet, as well as related commercial services, describes in detail more than two thousand online government resources from the Central Intelligence



GIZMO®

IN-DASH PERSONAL ASSISTANT

That's what Clarion is calling its *AutoPC* system (\$1299), the first product that integrates audio, computing functions, navigation, and wireless communication in a single-DIN-size unit in a car's dashboard. All functions are operated via hands-free voice activation. The *AutoPC* is based on a version of the Microsoft Windows CE operating system optimized for the car.

The system is a high-powered AM/FM stereo with integrated digital signal processing equalization and a built-in 35-watt × 4-channel amplifier. It features a Hitachi SH3 proces-



sor; 16MB DRAM/8MB ROM; and an in-dash CD-audio/CD-ROM drive, which supports an optional six-disc changer through the Universal Serial Bus (USB). The backlit, 8-color LCD screen provides an easy-to-read, icon-driven user interface. An infrared data port allows easy exchange of information with PC-companion devices. CompactFlash cards enable additional memory.

AutoPC recognizes simple voice commands, allowing drivers to select music and retrieve contact information without taking their eyes off the road. The system also speaks any displayed text. Personal Assistant functions include an address book and

voice memo. Add an optional map data from Navigation Technologies and an optional GPS receiver, and the *AutoPC* pinpoints the vehicle's precise location and provides route calculation and spoken turn-by-turn directions.

THIN IS IN

Proving you can't be too rich or too thin is the Marantz *PD-4280*, a 42-inch widescreen television monitor that uses flat-panel display technology to produce a high-resolution image in a display that measures only 3-1/2-inches deep. It carries a suggested price of \$13,999 (plus \$750 for the optional wall mount).

The DTV-ready monitor is compatible with NTSC, PAL, and SECAM formats, and is capable of delivering a line-doubled image from an NTSC source or a progressive-scan image from a

computer, DTV converter, or DVD player.

The *PD-4280*'s plasma technology uses electrodes and digital microprocessors to selectively illuminate gas-filled cells, or pixels, which contain red, green, or blue phosphors that produce an image. The process creates a bright, sharp display with 24-bit color accuracy. With a native resolution capability of 853 × 480 pixels and multiscan capability up to 48 kHz, the *PD-4280* can display SVGA computer images. The plasma TV includes composite-, S-, and component-video



inputs and is also Windows 95/98 Plug-and-Play compatible. It includes an RGB input for direct connection to a PC or WebTV browser.

COOL PAGER

Forget about learning verbal teen-speak. Quick: Can you translate 911, 143, and 87 from numeric-pager teen-speak into English? You might have guessed that 911 means "urgent." 143 is the numeric code for "I love you" (there is one letter in I, four in love, and three in you). And 87 means "Running late" (look at 87 upside down and you'll see L 8, or late).

Teen-s make up a large portion of pager users, and they're the buyers that Motorola is targeting with its *LS550* numeric pager (\$79). Featuring "Xtreme" styling and a cool, blue E-Luma-Glow display, the pager is as much about fashion as functionality. It measures just 2.4 × 1.7 inches and comes in bright "Blue Streak" and "Red Hot,"



as well as basic black and "Totally Teal." The LS550 has a 40-message memory capacity and offers QuickNotes, a feature that enables the pager to display preprogrammed numeric messages as text. The pager also offers Private Time, which allows the user to turn off all pager alerts at pre-selected times and still receive messages.

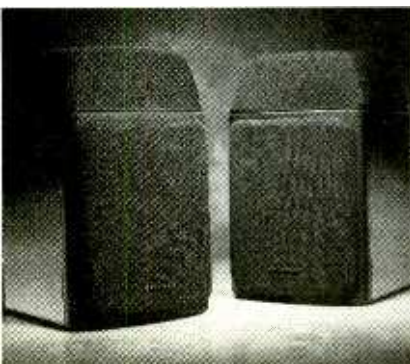
WATER-RESISTANT TV

Summer's just around the bend, with swimming, surfing, baseball, and barbecues. Whether the sunny season finds you out fishing, camping, or hanging around a pool, you won't have to miss a single baseball game if you bring along Amtel's *Model 1401* (\$69.95). The company is billing it as the world's first water-resistant, five-inch, black-and-white television. Too bad so many of these games are on cable!



BOOKSHELF SPEAKERS

The *Optimus Pro-LX5II* (\$149.99 each) from RadioShack is an updated version of the company's popular PRO-LX bookshelf speaker. The two-way speaker combines a top-mounted dipole tweeter that delivers 360° sound dispersion with a long-throw five-inch woofer that improves bass performance and power handling. The system is rounded out by two tapered ports in an enlarged enclosure. The speakers are magnetically shielded for close placement to a tele-



vision without picture distortion.

The frequency response of the PRO-LX5II is rated as 80 Hz to 25 kHz. Power handling is rated as 65 watts (RMS) continuous and 130 watts maximum. Impedance is 8 ohms.

PINT-SIZED HOME-THEATER PACKAGE

Has the home-theater movement passed you by? Have you been unable to afford, unwilling to hook-up, and/or reluctant to share your living space with expensive, complex, full-sized home-theater speakers?

H.H. Scott offers you a leg up onto the home-theater bandwagon with its *SCS60* five-piece (plus remote) compact *CinemaSurround* package.

Not just another Dolby Surround Sound system, *CinemaSurround* recreates authentic movie-theater sound from any stereo or mono audio/video source. The proprietary Interspatial acoustic design concepts eliminate the need for complex, expensive surround-sound circuitry. That means the *SCS60* system hooks up in minutes and is quite affordable (\$299). And the Micro-satellite speakers are touted as "the smallest satellite speakers ever offered."

It all sounds great on paper, but how does it sound in a typical living room? We were curious, but skeptical.

The system comes packaged in a single 18 × 19 × 11-inch box, with a convenient handle on top, weighing just over 30 pounds. The 60-watt powered subwoofer accounts for most of that weight; although at 8-½ × 12 × 15-inches, it's still pretty petite. We lifted it out, found all the necessary connecting cables packed beneath it, and then opened the rest of the Styrofoam packing material. Inside we found the center- and rear-channel speakers, and two cube things that we mistook at first glance for power adapters. They turned out to be the Micro-satellites. The wedge-shaped speakers measure 2-⅛ (W) ×

2-½ (D). At the back, they're 2-⅛ inch tall, sloping down to a mere 1-½ inches in front. The center- and rear-channel speakers were also quite small (approximately 5 × 7 × 2-½ and 4-½ × 6-½ × 2-½ inches, respectively). The "sixth" piece of the system is a remote control that uses two "AAA" batteries, the only things not included in the *SCS60* package.

Hookup is as simple as promised. A 15-foot RCA-type stereo audio cable connects the audio source (TV, VCR, DVD player, tuner) to the subwoofer. (You can connect up to three audio sources to the *CinemaSurround* system, but you'll have to supply your own cables for the second two.) A 15-foot, 8-pin DIN cable connects the center speaker to the subwoofer. Two 40-foot and one 50-foot RCA-type speaker cables connect the two Micro-satellites and the rear speaker to the subwoofer.

The subwoofer's rear panel jacks are clearly labeled (Center Out, Micro Out, etc.). Although its inputs are labeled DVD, VCR, and AUX, only the DVD input is intended specifically for that device, as it includes a special preamp circuit that compensates for DVD's lower recording level. If another device is connected to the DVD input jacks, the volume level will probably need to be reduced. The other two sets of input jacks can be used for connecting TVs, laserdisc or CD players, VCRs, tape decks, tuners, or other line-level sources.

The next step is positioning the speakers. The subwoofer belongs in front (TV side) of the room with the volume control and port tube facing the listener. The magnetically shielded center speaker should be placed on top of or just below the TV. There's a bit of play in placing the Micro-satellite speakers. Designed to face up, so that the sound can travel upward and reflect off walls and into the listening area, they should be positioned, ideally, at table height and close to a wall or other reflecting surface. They perform well even when hidden from sight, in a planter, for instance. The rear speaker, which also faces up, can be placed at the back of the room or on a table direct-

ly behind your listening position. Its independent volume control allows you to adjust the loudness based on closeness to your listening position.

If you've had any experience setting up surround-sound speaker systems, you know that this is the point at which the "fun" usually begins—it's time to adjust the system's balance so that it provides clear dialog that seems to come from the TV, bass effects that rumble realistically without drowning out the words, and a sense of being enveloped by the sound. This crucial stage can make or break your home-theater listening experience, and it can be a painstaking process.



Not so with the SCS60. Plug in and turn on the subwoofer, choose the source using buttons on the subwoofer or the remote, turn on the TV, and select a source (VCR, DVD—preferably one that has loud action scenes). Sit back and use the remote control to adjust the volume to a comfortable level, then adjust the rear-speaker volume until the surround effects sound realistic. You can even change the bass and treble settings from their factory presets without leaving your chair—the remote makes it a snap to do. That's all there is to it.

The setup process, which took about 20 minutes, is inherently easy and is further simplified by the inclusion of a manual that is written in plain English by people who speak English as a first language. So far, the SCS60 lived up to

three of its promises: It's affordable, small, and easy to set up.

But could its actual sound-reproduction capabilities match the company's claims? According to H.H. Scott: "... patented sound-reproduction technology eliminates the need for complex and unnatural-sounding signal-processing electronics ... proprietary center-channel speaker design provides unparalleled clarity and localization creates a realistic and uniform three-dimensional soundfield for unrestricted optimum listening throughout the room ... innovative design ... establishes a new standard of speaker miniaturization while delivering sonic performance comparable to, or better than, conventional sound systems sold at several times their price."

Had those claims not been backed up by the legendary H.H. Scott brand, our skepticism might have overshadowed our curiosity.

The basic premise of CinemaSurround is that the time-delay, active steering, and signal-processing circuits used to separate the sound channels in Dolby Pro Logic systems actually create problems. First, according to Scott, they require the purchase of a special decoder. Second, some technical savvy is needed to tweak the system for optimum performance. On the aural side (also according to Scott), the active steering circuits can create annoying "sonic artifacts," and the surround effects can change with the amount of dialog in the soundtrack.

CinemaSurround takes a different approach. It uses the same Interspatial technology developed for use in the company's multimedia surround-sound system. The reproduction of ambient sounds is completely separate from dialog, ensuring that the dialog always comes from the center speaker, with no shifting to the sides, and that ambient sounds are not affected by the dialog's starting and stopping. No decoder is needed, and the subwoofer provides all the system's amplification

needs.

So, how does it sound? Surprisingly good—especially considering its cost and size. We first used the SCS60 when watching *Godzilla*, and were treated to the full range of thumping, crashing, roaring sound effects. The nostalgic soundtrack of NBC's mini-series *The 60's* also got a boost from the speaker system.

While CinemaSurround is strictly an entry-level system, it is an excellent way to introduce skeptics (including those who believe that no improved sound is worth the eyesore of numerous speakers in the living room) to the benefits of home theater. Setup is simple, the thin wiring can be hidden easily, and the results are many miles ahead of what you can get from most TVs.

In short, the SCS60 gets around all the objections and concerns (cost, difficulty in setup and use, and obtrusiveness of numerous speakers and wires) that some family members might have about typical surround-sound systems. And if your family room is already equipped with a full Dolby surround system—hey, what are you listening to in the bedroom?

CHESS CHALLENGE

In today's world of fast-paced action movies and videogames, it's not easy to get kids interested in playing classic games, where competition comes in the form of other flesh-and-blood humans, and conversation, rather than sound effects, enhances game play. And that's a shame. Children are missing out on the opportunity to develop social skills through game playing and on the quiet, intellectual challenges offered by games like chess.

So, how do you lure your kids away from the Nintendo and over to the chess board? Well, you might just decide to take an "if-you-can't-beat-'em" approach and let Excalibur Electronics' *Ivan the Terrible* (\$149.95) teach them the game.

Granted, "Ivan" is not one of those flesh-and-blood humans whose participation we've been touting. He's a fast-talking computerized chess

game/tutor, complete with the sound-effects your kids have come to expect from games. And he just might provide enough electronic sparkle to hold your kids' attention long enough to learn the basic moves and strategies of the game.

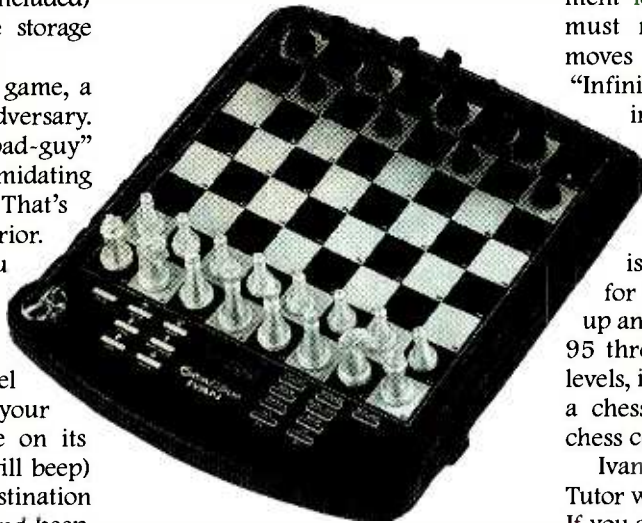
Ivan's eight-inch-square chessboard is mounted atop a black plastic rectangular box. Magnetic sensors under every square register all game moves. (The magnets are not strong enough, however, to hold the pieces securely in place for traveling chess games.) Below the game board are more than a dozen buttons for setup and game play, and a small LCD. There's also a speaker on the front of the unit. The back is home to both a battery compartment (the four required "AA" cells are not included) and to a clever game-piece storage compartment.

At the start of each new game, a drum roll announces the adversary. Ivan speaks in a classic "bad-guy" voice, booming out an intimidating greeting: "My name is Ivan. That's Ivan the Terrible. I am a warrior. Prepare for battle." If you already know how to play, you can jump right into the game, which is pre-set at the easiest level (6), to get a feel for your opponent. Make your move by pressing the piece on its starting square (the board will beep) and then pressing it on its destination square until you hear a second beep. Ivan indicates his move in the LCD; he might open with "C7*C5" to move a pawn forward two spaces, for instance. It's up to you to move his pieces as well as your own. (The board's squares are marked in a grid from A1 to H8, instead of traditional chess notation in which squares are known, for example, as KB4 for King's bishop 4.)

Ivan the Terrible brings a medieval flavor to the game, complete with blaring horns and crowd noises that suggest you're in a jousting tournament. His commanding voice is modeled on that of Sean Connery, who's done his fair share of movies set in the Middle Ages. Move the knight, and you'll hear the pounding of a

horse's hooves; a pawn's movement sounds like the marching of foot soldiers. Move to capture a piece and you'll hear the clash of swords and the grunt of a fallen soldier. A chorus of heavenly voices announces the queen's presence in the game, while a flourish of trumpets and drums indicates the king has moved.

Make a dumb move, and you'll hear about it. "A warrior would never let his horse move like that," Ivan chides; or he just laughs (as you wonder what you did wrong now). "I will grind you into the dust," he sneers. Take too long to make your move, and he'll remind you, "It's your move you know. Did you forget?" Not content to merely capture your pieces, he'll mock, "You didn't see that coming, did you?"



If you beat Ivan easily, it's time to move up to a more challenging level. If (like us) you were ground into the dust, you might want to opt for a chess refresher course.

Ivan offers 100 different levels of play, including several different styles of play. Level 1 adapts to your playing style, calculating the time you take to move and responding in the same average time. Level 6, the default level, is the easiest one, in which the computer uses only a "one-ply search" to determine its next move. A ply is defined as a half move; a complete move consists of your move and the computer's responding move. Levels 5 through 2 get progressively more difficult, adding a ply to each

level so that on Level 2 the computer uses a five-ply search.

Levels 7 through 36 are fixed-time levels, in which the computer always responds in the specified time (from one second to three minutes). The longer Ivan has to "think," the stronger his game will be. Levels 37 through 66 are average-time levels, in which the time Ivan takes to move will be averaged throughout his moves to match the specified average time, again ranging from one second to three minutes. Levels 67 through 89 are countdown levels, in which you or the computer must try to make all your moves within a fixed amount of time, ranging from two minutes to 120 minutes.

Levels 90 through 93 are tournament levels in which the computer must make a certain number of moves within a specified time. On "Infinite" level (94), Ivan keeps trying to find the best possible move until he either finds a "book" move, runs out of memory with which to continue the analysis, finds a satisfactory move (a forced mate, for instance), or until you get fed up and press the MOVE button. Levels 95 through 100 are "mate-solving" levels, in which you present Ivan with a chess puzzle (as in a newspaper chess column) and he tries to solve it.

Ivan the Terrible turns into Ivan the Tutor with a press of the MODE button. If you ask for a hint, he'll give you one. Although it seems every time we took his suggestion, we ended up losing one of our pieces! He lets up a bit on the taunting when he's in the teaching mode, but don't expect any gold stars on your forehead—just be glad Ivan doesn't come with a yardstick for swatting knuckles!

A good deal of Ivan's teaching is by the book—the manual, that is. That's where beginners learn how to set up the board, how to move the different pieces, and the basic rules of play. The manual also explains different styles of play (active and passive), describes how to probe the opponent for weaknesses, and outlines several game-playing strategies.

But Ivan the Terrible has a unique **23**

method of teaching beginners the strategies behind the moves by showing how various pieces interact. In five different "mini-chess" games, only selected pieces are used. By using just kings and pawns, for instance, players learn how a king can be used to attack enemy pawns or to prevent a passed pawn from being promoted. Four other teaching modes use kings and pawns and one other type of playing piece—knights, bishops, rooks, or queens.

We believe that chess holds an innate attraction for people who enjoy logical thinking, strategizing, and plotting several moves in advance as they try to outwit an opponent. Those folks don't need any bells or whistles (or clanking swords or insults) to make the game interesting or enjoyable. In fact, they're the ones most likely to turn off the sound effects and taunts.

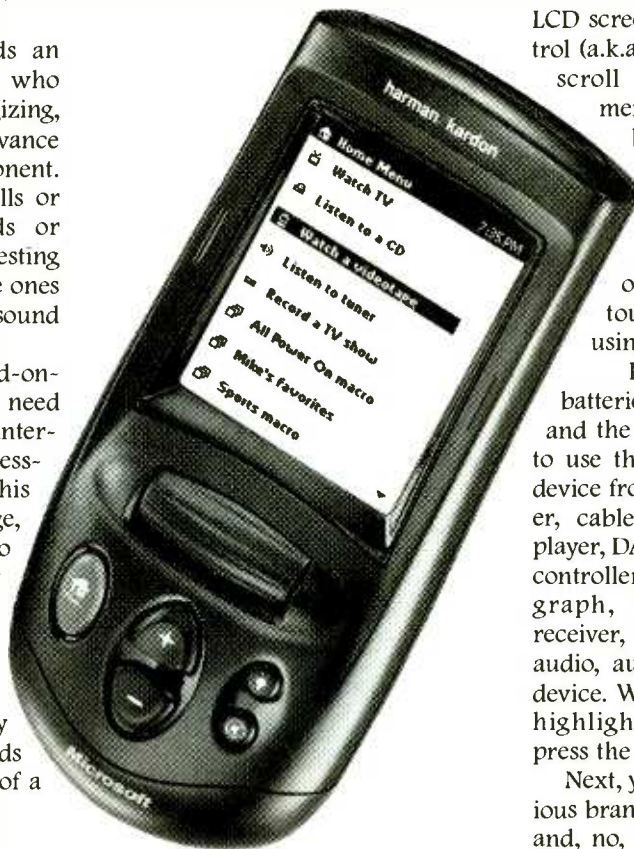
Kids—particularly this raised-on-Nintendo generation—often do need sound effects to capture their interest. If Ivan can get them to a chessboard, and if they perceive his nasty comments as a challenge, they just might make the effort to learn how to play. And if they find that they enjoy logical thinking and strategizing, they just might come to enjoy the game for its own merits ... and maybe they'll learn to enjoy playing chess against their friends (or even their parents?) instead of a computerized tyrant.

REMOTE POSSIBILITIES

If you had a choice of upgrading your A/V equipment with a universal remote control or an entry-level DVD player, would you think twice before plunking down your \$350 on the DVD deck? We'd have been right behind you on the DVD line—that is, until we looked at Harman/Kardon's TC1000 Take Control.

Due to our line of work, our home-entertainment center is home to an ever-changing array of gear, some of it run-of-the-mill, but also

quite a few unusual items. We've never found a universal remote control that could handle our assortment of electronics, let alone one that could be easily updated to accommodate the addition and/or deletion of various components. We've learned from necessity to juggle several different clickers at once, and our coffee table is buried under what seems like dozens of them.



Granted, our situation is a bit drastic. But many people live with an abundance of remotes (for TV, VCR, cable box, DSS, stereo, CD player, etc.), and have to search to find the one they need. Universal remotes are good up to a point, but few of them are truly universal (working with all of today's A/V equipment), and fewer still allow access to every product's sophisticated functions. They simply don't have the brains for it.

That's not the case with the Take Control, a remote with the power of a PC behind it. Developed jointly with Microsoft, the TC1000 can be con-

nected to your PC and taught to control your particular A/V setup. Actually, the TC1000 is pretty impressive even without any additional PC processing power, with built-in software that walks you through the setup process, and pre-programmed control codes for hundreds of audio and video devices.

Larger and heavier than your typical clicker, the Take Control's face is dominated by the (2-1/4 × 2-3/4-inch) LCD screen. Below it is a roller control (a.k.a. the selector wheel) used to scroll through the on-screen menus and a grand total of five buttons. There's a big, gray MENU/HOME button, volume up and down keys, a MUTE button, and one to activate the backlight. All other functions are chosen by touching the screen and/or using the selector wheel.

Install the four included AA batteries, press the MENU button, and the Setup Wizard prompts you to use the roller control to select a device from its extensive list: amplifier, cable box, cassette player, CD player, DAT player, DVD player, home controller, laserdisc player, phonograph, receiver/tuner, satellite receiver, TV, VCR, WebTV, auxiliary audio, auxiliary video, and unlisted device. When the device you want is highlighted, touch the screen or press the roller to select that device.

Next, you'll be presented with various brand names. Pick the right one, and, no, the Take Control won't list each and every model number. There is still a bit of trial and error involved in the setup.

In our case, the TC1000 found three possible matches for our Zenith TV. To find the best match, we were instructed to press an onscreen power button, and then asked if the TV had powered up. When we answered with a press of the no button, Take Control tried the next pos-

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sible match. The third one finally operated our set. It took four tries to find the proper codes for our VCR.

When it came to the DVD player, Sharp was not listed as a brand name. In that case, we had to resort to “teaching” the Take Control to operate the player by lining it up head-to-head with the original remote and following the onscreen prompts to press certain buttons.

The setup process is relatively easy, especially when you consider how many devices the TC1000 can be programmed to control. Because the Setup Wizard serves as a manual, everything you need to know is right in front of your eyes. The combination of roller and touchscreen was simple to learn, and the initial process is fairly intuitive.

Select a device, and the touchscreen will display the controls for that piece of equipment. You’ll see channel-selection buttons for your TV, and play, pause, and rewind buttons for your VCR. A touch of your fingertip activates one of those buttons.

But we’ve barely scratched the surface of Take Control’s capabilities. The device introduces the concept of “activities”—events, such as watching a videotape or listening to a CD, that require the use of more than one piece of equipment. Take Control asks you what steps you take to watch a movie on your VCR (What display device do you use? What device is used to control the volume? What button is used to select the input?). By analyzing your answers, the remote control groups controls sensibly so that you can, for example, power up your TV and VCR from the same screen when you select Watch a Videotape as your activity. That’s more convenient than having to switch the remote between devices.

So far, everything we’ve described was done using the TC1000 without connecting it to a PC. Obviously, it operates as a full-function universal remote, complete with customized

macros, without a computer.

However, Take Control puts even more power into your hands when you use your PC to further customize the remote. A serial cable and software on CD-ROM are included with the remote. (Minimum PC requirements are a 486/25-MHz machine running Windows 95, 98, or NT, with 8MB RAM, 2MB free hard disk space, a CD-ROM drive, and an available serial port.) The software, called the Take Control Editor, installs automatically upon insertion into the CD-ROM drive.

Once the TC1000 is hooked up to the PC and the software is running, you can use the PC to add new activities (tape a movie from satellite) and further customize existing activities. You can also customize any button or menu command on the touchscreen, and even change the functions of the tactile buttons on the remote.

Finally, the Take Control Editor allows you to create macros. If you’re still turned off by having to push two “buttons” to watch a videotape (as required in the Activity mode), you can set up a macro to turn on the TV and VHS deck—and perhaps even your surround-sound receiver set to the proper input—with the press of a single button.

The more complex your home-theater setup, the longer it takes to program the Take Control. But its benefits also increase with the complexity of your setup. If, for instance, your TV is hooked up to your stereo amplifier and surround-sound speakers, and your video sources include VCR, laserdisc, DVD, cable, and satellite, each time you

want to watch something, you might have to turn on the TV, stereo, and the source; and use the TV remote to select the source; the stereo remote to adjust the volume; and the source remote to select a channel or begin playing disc or tape. With Take Control, you simply select an activity or a macro, and the remote does it all.

Of course, if your “home theater” setup consists of a TV and a VCR, we’d recommend upgrading the audio portion, then perhaps adding a satellite system and/or a DVD player. If money is tight, it certainly doesn’t make sense to spend \$350 on an accessory, no matter how neat.

However if your home-theater setup is an elaborate one that takes too much time and effort—and too many remote controls—to get up and running each night, and if half your family can’t figure it out, then Take Control would be a good investment. (Remember, if you can teach them to use and enjoy your system, it’ll be in their best interests to let you buy more stuff!)

TRAVELIN’ ON

What do you take along when you take to the road? We rarely leave home without a personal CD player and a few favorite discs. It makes a plane ride more pleasant and gives us something to listen to in hotels (which don’t necessarily come with clock radios these days). On business trips, we often must carry along a laptop PC as well.

One problem with a personal CD player is that it doesn’t allow you to share the music with anyone else. And one problem with a laptop PC is that its sound just can’t rival that of a desktop PC equipped with multimedia/surround speakers. (How quickly we get spoiled!)

Kodak provides a cleverly convenient way to maximize the sound of those portable devices wherever you might use them.

The *FlatOut Traveler* (\$69.95) is a portable flat-panel speaker system, complete with amplifier. Its carrying case is designed to hold the included



speakers, amp, cables, and power cord as well as your CD player and up to 10 discs. The entire system weighs just two pounds (without the CD player, that is). Zipped shut, and fully loaded, it measures just 9 × 9 × 3 inches—easy to fit into a briefcase or backpack.

The black carrying case opens like a book to reveal the rectangular amplifier, affixed to the “spine” with Velcro. The inside front and back “book covers” also have Velcro strips to hold the speakers securely in place while traveling. A hole in the front cover to the outside storage compartment allows the connection of a Walkman or CD player to the amplifier. A page-like insert to the right of the amp holds up to ten discs.

The amplifier has a volume control (which also serves as the power switch) on the front, a speaker input on each side, and an audio input on the left side. The audio signal can come from the “line out” of any CD player, A/V source, or sound card. The power adapter plugs into the top of the amplifier, and a battery compartment is found on its front. (It takes eight AA batteries.) Hookup is a simple matter of plugging in the speakers and audio source, and powering up.

You can use the speakers while they're secured in the carrying case, but they sound better standing separately. Each speaker has a crossbar base that allows it to stand upright on any flat surface. The best sound is achieved by allowing at least two inches of space behind the speakers.

The speakers themselves measure just shy of an inch deep, stand about 7-½ inches tall, and are about 6-¼ inches wide. A word of warning: Because the magnets in the flat-panel speakers are close to the outside wall of the frame, the speakers should not be placed close to any video monitor or magnetic storage devices. (Keep that in mind if you're thinking of using the FlatOut Traveler to tote a portable DVD player and discs!)

The FlatOut Traveler uses patented NXT flat-panel technology, in which “fine vibrations set up a spherical sound pattern engulfing the panel so that you can hear the same quality

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sound from any angle.” Speakers vibrate like a piano or guitar, dispersing sound throughout the body of the instrument. Each panel has two one-inch neodymium drivers bonded to it. Its frequency response is rated at 200 Hz to 17 kHz, amplifier power at 2 watts per channel, and the speakers are rated to deliver 80 dB. According to Kodel, because the openings in the back of the speaker's frame allow more energy to radiate, the “2-watt speakers have the equivalent power of a 5-watt cone speaker system.”

Well, you're not going to rock the house down with a 5-watt system, and you certainly won't do so with the FlatOut Traveler. In our small office, we could crank up the volume with no discomfort and with minimal distortion. Nor is there any worry about disturbing folks in nearby hotel rooms with thundering bass. There's

no bass boost (or bass or treble adjustments, for that matter); particularly for rock music and game-playing, the bass was insufficient.

But the FlatOut Traveler is not meant to replace your home stereo speakers or to deliver home-theater sound. What it sets out to do—provide a means of listening to a personal CD player or Walkman without headphones—it does adequately. Check into a hotel room with the FlatOut Traveler speaker system, and you won't have to rely on the clock radio for your music. Travel with a portable DVD player, for that matter, and you've got storage for the player and video discs, and a step-up sound system from that of the player itself or of the TV. Using your laptop for an out-of-town business presentation? The FlatOut Traveler can add room-filling audio to your show.

GIZMO NEWS

THE TIMES THEY ARE
A CHANGIN'...

... in the music industry, that is, with mergers galore. In the traditional music production/marketing arena, Seagram has acquired Polygram Records from Philips. When combined with Seagram's Universal Music Group, the new company will be the largest record company in the U.S.

Meanwhile, a truce could be imminent in the war between traditional record companies and those who are distributing music over the Internet. The problem, as usual, stems from copy protection issues. As technologies such as MP3, which compresses songs so that they can be easily transferred and downloaded with CD-quality sound, and devices such as Diamond Multimedia's Rio portable MP3 player, are proliferating, major record labels and some of the artists they represent are worried about piracy. Internet music sites, which are quickly gaining in popularity, accuse the mainstream music industry of trying to suppress new technology (and the competition it represents to traditional music distribution channels) with their talk of possible piracy.

Early in February, IBM and five major record companies announced a system to deliver music securely over the Internet. The five companies—Warner Music, Universal Music, EMI Music, Sony Music, and BMG Entertainment Group—want to protect the royalties due them and the artists each time a song is transmitted. The IBM system, which is said to deliver music in a pirate-proof “digital envelope,” will allow consumers to buy albums over the ‘Net and record them to CD at home, at prices not yet determined, but expected to be comparable to buying the disc at a record store.

The system is to be tested over a period of six months in 1000 households in San Diego, beginning this spring. The participating households are equipped with Time Warner's Road Runner high-speed cable

modems, which will allow a one-hour CD to be downloaded in less than 10 minutes; tests in homes with standard telephone modems will come later. More than 2000 albums and a variety of singles will be made available to test participants, who will be able to charge their purchases at an online store.

Among the players who will be carefully monitoring the test results are IBM's competitors in the music-security race. Those include AT&T, LiquidAudio, and RealNetworks.

WIRELESS INTERNET
SERVICE

Wireless communications giant Motorola announced a strategic alliance with Internet-equipment provider Cisco Systems, “to develop and construct a New World framework for wireless, Internet-based networks.” The goal of the alliance is to create a global network to provide businesses and consumers with high-speed, wireless Internet access to e-mail and faxes and to introduce an open Internet Protocol (IP) platform that would unite standards worldwide.

The two companies plan to pour more than \$1 billion dollars into the venture over the next five years and to open four joint research centers. They intend to develop a system to transmit voice, data, and video over existing cellular phone stations directly to wireless telephones, laptop computers, and other wireless products. The transmissions would use an Internet Protocol (IP) platform that is compatible with all wireless formats. The companies plan to adopt an “open” architecture that would unite data, voice, and video services over a single wireless network.

Motorola compares the move to Internet-based wireless networks to the transition from centralized mainframes to decentralized PC environments. The company envisions the introduction of new products to take advantage of the new wireless service, including some “convergence” products that could combine the

functions of pager, cell phone, and even computer, television, and radio.

“Cisco and Motorola are bringing a New World Internet framework to the wireless industry,” said Cisco executive vice president Don Listwin. “This extends the Internet to a world without wires, and represents the first major deployment of data, voice, and video services under an Internet-based cellular infrastructure.”

Bo Hedfors, senior vice president of Motorola and president of the Network Solutions Sector, added, “Our architectural breakthrough will create a new market and will radically change the industry as we know it today.”

That architecture is open to anyone who wants to be a developer, provider, or user of integrated data, voice, and video services over wireless networks. Potential applications include unified messaging, which would allow a cell-phone user to simultaneously send and receive voice mail, e-mail, and fax messages while talking on the same phone; extended virtual private networks that allow users to be virtually connected to their corporate intranets via a subscriber device such as a cellular phone; and wireless commerce through the use of embedded smart cards that will allow users to make real-time transactions.

The Motorola/Cisco project might turn out to be the largest wireless Internet service, but it's not the first or only joint effort. According to Roberta Wiggins, a wireless communications analyst for the Boston-based Yankee Group, we're seeing the start of a trend. “There are all these people with cell phones and all these people accessing the Internet, and at some point people are going to put these things together.”

AT&T already offers wireless service that includes access to the Internet and e-mail. Lucent Technologies recently acquired Ascend Communications, a provider of Internet equipment; and Canadian Northern Telecom Ltd., a major manufacturer of telecommunications equipment, bought a data-networking company called Bay Networks.



ATN Guardian Eye Security Camera

Protect your children, home, or office with this CCD video camera disguised as a clock/radio.

Do you ever wonder what's going on at home when you leave your child in someone else's care? Want to check up on whether anyone's been invading your office space after hours? Whatever your curiosity may be, you have a right to use electronic surveillance on your property.

So what should you do? Sure, you can put an overt camera in a corner mount and let everyone know an area's under supervision. But that only makes it easier for wrongdoers to avoid detection. Ask the experts and they'll agree—you need a covert, undetectable camera for true security. For finding out what goes on when no one thinks you're watching.

An Eye in Disguise. American Technologies Network (ATN) has come up with the perfect solution. Called the *Guardian Eye*, it's a high-resolution CCD (charge-coupled device) camera in one of two clever disguises. Our review unit came concealed within a working AM/FM alarm clock radio. You can also get the Eye in a smoke-detector form (which looks less conspicuous in certain rooms).

What really impressed us when connecting the camera to a TV was its wonderful resolution. Though a black-and-white unit (color versions are available, too), the camera provided 380 lines of resolution when viewed on a TV. This sharp imaging even works under very low lighting, as the camera operates with only 1 lux of illumination (a typical, lighted room has 100 to 300 lux).

The pinhole CCD camera in our unit outputs its signal through a cable terminating in a standard RCA plug. For most applications,



It may look like a normal alarm clockradio and function as one, but the Guardian Eye also contains a CCD camera that can help you "see" what's going on when you're not around.

this unobtrusive wire (it looks like part of the power cord) is adequate. Those who opt for the smoke-alarm version of the camera, or who have a difficult time running wires in certain areas, may want to invest in a 2.4-GHz wireless form (see pricing info later on).

Once set up, the Guardian Eye is difficult to hoodwink. With its focus-free, auto-exposure lens system, no activity in the room will go unnoticed. While not exactly a fish-eye camera, the Eye's 62-degree viewing angle does provide decent results. You'll just have to experiment to find the best placement—room corners are usually best.

Applications. Finding a use for a camera like the Guardian Eye doesn't take much imagination. Home owners can easily connect the camera to a VCR, set the latter to EP mode (providing 6-8 hours of recording, depending on the tape used), and go out for a night of fun. It's a great way to keep tabs on the babysitter or make sure your older kids don't get out of hand. You'll have a record of the entire night, should something occur.

Similar setups can be arranged in an office. Of course, since you're usually gone from work for a longer time

than you are from home, you might want to set a VCR to turn on and off periodically throughout the night (depending on how many programs it allows you to set). If something happens in your absence, there's a good chance you have the event, or part of it, on tape.

But what about prevention? Wouldn't it be great to be able to actually do something about an inappropriate event that your Guardian Eye's catching? The folks of ATN have come up with a terrific application that helps bring peace of mind to users with such concerns.

Though we didn't get one with our review package, a PC-connection kit is available. According to ATN, this lets you connect your camera to a computer at, say, your office, and monitor via the Internet what's going on in front of the camera. You can even set the security software to trigger when motion's detected. The software can then page you or send you notification through the Net, making it easy for you to take action before disaster strikes.

However you use it, the Guardian Eye is sure to please. Pinhole cameras have come a long way since the early days of grainy, pixelated images. With this new sharp lookout on your side, security takes on a whole new meaning.

The Guardian Eye retails for \$249 in a wired, black-and-white version (\$499 for wireless). A wired, color version is \$449 (\$699 wireless). A PC-connection kit is \$139. Contact American Technologies Network Corp., 20 S. Linden Ave., Unit #1B, South San Francisco, CA 94080; Tel. 800-353-2682; visit the company's Web site at www.atncorp.com; or circle 50 on the Free Information Card. ■

TELE-COMPUTER CONTROLLER

Build a circuit that lets you take your telecommunications to the next level by allowing you to remotely control home or office appliances and equipment through any touch-tone phone.

The telephone is one of the many devices that have become so ingrained in our daily lives that they can be considered indispensable. It is hard to imagine living without it (although there are many of us who would love to try). In fact, the telephone has outgrown its original function of connecting two persons in conversation. Today, the telephone line provides access to other services—such as the Internet, video conferencing, and telephone answering services—not even imagined just a few years ago.

But why stop there? The telephone line makes a viable avenue through which to remotely control home and office equipment and appliances. For example, imagine that while you are away from home, you are able to dial in and establish a remote link between your location and your home PC. Then once the link is established, you're able to input a couple of telephone key-strokes that tell the PC to turn on a microphone so that you can monitor your home. Other applications of such a system might be to set an alarm or turn a light, a heater, or an air-conditioner on/off before you get home. You could even use your portable cell-phone as a remote controller while you are on the premises!

With a PC and the simple circuit—dubbed the *Tele-Computer Controller*—described in this article, the telephone line can be used to

remotely control devices at home or in the office while you're away.

Phone Operation. At present, there are two dominant dialing formats used to initiate a telephone call—

MICHAEL CHAN



pulse dial and Dual Tone Multi-Frequency (DTMF), better known as touch tone. Pulse-dial telephones fall into two categories: rotary dial and pushbutton. Old-fashioned rotary and pulse-dial (pushbutton) telephones use an electromechanical scheme to initiate a call. In such phones, the contacts of an

electromechanical relay within the telephone base are closed and opened in accordance with maximum dial rotation (for rotary phones) or the key depressed (for pushbutton phones), generating a series of pulses that represent the number being dialed.

The pulses are transmitted to the telephone carrier's switching station, where the dialed pulses are decoded and used to alert the receiving station of an incoming call by activating a bell, buzzer, or other annunciator.

Modern telephone equipment, on the other hand, use DTMF signals to represent the dialed telephone number. In the DTMF format (which is now standard in the telecommunications industry), the telephone keypad is set up in a matrix configuration. Pressing a single key on the telephone keypad generates two distinct frequencies or tones, one modulating the other, that are transmitted to the central switching station as a single entity. At the switching station, the key-press information is extracted from the DTMF signal and used to establish a link between

the calling and receiving stations.

Regardless of the dialing format used in the telephone itself, system operation is governed by essentially the same DC voltages and AC signals.

In normal operation, the telephone company transmits an independent DC voltage to your sta-

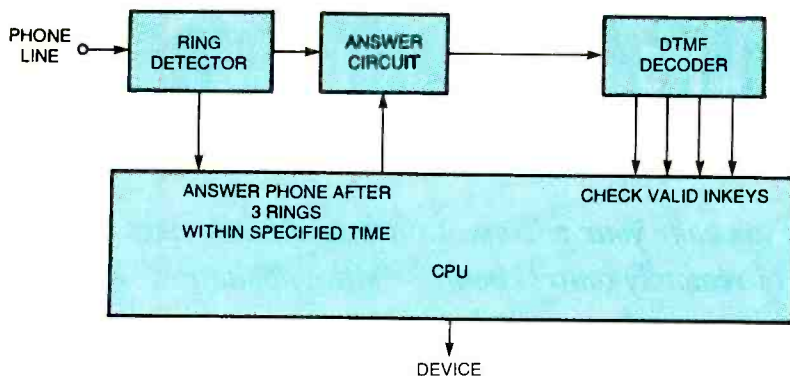


Fig. 1. As illustrated by this simple functional block diagram, the Tele-Computer Controller is connected between the telephone line and your PC, allowing the PC to monitor the telephone line.

tion. That voltage is used to operate the various telephone functions (dialing, conversation, etc.). Normally when the handset is on hook, the DC circuit is open. When someone dials your assigned

phone number, the central switching station transmits an AC ring-signal voltage to your location. The AC ring signal is applied to the telephone's signaling circuitry, causing an annunciator within the telephone base to activate. The telephone continues to signal as long as the call initiator remains on the line and the receiving station's handset remains on hook. When the telephone handset is taken off hook, the DC voltage from the central switching office is applied to circuitry within the phone base, causing the ring signal to be blocked and, thereby, permitting communication between the calling and receiving stations.

LISTING 1—BASIC PROGRAM FOR THE TELE-COMPUTER CONTROLLER

```

10 REM Telecomputer Controller
15 REM written by M. Chan
20 REM Printer Port Controlled:
   #11(B7^)-ring; #3(A1)-answer; #2
   (A0)-control
30 REM #10(B6)-ST Tone; #11(B3)-
   Q1; #13(B4)-Q2; #12(B5)-Q3.
31 REM keypad pass code is 1234;
   instruction code:5
35 DEFINT A-Z
36 DATA 8,16,24,32,40
38 OUT 890, 0
40 DIM code(5), inst(5)
41 FOR i = 1 TO 5
42 READ code(i)
43 inst(i) = 40
44 NEXT i
80 REM Hangup routine
90 OUT 888, 0
100 REM routine to check incoming
   rings
104 REM check ring signal
105 WAIT 889, 128, 128
110 tim = 0
120 dead = 0
128 REM check ring signal stops
130 WAIT 889, 128, 0
135 PRINT "pause between rings"
136 IF tim = 3 GOTO 200
140 WHILE (INP(889) >= 128)
150 dead = dead + 1
151 PRINT "between rings", dead
155 IF (dead > 8000) GOTO 100
160 WEND
180 tim = tim + 1
181 PRINT "no of rings :", tim
190 GOTO 120
200 REM answer after three rings
210 OUT 888, 2
211 PRINT "answer after three rings"
300 REM routine checking codes
302 FOR i = 1 TO 800
304 PRINT "not ready for code yet", i
306 NEXT i
310 FOR i = 1 TO 5
320 tim = 0
330 WHILE ((INP(889) AND 64) = 0)
340 tim = tim + 1
345 PRINT "waiting for code :", tim, i
350 IF tim > 8000 GOTO 80
360 WEND
362 FOR j = 1 TO 500
363 FOR k = 1 TO 100
364 NEXT k
366 NEXT j
370 decode = INP(889) AND 56
371 PRINT i, "decode :", decode
375 IF i = 5 GOTO 400
376 IF decode <> code(i) THEN
   PRINT "illegal code"
380 IF decode <> code(i) GOTO 80
382 FOR j = 1 TO 800
383 PRINT i, "decode", decode
385 NEXT j
390 NEXT i
400 REM routine to execute instructions
410 FOR i = 1 TO 3
420 IF decode = inst(i) GOTO 500
430 NEXT i
435 PRINT "invalid instruction hangs
   up"
440 GOTO 80
500 REM execution
510 OUT 888, 1
512 REM OUT 890, 255
520 PRINT "execution and hangs up"
530 STOP
540 END

```

A Little Background. As illustrated by the simple functional block diagram shown in Fig. 1, the operation of the Tele-Computer Controller is very straightforward. The Controller is connected between the telephone line and your PC, allowing the PC to monitor the status of the telephone line.

When a ringing signal is detected, the PC (operating through the Tele-Computer Controller) takes the phone off-hook and waits for the caller to input a series of keystrokes representing security codes and instructions. If the sequence of keystrokes matches preprogrammed security codes, the computer executes the instructions.

A Look At The Circuit. A complete schematic diagram of the Tele-Computer Controller is shown in Fig. 2. The circuit is comprised of a Darlington output optoisolator/coupler (IC1); an MT8870DE DTMF receiver (IC2); a pair of 2N3904 general-purpose NPN silicon transistor (Q1 and Q2); a DF02 1-amp, 50-PIV full-wave bridge rectifier (BR1); a couple of 1N4002 1-amp, 100-PIV rectifier diodes (D1 and D2); a 1N4733A 5.1-volt, 1-watt, Zener diode (D3); four light-emitting diodes (LED1-LED4), one of which (LED4) is a bi-color unit; and a handful of support components (resistors, capacitors, etc.).

At the heart of the circuit is Mitel's MT8870 dual-tone, modulated-frequency receiver, which decodes only DTMF-type tele-

phone digits; rotary-pulse-dialed digits are ignored. The DTMF-encoding standard defines up to 16 dual-tone combinations. The MT8870, which integrates a band-

PARTS LIST FOR THE TELE-COMPUTER CONTROLLER

SEMICONDUCTORS

- IC1—NTE3044, ECG3044, 4N31, or equivalent NPN Darlington output, optoisolator/coupler, integrated circuit
 IC2—MT8870DE DTMF receiver, integrated circuit
 Q1, Q2—2N3904 general-purpose NPN silicon transistor
 BR1—DF02 1-amp, 50-PIV, 6-pin DIP, full-wave bridge rectifier (Digi-Key Part DF02MD1 or equivalent)
 D1, D2—1N4002 1-amp, 100-PIV rectifier diode
 D3—1N4733A 5.1-volt, 1-watt, Zener diode
 LED1-LED3—Light-emitting diode
 LED4—Bi-color light-emitting diode
 MOV1—130-volt, 600-amp, metal-oxide varistor

RESISTORS

- (All fixed resistors are 1/4-watt, 1% units, unless otherwise noted.)
 R1—1500-ohm
 R2—10,000-ohm
 R3-R9, R13—2200-ohm
 R10—390,000-ohm
 R11—100,000-ohm
 R12—71,500-ohm
 R14-R16—1000-ohm

CAPACITORS

- C1-C3—0.47- μ F, Mylar
 C4—0.01- μ F, ceramic-disc
 C5, C6—0.001- μ F, ceramic-disc
 C7—2.2- μ F, 25-WVDC, electrolytic

ADDITIONAL PARTS AND MATERIALS

- XTAL1—3.5796-MHz color-burst crystal
 T1—T2104 600/600 isolation transformer (Microtran T2110 or equivalent)
 RY1, RY2—T83S11D212-05 (Electrosonic) or equivalent, 5-volt, 2-amp DPDT, 16-pin miniature DIP relay
 J1—PC-mount, right-angle, modular telephone jack
 J2—DB-25 female, PC-mount printer connector

Note: A complete kit of parts, including printed-circuit board and software, is available for \$57 at Web site: www.geocities.com/siliconvalley/foothills/1897/.

split filter and digital decoder, uses digital counting techniques to generate a 4-bit code (see Table 1) for each of the 16 possible DTMF tone-pairs (only 12 of which are used in standard DTMF phones).

In the standard DTMF telephone format, 12 keys are arranged in four rows and three columns; those in a given row or column have one tone in common. The MT8870 uses switch capacitor filtering to separate the low- and high-frequency tone groups.

Since our circuit uses only the

three least-significant bits of the register, the circuit can read keyed numbers from 1 up to 7. For example, if you press the 3 digit, a 697-Hz tone and a 1477-Hz tone are combined.

Seven frequencies are involved in standard DTMF generation, and they are separated into two groups. The row information is called the low group and has the frequencies that range from 697 Hz to 941 Hz. The column information is called the high group, and it covers frequencies from 1209 Hz to 1477

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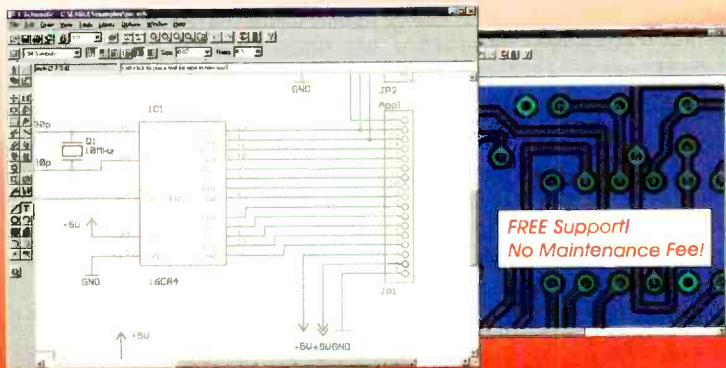
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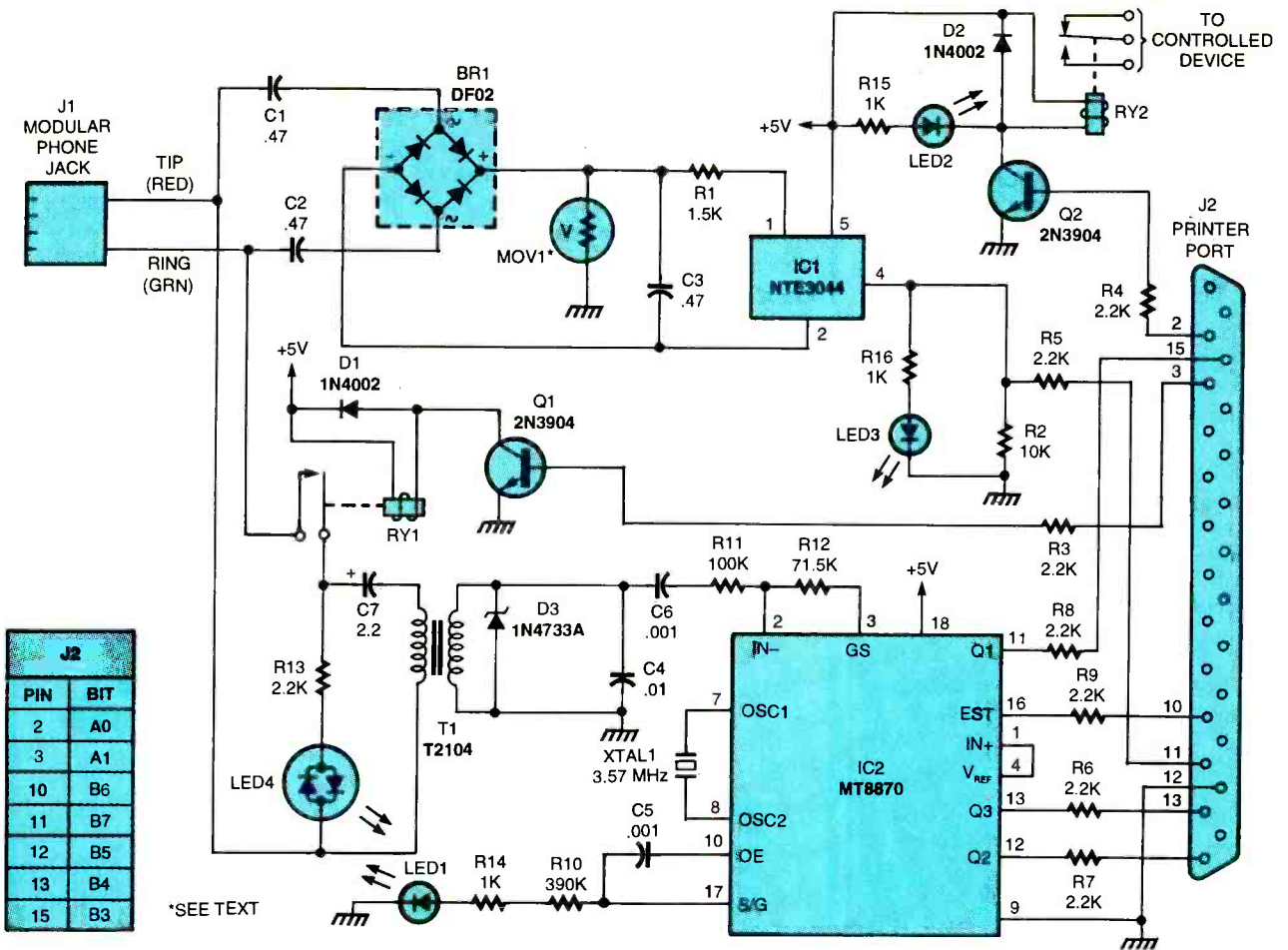


Fig. 2. The Tele-Computer Controller is comprised of a Darlington output optoisolator/coupler (IC1), a DTMF receiver (IC2), a pair of 2N3904 general-purpose transistors (Q1 and Q2), a DF02 full-wave bridge rectifier (BR1), a couple of 1N4002 rectifier diodes (D1 and D2), a 1N4733A Zener diode (D3), four light-emitting diodes (LED1-LED4), and a handful of support components (resistors, capacitors, etc.).

Hz. Table 1 also shows the layout of the DTMF tone pairs.

Incoming ring signals are applied to the circuit through J1, a modular telephone jack, and fed to BR1. The rectified ring signal is applied to IC1 (the optoisolator/coupler), causing its pin 4 output to go to +5 volts. That causes LED3 (the ring indicator) to turn on, while at the same time, the high output of IC1 is fed to pin 11 of J2 (the printer port). Upon receiving three consecutive rings within 15 seconds, the PC outputs a logic high at pin 3 of J2. That signal is applied to the base of Q1, causing it to turn on, providing a ground path through Q1 for the coil of relay RY1. That causes the normally open contacts of RY1 to close, connecting the decoder circuit to the telephone line, and causing LED4 to turn on; LED4 is used to simulate an off-hook

condition regardless of the phone-line polarities. From there the signal is applied to T1 (which is used to isolate the decoder circuitry from the phone line). The output of T1 is applied to pin 2 of IC2, causing pin 16 to go high. That, in turn, causes LED1 to turn on and the 3-bit DTMF code to be latched across the data-outputs (pins 11-13) of IC2 and applied to the PC.

Once the PC validates the data, it activates RY2 via Q2 as instructed. That also causes LED2 to turn on. The independent normally open and normally closed relay contacts, which are capable of handling 117 volts at 2 amps, could be used to control almost any electrical circuit. For example, the circuit could be used to control loads such as a lamp or a recorder by simply connecting the normally open contacts

of RY2 in series with the device to be controlled.

Power for the detector circuit (+5 volts) can be easily pirated from the PC by connecting the red and black wires from any unused 4-pin power-supply socket—the sockets are normally used to deliver operating power to peripheral devices.

The ratings and values of C1-C3 are critical to the operation of the detector circuit. Making their values too high could result in damaging high currents, while values that are too low could produce erratic operation.

PC Printer Port. The PC printer port offers 8-bit output, 4-bit output, and 5-bit input ports for interfacing peripherals' applications. The J2 table in Fig. 2 shows which printer

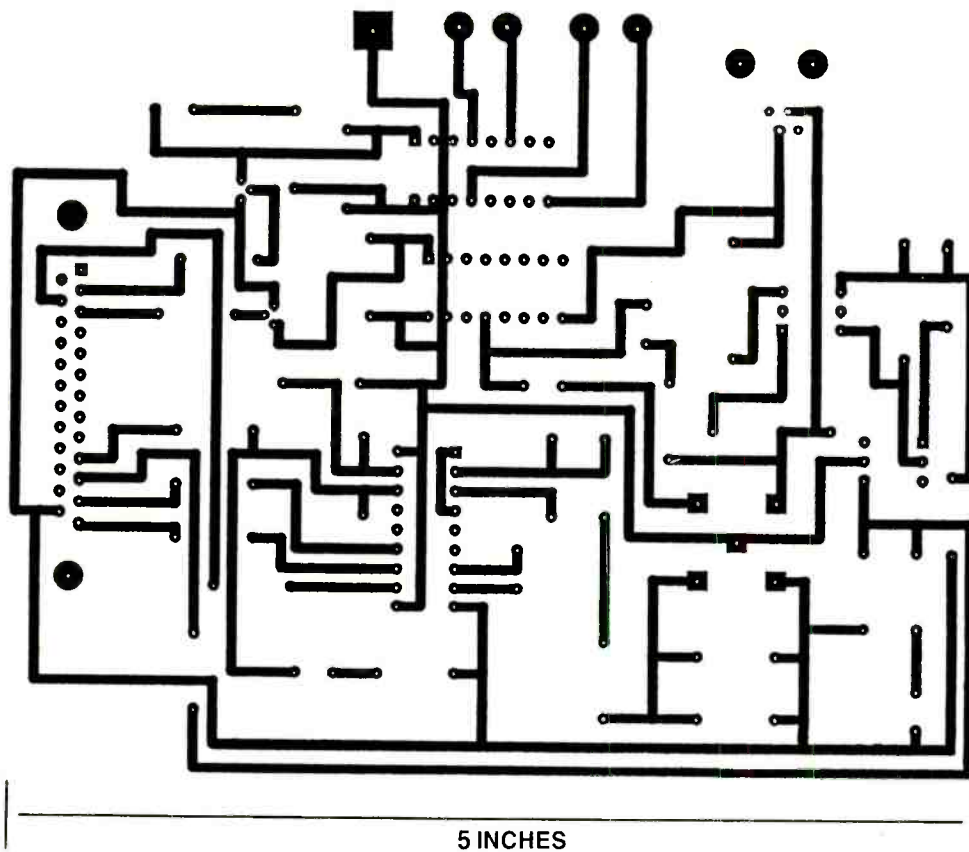


Fig. 3. The author's prototype of the Tele-Computer Controller was assembled on a printed-circuit board measuring $5\frac{1}{16} \times 4\frac{3}{16}$ inches, a full-size template of which is shown here.

port bits are used or connected to the controller's jack J2.

Two bits of the input port are used to monitor ringing and validate tone pairs. The other three input bits interpret the keyed-in number that's stored in the decoder's register. An output bit is required to place the circuit in the off-hook condition. For example, only one output bit is used to turn on a relay and its associated LED indicator. Theoretically, that leaves 10 controlling bits available for other applications.

About the Program. A simple program written in BASIC is required in order for the PC to properly interpret the instruction-data input from the telephone keypad. The program (you can type it in from Listing 1 or download the file named TELECOMPBAS from the Gernsback FPT site at ftp.gernsback.com/pub/PE/) starts with ringing-signal detection.

Ringing-signal detection involves

counting the number of rings (3) within a specified time (10–15 seconds) before it answers the phone. Once the phone line goes into the answer mode, the program monitors pin 17 of IC2 looking for a valid incoming DTMF signal (indicated by a high at pin 17). The contents of the decoder register is then read via the input port and compared with a stored 4-word code. If the two do not match or the adjacent key inputs are not done within 5–10 seconds, the phone is returned to the on-hook condition, awaiting another call.

If the keyed data matches, the PC activates RY2 via Q2 once the phone has been hung up.

Construction. Since the Tele-Computer Controller connects to the telephone line, there are a few things that must be understood before you begin building the circuit. First, it must be understood that **the voltages transmitted through the phone line can be hazardous.** The

ringing signal can go as high as 130 volts AC, while the DC operating voltage can range from 45 to 105 volts. Voltages of that magnitude can cause serious damage to your person (and in some extreme cases, death). Therefore, exercise extreme caution when building and/or connecting the project between your PC and the phone line.

Transients caused by inductive devices, lightning, or electrical faults can create hazardous voltages. Because of that, the phone line should be treated with the same respect as you would afford domestic AC lines.

The Tele-Computer Controller was assembled on a printed-circuit board measuring $5\frac{1}{16} \times 4\frac{3}{16}$ inches. A full-size template of the author's printed-circuit layout is shown in Fig. 3. That foil-pattern layout can be copied from the page and used to etch your own printed-circuit board. Or, if you prefer, the board is available as part of a complete kit of parts from the sup-

TABLE 1—FUNCTIONAL DECODE TABLE

f_{LOW} (Hz)	f_{HIGH} (Hz)	KEY (Ref.)	OE	Q4	Q3	Q2	Q1
697	1209	1	H	0	0	0	1
697	1336	2	H	0	0	1	0
697	1477	3	H	0	0	1	1
770	1209	4	H	0	1	0	0
770	1336	5	H	0	1	0	1
770	1477	6	H	0	1	1	0
852	1209	7	H	0	1	1	1
852	1336	8	H	1	0	0	0
852	1477	9	H	1	0	0	1
941	1336	0	H	1	0	1	0
941	1209	*	H	1	0	1	1
941	1477	#	H	1	1	0	0
697	1633	A	H	1	1	0	1
770	1633	B	H	1	1	1	0
852	1633	C	H	1	1	1	1
941	1633	D	H	0	0	0	0
ANY	ANY	ANY	L	Z	Z	Z	Z

L = logic low, H = logic high, Z = high impedance

plier listed in the Parts List.

In any event, once you've gathered all of the necessary components, construction can begin. Assemble the circuit guided by the parts-placement diagram shown in Fig. 4. It is highly recommended that IC1 and IC2 be socketed. Socketing the ICs helps to avoid possible thermal damage to IC1 and IC2 during soldering. Begin assembly by

mounting and soldering the IC sockets and passive components (resistors, capacitor, connectors, etc.) into position, making sure that the electrolytic capacitor (C7) is properly oriented. **Note:** A right-angle, PC mounted DB-25 connector is used to interface the Tele-Computer Controller's printed-circuit board to your PC, while the connection between the circuit

and the telephone line is accomplished through a right-angle PC-mounted modular telephone jack. Be careful when installing the relays; 16-pin, dual-in-line package (DIP) outlines were used at the relay positions. But not all of the pads in the DIP outline are required for the relay. So be, very, very careful when installing the relays.

Next, install the semiconductors, paying close attention to their proper orientation. Due to the layout of the board, the bridge rectifier (BR1) should be the one specified in the Parts List; otherwise, it might be necessary to slightly modify the board in order to get the circuit to function properly. Since the project makes use of the phone line, double-check your work for construction errors—short circuits, misoriented or misplaced components, and any other potential problem spot—and correct any of these deficiencies before proceeding.

Depending on the running speed of the PC, it may be necessary to adjust the time delay variables (TIM, J, and K loops) and/or introduce printing statements in the program to match the physical circuit operating rate.

It is recommended that if you own or have access to a cordless home phone, you modify the program and troubleshoot the Tele-Computer Controller off line. To accomplish that, simply connect the circuit directly to the phone base. The phone AC adapter will keep the phone in operation without the phone line. Simulate the phone ring signal to the module by momentarily sending printer port pin 11 high.

Conclusion. Telephones and computers have become ingrained into nearly every aspect of our daily lives. This project neatly introduces the basic concepts of combining the two technologies. In fact, we've only touched the tip of the iceberg. There are many areas where the melding of the two technologies may offer exciting career opportunities. Hopefully this is just the beginning of many projects making use of the telephone and PC for office and home applications. ■

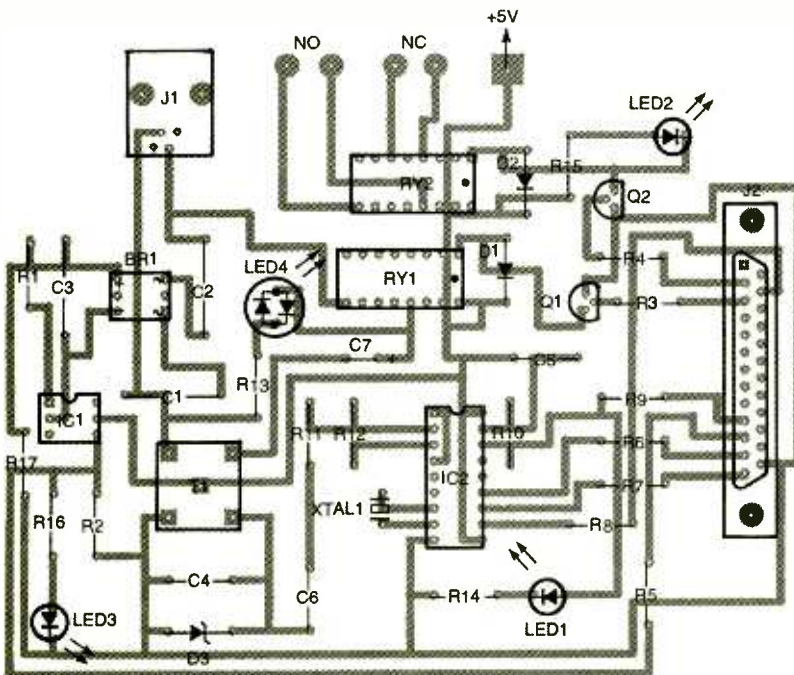


Fig. 4. Assemble the circuit guided by this parts-placement diagram. Begin by soldering sockets at the points where IC1 and IC2 are indicated. Socketing the ICs helps to avoid possible thermal damage to the chips during soldering.

Remote-Controlled Courtesy- Lamp Timer

Build a simple, yet useful electronic circuit, which allows you to remotely control an interior lamp or a porch light with the push of a button.



Since no one likes returning home to a totally dark house late at night, wouldn't it be a great convenience to be able to turn on a lamp in your living room before entering your home? Well, with the *Remote-Controlled Courtesy-Lamp Timer* described in this article, anyone can control a connected lamp from up to 60 or even 300 feet away using a tiny keying remote control. The project also has a local on/off switch, allowing the connected lamp to be controlled from within your home.

The Remote-Controlled Courtesy-Lamp Timer can be toggled on or off to activate and deactivate the lamp only as needed (for example, when entering or exiting your home), or the timer can be left on so that it automatically turns off the associated lamp after a delay of 4 1/2 minutes. The Remote-Controlled Courtesy-Lamp Timer, which has a single AC outlet for easy connection of the lamp that's to be controlled, simply plugs into any unswitched household AC outlet. The AC outlet allows the project to be used with almost any incandescent lamp of 150 watts or less—even an ordinary table lamp.

How It Works. A schematic diagram of the Remote-Controlled

Courtesy-Lamp Timer is shown in Fig. 1. Power for the circuit is derived from the 117-volt AC mains. The 117-volt AC power is applied to the Remote-Controlled Courtesy-Lamp Time via plug PL1. From there, it is fed to the primary of power transformer T1 (a 12.6-volt, 300-mA unit). The secondary of T1 is connected to BR1 (a 1-amp, 50-PIV full-wave bridge rectifier), which converts the 12.6 volts AC output of T1 into unregulated DC, with capacitor C1 acting as a filter to remove AC ripple. The unregulated DC voltage is then fed to IC1 (an LM7812 12-volt, 1-amp, fixed-voltage regulator), which provides a regulated +12-volt DC source that is used to power part of the project. The output of IC1 is also fed to IC2 (an LM78L05 5-volt, 100-mA, low-current, fixed-voltage regulator), which provides a stable +5-volt DC source to operate the remainder of the project.

Capacitors C2 and C3 are used as filters to further improve the stability of the power supply against transients and noise. The secondary of power transformer T1 is also connected to IC3 (a 4N26 optoisolator/coupler) through a current-limit-

ing resistor, R1. The optoisolator/coupler (IC3) allows the project to "borrow" the 60-Hz signal present in the household AC power and use it as a stable reference signal for timing purposes. That was done in order to produce reliable and repeatable time delays regardless of ambient temperature variations and component aging. The optoisolator/coupler contains an LED and an NPN phototransistor that are electrically isolated from each other.

When IC3's internal LED is forward-biased, it turns on. That causes the phototransistor to turn on, causing its collector lead to be pulled to ground. When the LED becomes reverse-biased (the applied voltage reverses), the LED turns off, causing the phototransistor to turn off, permitting its collector to be pulled high (to +5 volts) through resistor R2. Diode D1 is included in the circuit to prevent damage from occurring to the LED during negative half-cycles of the AC voltage. Since the AC voltage reverses at the rate of 60 Hz, a 60-Hz logic-level squarewave appears at

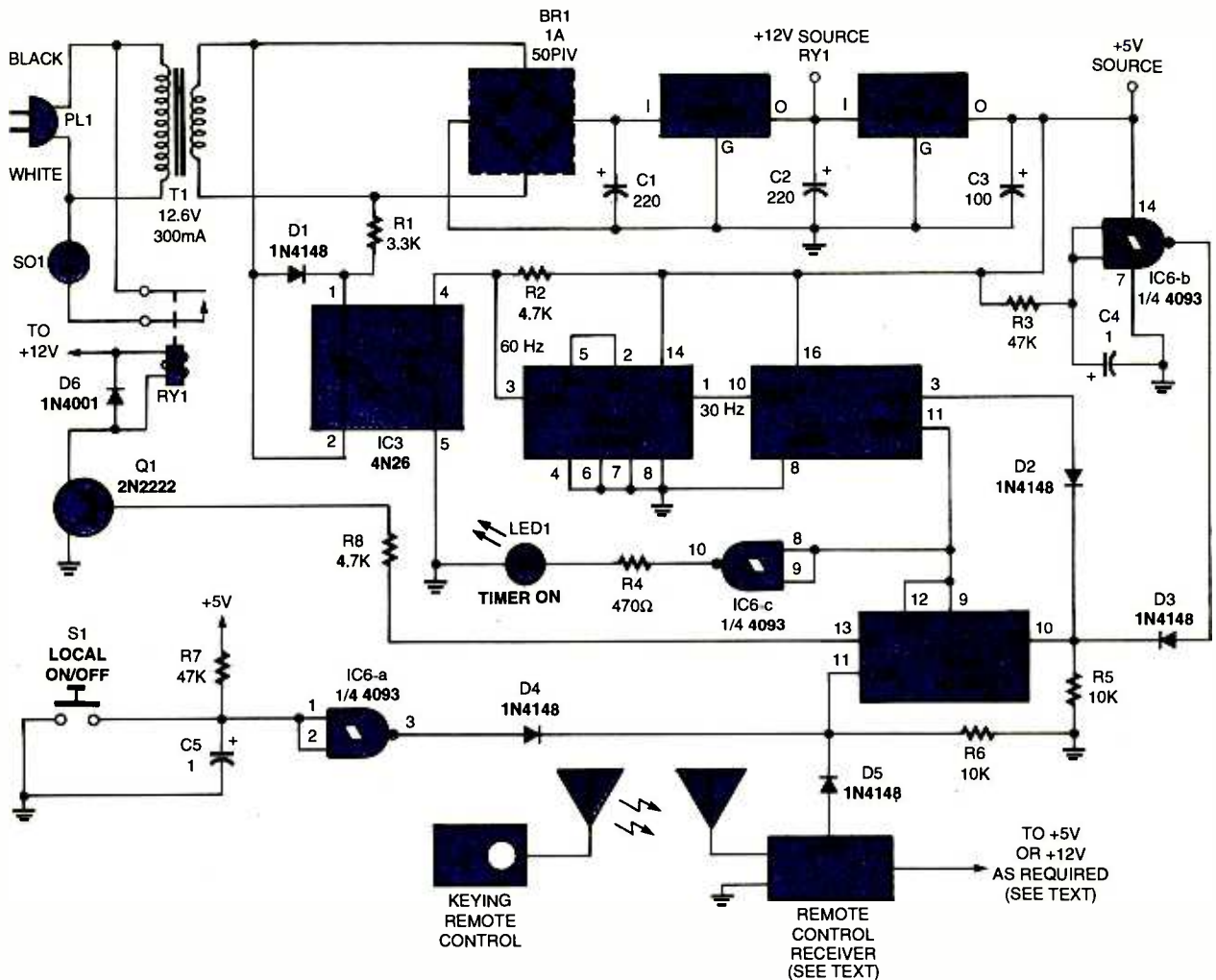


Fig. 1. The Remote-Controlled Courtesy-Lamp Timer is comprised of six ICs—IC1, an LM7812 fixed 12-volt regulator; IC2, an LM78L05 fixed 5-volt low-power regulator; IC3, a 4N26 optoisolator/coupler; IC4, a 4013 dual D-type flip-flop; IC5, a CD4020 14-stage binary ripple counter; and IC6, a CD4093 quad 2-input NAND Schmitt-trigger; BR1, a 1-amp, 50-PIV (or greater), full-wave bridge rectifier; 6 diodes—D1–D5, which are 1N4148 general-purpose small-signal, silicon diodes, and D6, a 1N4001 1-amp, 50-PIV silicon rectifier diode; Q1, a 2N2222 general-purpose NPN silicon transistor; and several support components.

pin 5 of IC3. That 60-Hz squarewave signal is fed to IC4-a (half of a 4013 dual D-type flip-flop), which divides the signal by two, thereby outputting a 30-Hz squarewave signal that is used as a clock signal to drive IC5 (a 4020 14-stage ripple counter). The ripple counter is responsible for the precise 4-1/2 minute time delays, and it is controlled by IC4-b (but more about IC4-b and IC5 shortly).

Resistor R7 and capacitor C5, along with IC6-a (1/4 of a 4093 quad two-input NAND Schmitt trigger), form a switch-debouncer circuit. When pushbutton switch S1 (LOCAL ON/OFF) is pressed, capacitor C5 is discharged

immediately, causing the output of IC6-a at pin 3 to go high (+5 volts), generating a trigger pulse. That pulse is coupled through diode D4 to the clock input of IC4-b at pin 11, causing its "Q" output at pin 13 to go high. That high is delivered to the base of transistor Q1, turning it on, which in turn activates relay RY1, applying 117 volts AC to socket SO1 and the connected lamp.

At the same time that the "Q" output of IC4-b goes high, the "Q" output at pin 12 goes low. That causes the "TIMER ON" indicator (LED1) to illuminate (via inverter IC6-c), and also removes the "reset" signal from IC5 at pin 11, allowing

IC5 to begin accumulating pulses from the 30-Hz clock. After 4 1/2 minutes of counting 30-Hz clock pulses, the pin 3 output of IC5 goes high. That high travels through diode D2 to the "RESET" input of IC4-b at pin 10, resetting the flip-flop. That causes the "Q" output of IC4-b to go low, turning transistor Q1 off, deactivating relay RY1, and removing AC power from socket SO1, which, in turn, extinguishes the connected lamp. At the same time that IC4-b's "Q" output goes low, its "Q-bar" output goes high, extinguishing the "TIMER ON" LED and resetting IC5 (and also inhibiting its operation). That causes the output of IC5 at pin 3 to go low

once again. Resistor R3 and capacitor C4, along with IC6-b, form a one-shot multivibrator that outputs a short high pulse at pin 4 of IC6-b once each time the project receives AC power.

The "power-on reset" signal is routed through diode D3 to the "RESET" input of IC4-b and ensures that the project will be in the stand-by state (lamp off) when power is applied. That prevents possible false-triggering due to AC power fluctuations or outages when power is restored.

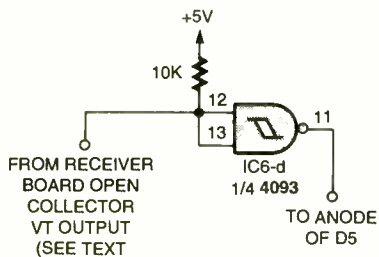


Fig. 2. The keying remote control and the matching receiver used in the author's prototype were salvaged from an unused car alarm. Regardless of the source of your transmitter/receiver set, make sure that the "vt" signal doesn't exceed 15 volts. For remote-control receiver boards that use an open-collector output for the "vt" signal, IC6-d can be connected as an inverter (as show here) to allow the timer to operate with that type of receiver board.

When the pushbutton switch on the keying remote has been pressed and the receiver board has verified the signal, a +5-volt valid transmission (vt) signal is output from the receiver board. The "vt" signal is routed through diode D5 to the clock input (pin 11) of IC4-b; thus activating the project in the same manner as if the "LOCAL ON/OFF" switch had been pressed.

The keying remote-control unit and the matching receiver board used in the author's prototype were salvaged from a car-alarm unit. But inexpensive, RF remote-control transmitter and receiver units are readily available with operating ranges of 60 to 300 feet. Additionally, many electronic companies offer suitable kits that can be used (see Parts List). Most of the RF remote-receiver boards currently available operate from +5 volts, but +12 volts is also available for those units requiring it. (Just make sure that the "vt" signal doesn't exceed +5 volts.)

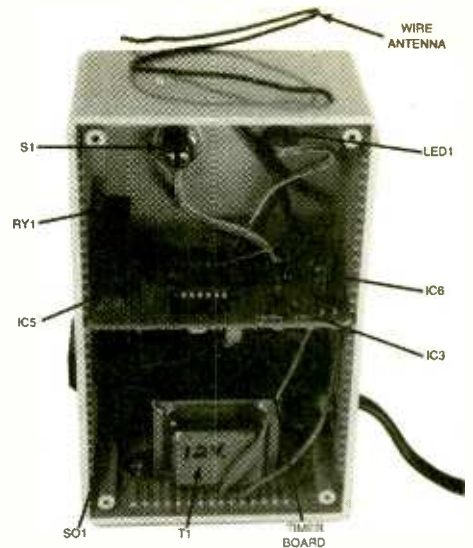
For remote-control receiver boards that contain an open-collector output lead (pulled to ground) for the "vt" signal, IC6-d can be connected as an inverter (see Fig. 2) to allow operation with that type of receiver board as well.

Construction. The author's prototype was assembled on a section of perfboard, using point-to-point wiring, and was housed in a plastic enclosure. Metal enclosures are not recommended as metal could reduce the operating range of the remote. The relay used in the project should have enclosed switch contacts rated at 2 amps or more at 250 volts AC. That allows the project to safely control an ordinary incandescent lamp of up to 150 watts.

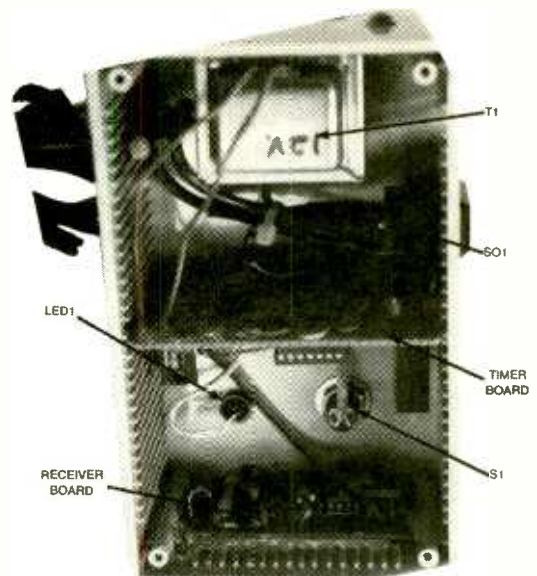
When assembling the Remote-Controlled Courtesy-Lamp Timer, it is recommended that sockets be used for the ICs. Socketing the ICs allows them to be easily removed from the circuit during troubleshooting or for replacement. Begin assembly of the circuit by mounting the sockets to the board, and then wiring the other components to the sockets, guided by the schematic diagram, as if the sockets were the actual ICs.

To improve electrical safety (and prevent possible overloads), a 2-amp fuse could be placed in the "hot" AC input lead before connection is made to the "moving contact" (wiper) of relay RY1 and the primary of transformer T1. Be sure to carefully insulate all the 117-volt AC connections with heatshrink tubing or electrical tape.

When the circuit board is complete, check for errors (misconnect-



The author's prototype of the Remote-Controlled Courtesy-Lamp Timer was housed in a plastic enclosure, measuring approximately 6 by 3 1/2 by 2 inches. The enclosure has more than enough room to accommodate the project's printed-circuit board, the remote-control receiver board, the power transformer, and the off-board components. Prepare the enclosure by drilling or cutting five holes in the enclosure for LED1, S1, SO1, and PL1 (a two-conductor AC line cord with molded plug).



Shown here is an open-cabinet view of the Remote-Controlled Courtesy-Lamp Timer. Note that the remote-control receiver board is mounted to one end of the enclosure and secured in place with a healthy amount of silicon cement.

ed or misoriented components, solder bridges, cold solder joints, etc.) before mounting it into an enclosure. When you are reasonably sure that the circuit is error free, move on

PARTS SOURCES

SOURCE

All Electronics Corp.
PO Box 567
Van Nuys, CA 91408-0567
800-826-5432 (orders)
www.allcorp.com

Electronic Goldmine
PO Box 5408
Scottsdale, AZ 85261
800-445-0697 (orders)
www.goldmine-elec.com

Jameco
1355 Shoreway Road
Belmont, CA 94002-4100
800-831-4242 (orders)
www.jameco.com

M.P.J.A.
PO Box 12685
Lake Park, FL 33403-0685
800-652-6733 (orders)
www.mpja.com

Visitect, Inc.
PO Box 14156
Fremont, CA 94539
Tel. 510-651-1425 (orders)

PARTS

Relays, enclosures, transformers

Relays, enclosures, transformers,
surplus RF remotes

Relays, transformers, enclosures,
RF remote control kits

Relays, enclosures,
transformers, panel mount
AC sockets, remote control kits

RF remote-control transmitters
& receivers (models with 60 & 300
feet range), #RF 60= keying
transmitter and matching receiver
board with up to 60-foot operating
range control kits

to the next phase.

In the author's prototype, the remote-control receiver board was connected to the timer board through three leads of a short length (approximately 3 to 5 inches) of multiconductor flat ribbon cable. Two additional pairs of ribbon cable

conductors were used to connect LED1 and S1 to the timer's circuit board. A pair of heavier wires (14 gauge or larger) were used to connect SO1 to the relay contacts.

As noted earlier, the Timer was housed in a plastic enclosure to improve electrical safety. The enclou-

sure selected by the author measures approximately 6 by 3 1/2 by 2 inches. The enclosure has more than enough room to accommodate the project's printed-circuit board, the remote-control receiver board, and the power transformer. Prepare the enclosure by drilling or cutting five holes in the enclosure for LED1, S1, SO1, and PL1 (a two-conductor AC line cord with molded plug).

Checkout and Use. Connect an ordinary table lamp to socket SO1, and flip the lamp's power switch to the ON position. Plug PL1 into any convenient electrical outlet. Press the project's LOCAL ON/OFF switch (S1). The relay should click on, the TIMER ON LED should illuminate, and the table lamp should also light. After about 4 1/2 minutes have passed, the relay contacts should open, extinguishing the "TIMER ON" LED and the table lamp. If the circuit is working properly up to this point, try pressing the button on the remote-control unit.

Once again the table lamp should come on. Note that once the project has been activated, either by pressing the LOCAL ON/OFF switch or with the remote-control unit, it can be turned off at any time before the 4 1/2-minute delay has elapsed by simply pressing either button a second time.

If the circuit performs as expected, seal the enclosure—your Lamp Timer is ready to use. ■

PARTS LIST FOR THE REMOTE-CONTROLLED COURTESY-LAMP TIMER

SEMICONDUCTORS

IC1—LM7812 (or similar) 12-volt, 1-amp. fixed, voltage regulator, integrated circuit
IC2—LM78L05 (or similar), 5-volt, 100-mA. low-power. fixed, voltage regulator, integrated circuit
IC3—4N26 (or similar), optoisolator/coupler, integrated circuit
IC4—CD4013 (or similar), dual D-type flip-flop, integrated circuit
IC5—CD4020 (or similar), 14-stage binary ripple counter, integrated circuit
IC6—CD4093 (or similar), quad 2-input NAND Schmitt-trigger, integrated circuit
Q1—2N2222 (or similar), general-purpose NPN silicon transistor

BR1—1-amp. 50-PIV (or greater), full-wave bridge rectifier
D1—D5—1N4148 (or similar) general-purpose, small-signal, silicon diode
D6—1N4001 (or similar) 1-amp, 50-PIV, silicon rectifier diode
LED1—Jumbo red light-emitting diode (T-1 3/4)

RESISTORS

(All resistors are 1/4 watt, 5% units)
R1—3300-ohm
R2, R8—4700-ohm
R3, R7—47,000-ohm
R4—470-ohm
R5, R6—10,000-ohm

CAPACITORS

C1, C2—220-μF, 25-WVDC, electrolytic

C3—100-μF, 16-WVDC, electrolytic
C4, C5—1-μF, 50-WVDC, electrolytic

ADDITIONAL PARTS AND MATERIALS

RY1—12-volt, SPST relay with 250-volt AC, 2-amp (or greater) contacts
PL1—Two-terminal, polarized AC plug
S1—SPST normally-open pushbutton switch
SO1—Two-terminal, polarized, panel-mount, AC socket
T1—12.6-volt, 300-mA, step-down, power transformer
Perfboard materials, RF remote-control transmitter/receiver pair (Visitect # RF60 or similar), plastic enclosure, IC sockets, LED bezel, wire, solder, etc.

UNIVERSAL SENSOR INTERFACE

Combining this interface circuit with your PC and a handful of sensors of various types allows you to keep track of nearly any parameter—ranging from moisture to light to temperature, among others—that you can imagine.

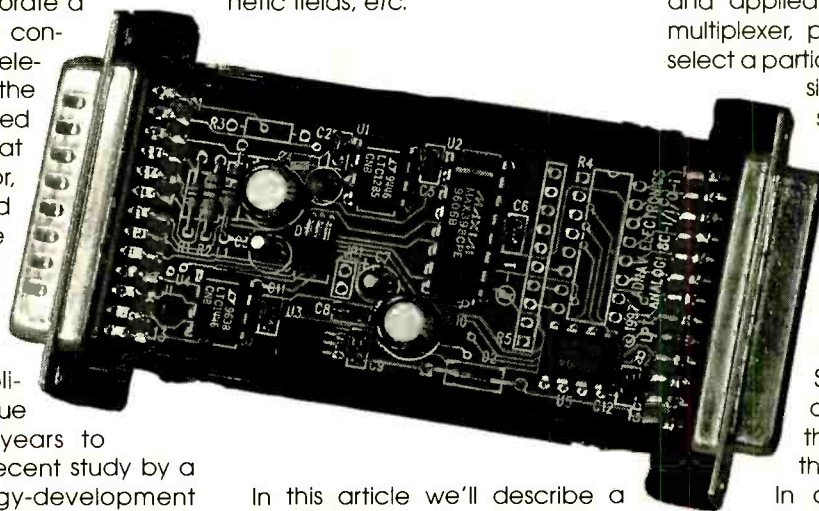
If you're like most of us, you probably still have a toaster that simply pops out the bread after a certain period of time has elapsed. Well, your next toaster may actually be a lot smarter than that. It will probably be able to defrost and toast your pastry to perfection every time, whether you put in frozen bagels, sliced white bread, or pop tarts. To accomplish its task, such a device would likely incorporate a microprocessor to control the heating elements based on the information received from sensors that monitor the color, temperature, and humidity of the pastry.

The trend of embedding sensors and intelligence into appliances will continue to grow in the years to come. In fact, a recent study by a major technology-development company demonstrated that the largest emerging markets for the next decade are likely to be based on affordable, highly specific, and very reliable sensors.

That trend has already resulted in the development of many self-contained sensors that incorporate all the necessary front-end electronics. Typically, sensors need only a power source to produce high-level output signals that are propor-

DAVID PRUTCHI, PH.D.

tional to the measured variable. As demonstrated by Table 1, there are many readily available sensors with onboard electronics already on the market that are designed to gauge various parameters, such as temperature, pressure, acceleration, gas concentrations, flow, magnetic fields, etc.



In this article we'll describe a device—the *Universal Sensor Interface*—that connects to your PC's printer port, enabling you to excite, control, and read inputs from a wide variety of sensors. The circuit, which is built around an eight-channel, 12-bit, analog-to-digital converter (ADC) with user-selectable input ranges and a dual 12-bit digital-to-analog converter (DAC), features two 100- μ A current sources for direct sensor excitation,

as well as an uncommitted current mirror and multiple digital I/O lines.

System Overview. A block diagram of the Universal Serial Interface is shown in Fig. 1. Note from that illustration that the Universal Sensor Interface can accept and read analog signals from up to eight sensors. The sensor-derived signals are fed through individual prescalers and applied to an eight-channel multiplexer, permitting the user to select a particular sensor-generated signal. The selected sensor signal is then sent to the ADC, where it is converted to a digital representation of the original analog input, and the resulting data is transmitted to your PC for viewing. The Universal Sensor Interface also offers analog outputs that are generated by the dual DAC.

In order to simplify the reading of resistive sensors, the Universal Sensor Interface contains a precision current-reference, which features two current sources and an uncommitted current mirror, that can be configured to provide constant-current excitation in the 100- to 400- μ A range.

Power for the ADC section is derived directly from the printer port. The DAC and current sources are powered from a +5-volt regula-

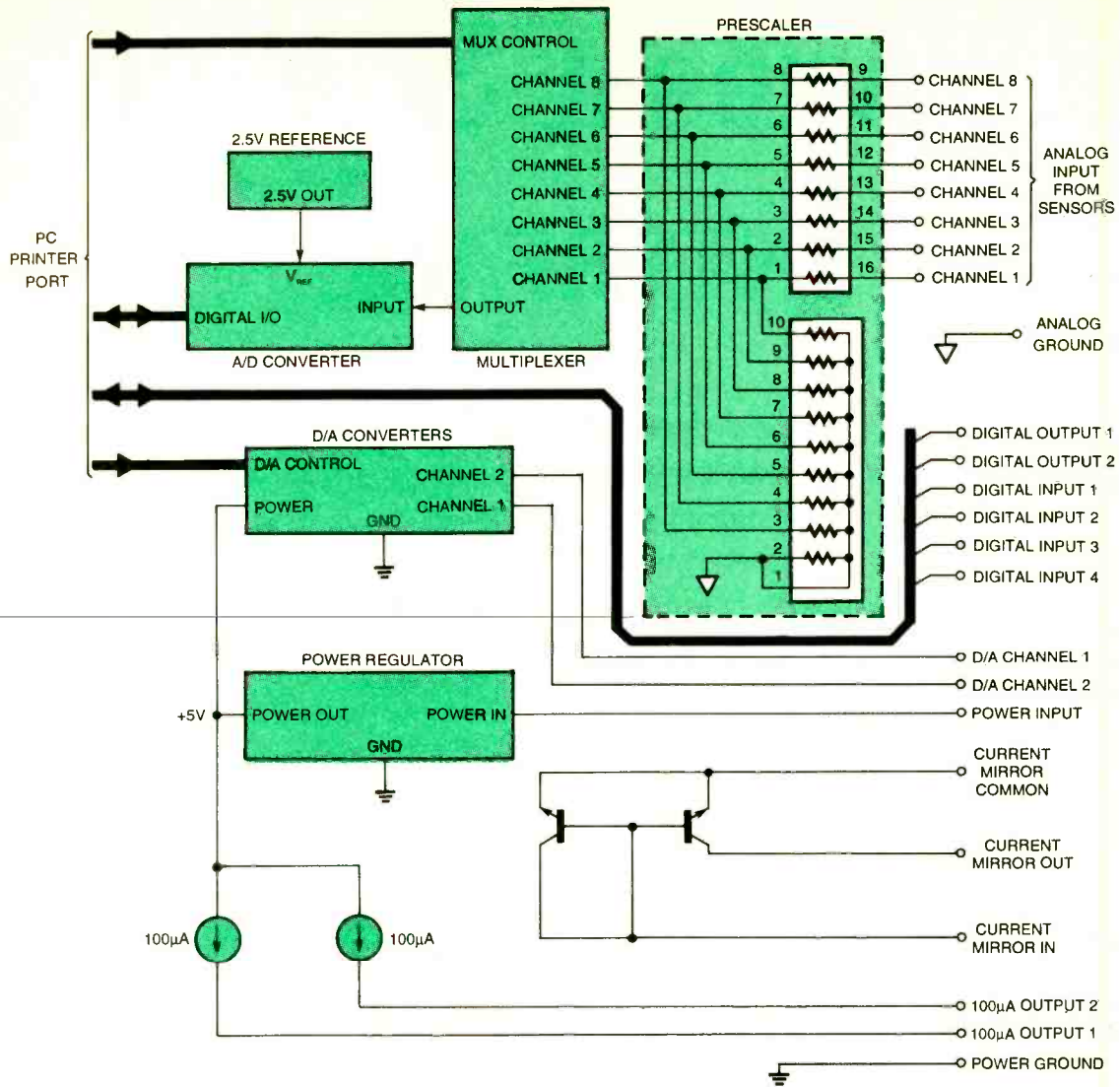


Fig. 1. Block diagram of the Universal Sensor Interface. This device features an eight-channel 12-bit ADC with user-selectable input ranges, a 12-bit dual-output DAC, two 100- μ A current sources for direct sensor excitation, as well as an uncommitted current mirror and multiple digital I/O lines.

tor that is fed from an external +9 to +12-volt source. The external power source is not required if the DAC section is not used.

Unused digital inputs and outputs (I/Os) of the printer port are available to the user as general-purpose I/O lines, which can be used to read switches, provide power to sensors with integrated electronics, or effect real-time control of devices based on information gathered from the sensors.

ADC Section. A schematic diagram of the Universal Serial Interface is shown in Fig. 2. At the heart of the circuit is an LTC1285 12-bit successive-approximation ADC (IC1), which contains a sample-and-

hold circuit and a high-speed three-wire serial interface. Data from the sensors is fed to the circuit via J2 (a DB-25 connector) and routed through R4 (a 10k DIP resistor) to IC2

(an analog multiplexer), which, under software control, routes the selected sensor signal to IC1, generating a digital representation of the analog input signal. (Table 2 gives

TABLE 1—TYPES OF SENSORS

SENSOR	MANUFACTURER	REPRESENTATIVE PART	EXCITATION	RANGE	OUTPUT
Temperature	Analog Devices	AD590	4 to 30VDC	-55 to +150°C	1 mA/°K
Acceleration	Analog Devices	ADXL05	5VDC	Selectable $\pm 1g$ or $\pm 5g$	Selectable 200 mV/g or 1V/g
Fluid Pressure	MSI	MPS3102	10 to 32VDC	0 to 1000 psi	4mV/psi
Barometric Pressure	Sensortech	144SC0811-BARO	7 to 24VDC	800 to 1100 mBar	16mV/mBar
Magnetic Field	Honeywell	IfMC2003	6 to 15VDC	± 2 Gauss	1V/Gauss
Gas Concentration (CO, combustible gases, etc.)	Capteur	Various with driver circuit	5VDC	Sensor dependent	0 to 5V range, sensor dependent
AC or DC current (no-contact)	Lem Heme	LTA50P	± 15 VDC	0 to 50A	100mV/A
Air/Gas Flow	Honeywell	AWM3300V	10VDC	0 to 1 l/min	4V/l/min
Humidity	Thermometrics	RHU-217	5VDC	30 to 90% RH	33mV/%RH

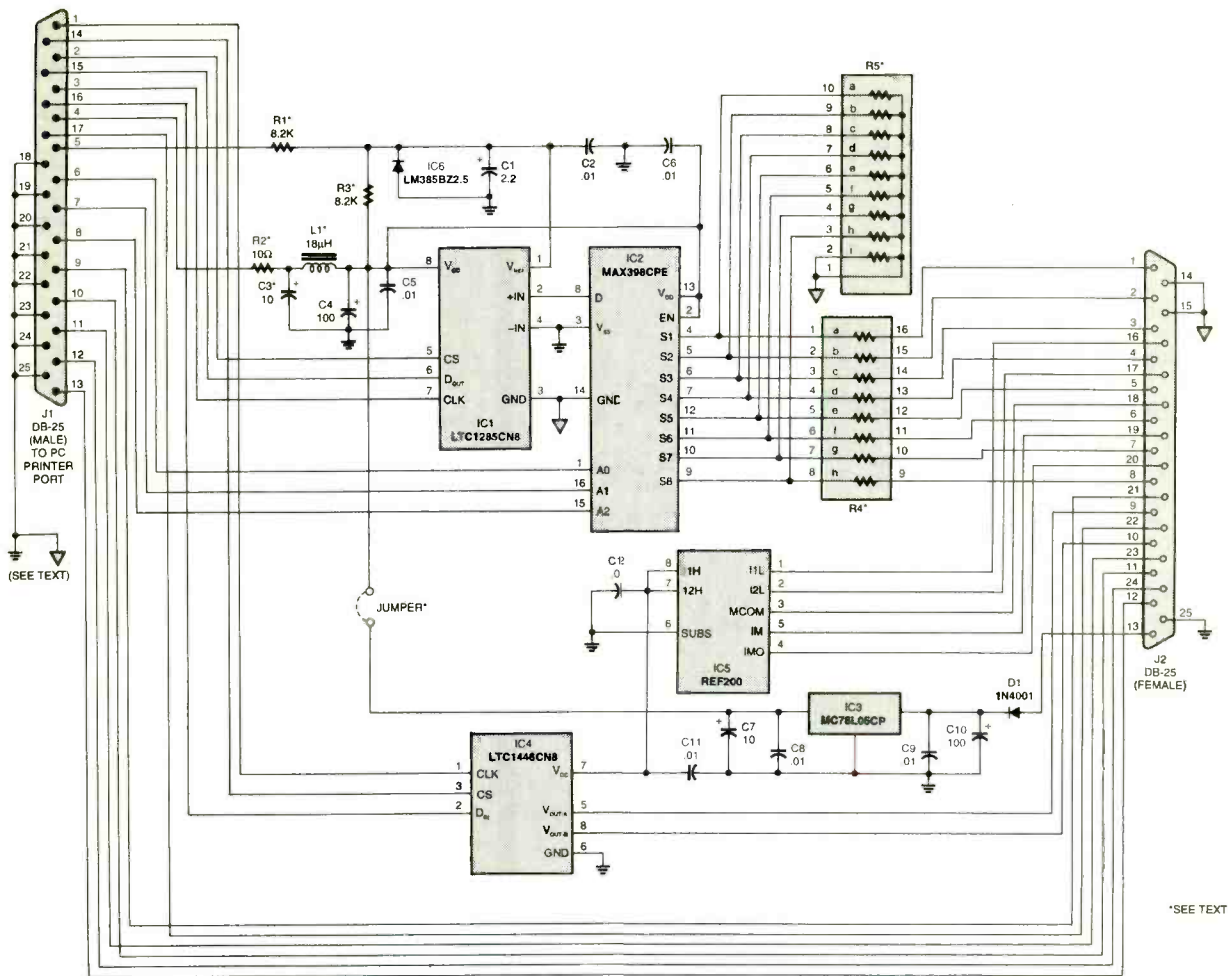


Fig. 2. Schematic diagram of the Universal Sensor Interface. The micropower components of the ADC section are supplied directly from the printer port. The DAC and current sources require an external power supply.

TABLE 2—J2 PIN-FUNCTION ASSIGNMENTS

PIN	FUNCTION
1	Analog Input 1
14	Signal Gnd
2	Analog Input 2
15	Signal Gnd
3	Analog Input 3
16	100-µA Out 1
4	Analog Input 4
17	100-µA Out 2
5	Analog Input 5
18	Current Mirror Common
6	Analog Input 6
19	Current Mirror Input
7	Analog Input 7
20	Current Mirror Output
8	Analog Input 8
21	Digital Output 1
9	Analog Output 1
22	Digital Output 2
10	Analog Output 2
23	Digital Input 1
11	Digital Input 2 + Interrupt
24	Digital Input 3
12	Digital Input 4
25	Ground
13	Battery

the pin-function assignments for J2.) Data-conversion and data-read operations are controlled through IC1's chip select (cs) and clock (clk) inputs at pins 5 and 7, respectively.

Analog-to-digital conversion is initiated on the falling-edge (see Fig. 3A) of the cs line. At that point, IC1's internal sample-and-hold circuits store the input voltage, and the successive-approximation process commences. After the third clock pulse, data is serially output at pin 6 (D_{OUT}) of IC1 on the falling-edge of the clock signal. The digitized signal is then routed through another DB-25 connector (J1) to your PC for display.

Since IC1 is a 12-bit unit, a minimum of 14 falling-edge pulses are required to shift the digitized signal to IC1's output lines. Bits 0 and 1 of the LPT 8-bit output port (hex address 378 for LPT1;) are toggled by software to implement the control portion of the ADC's serial pro-

col. Serial data from the ADC is applied to bit 0 of the printer-port's status register (hex address 379 for LPT1:). A 3-line parallel interface—using bits 4, 5, and 6 of the LPT 8-bit output port (hex address 378 for LPT1:)—controls analog multiplexer IC2, which is used to select one of the circuit's eight analog inputs for application to the ADC.

The ADC requires a reference voltage—generated by IC6 (a 2.5-volt precision reference)—that is fed to pin 1 (V_{REF}) of IC1. Power for the ADC, the 2.5-volt reference, and the multiplexer is supplied directly from the lines controlled by bits 2 and 3 of the parallel printer port.

Signal Conditioning. Input signals rarely conform to the Universal Sensor Interface's 0- to 2.5-volt range. Because of that, signals of less than full range waste resolution. On the other hand, signals greater

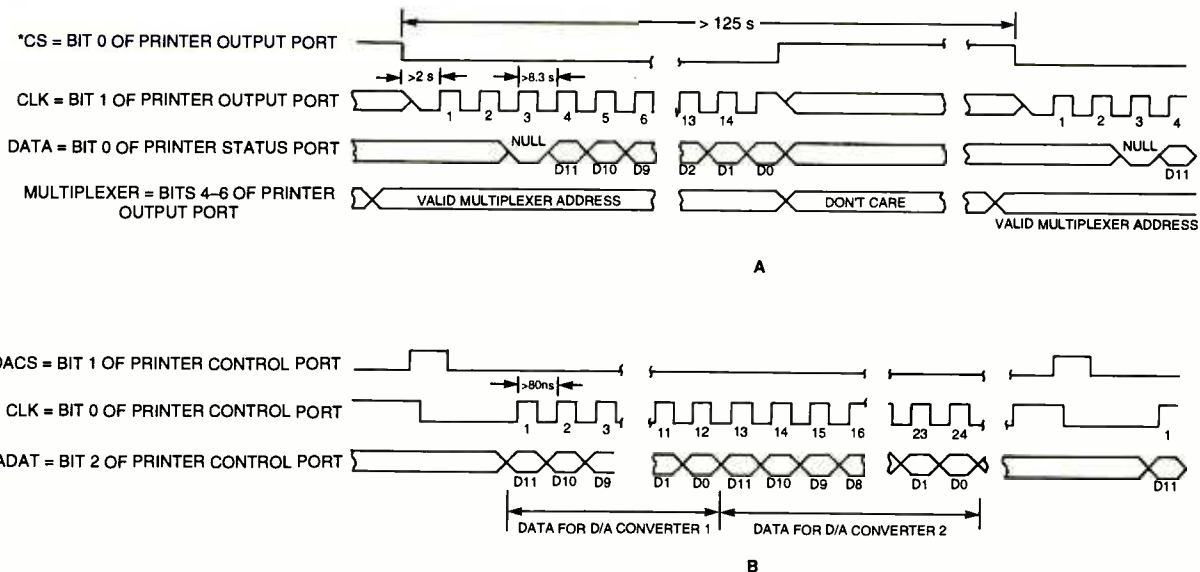


Fig. 3. Timing diagram for the serial protocols of the ADC and DAC of the Universal Sensor Interface. The Timing diagram for the ADC section is shown in A, while the protocol for the LTC1446 DAC is shown in B.

than the full-range voltage must be clipped to the prescribed limits, since any signal exceeding the 0- to 2.5-volt range can cause permanent damage to the interface. Measuring signals greater than 2.5 volts can easily be accomplished with the aid of a resistive voltage divider, like that in Fig. 4A, which can be used to scale large unipolar signals to the desired level. To that end, the Universal Sensor Interface contains a pair of integrated resistor packs: R4 (in a DIP-type package) and R5 (a bus resistor network in a SIP package). (Resistor pack, R4, can be replaced by individual, precision 1/4-watt units.)

Logging data from sensors mounted to a race car serves as a good example of how the values of R4 and R5 are selected. Table 3 gives typical output-voltage ranges for the sensors used to monitor a fuel-injected engine. Note that the sensor voltage should be 0 to 5 volts for channels 1-4; for channel 5, the sensor voltage should be 0 to 10 volts; and the voltage range of channels 6-8 should remain at 2.5 volts, assuming an impedance of 10k for all channels.

Figure 4B shows how a simple amplifier can be used to take advantage of the ADC's full resolution. Signals riding on a median other than the ADC's midpoint voltage (1.25 volts) can be offset using the circuit in Fig. 4C. Another way of

introducing offset is to place a 1.5-volt battery in series with the signal source.

Current measurements can be obtained using a suitable shunt, like

that shown in Fig. 4D. That circuit allows the output of the 4-20 mA current loop to be used to convey information from many industrial instruments and sensors to the Universal

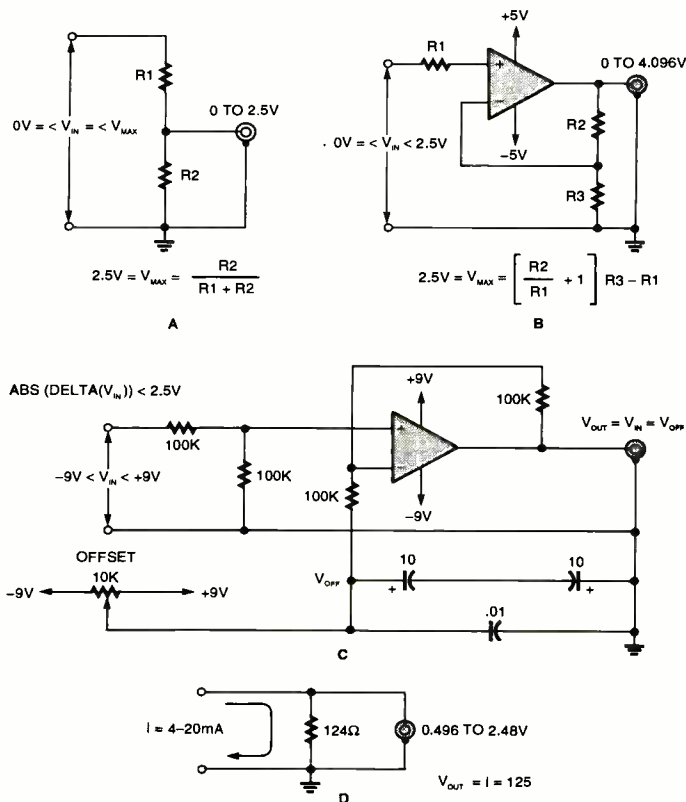


Fig. 4. Simple circuits can be used to scale different signals to fit within the 0 to 2.5-volt range of the Universal Sensor Interface. The circuit in A illustrates how large unipolar signals can be attenuated by a voltage divider; B shows how small unipolar signals can be amplified to make use of the ADC's full resolution; C demonstrates how bipolar signals can be converted into unipolar signals by introducing offset; and D outlines how 4-20 mA current-loop signals can be read through a resistive shunt.

TABLE 3—FUEL-INJECTED ENGINE MONITOR

ADC CHANNEL	SENSOR	OUTPUT RANGE
1	Throttle Position	0–5 V
2	Manifold Air Pressure	0–5 V
3	Engine Oil Pressure	0–5 V
4	Fuel Pressure	0–5 V
5	Engine RPM	0–10 V
6	Intake Oxygen Partial Pressure	0–1.2 V
7	Exhaust Oxygen Partial Pressure	0–1.2 V
8	Engine block temperature	0–2.5 V

Sensor Interface by placing 124-ohm, 1% metal-film resistors in shunt across the circuit's input terminals. Since 4–20 mA translates to a voltage of 0.496–2.48 volts, some measurement resolution is wasted. If full 12-bit resolution is desired, a 154-ohm, 1% resistor and an op-amp can be used instead to introduce a 0.616-volt offset to the measurement.

DAC Section. Analog outputs from the interface circuit are generated by an LTC1446 12-bit, dual-output DAC (IC4), which provides 1 mV per bit over the 0- to 4.096-volt range. There may be an offset error of up to 18 mV (less than 3 mV typical), with a non-linearity of ± 0.5 LSB maximum. The DAC outputs have a maximum current handling capa-

bility of 100 mA, and their maximum source impedance to ground is 120 ohms. In practice, the rail-to-rail buffered outputs can source or sink 5 mA when operating from a 5-volt supply, while pulling to within 300 mV of the positive supply voltage or ground. The outputs swing to within a few millivolts of either supply rail when unloaded and have an equivalent output resistance of 40 ohms when driving a load to the rails. The DAC can drive 1000 pF without going into oscillation.

Power for the DAC is provided by a +5-volt regulator (IC3) that is fed from an external power source. Whenever either the DACs or the current sources are needed, an external +9–12-volt supply must be provided. In some cases, powering the ADC section through an exter-

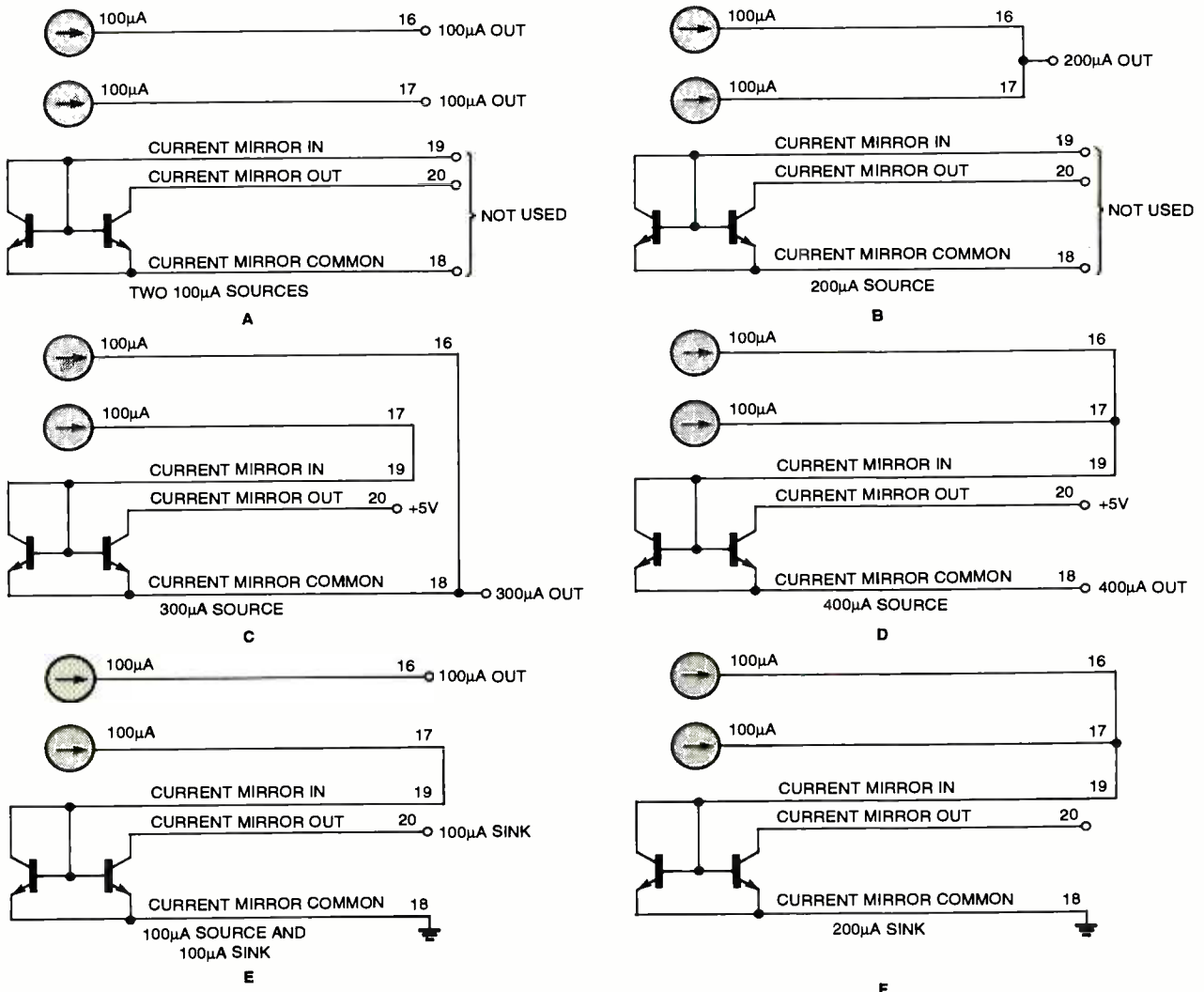


Fig. 5. The current sources and current mirror can be wired to obtain various configurations within the 100- to 400- μ A range.

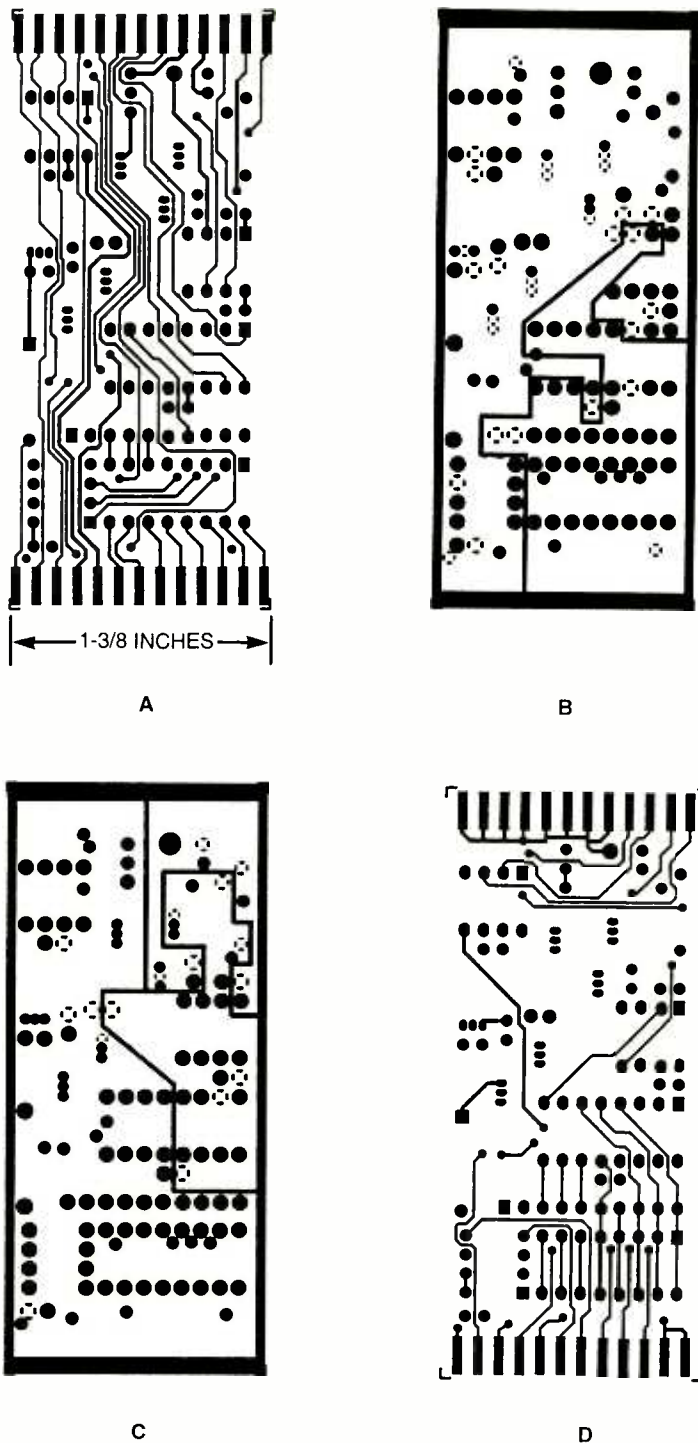


Fig. 6. The Universal Sensor Interface was built on a four-layer printed-circuit board. Full-scale templates for that multi-layer layout are shown here. The template in A is the component-side of the board, B and C are the embedded layers, and D is the solder-side of the board.

nal power supply may also be desirable. (To use an external supply for the ADC section of the circuit, omit R1, R2, C3, and L1 from the circuit; install R3; and place a jumper in the circuit. Those changes allow the ADC section of the Universal Sensor Interface to be powered from the

regulated +5-volt source provided by IC3.)

The DACs are controlled through a serial protocol that requires only three lines, bits 0–2 of the LPT control port (hex address 37A for LPT1:). As shown in Fig. 3B, data-conversion and data-write operations are con-

trolled through the DAC's chip select (cs) and serial clock (clk) signals, while data are transmitted to the DAC serially through the DAT line.

Data arriving at the DAT input are loaded into the DAC's internal shift register on the rising edge of the clk signal. Data are loaded in the dual DAC as a 24-bit word—the first 12 bits are fed to DAC 1 and the second 12 are fed to DAC 2. For each 12-bit segment, the MSB is loaded first. Data from the shift register are loaded into the DAC's register when the cs line is pulled high. The high on the cs line also disables the DAC's internal clock. Pin 7 (clk) of IC1 must go low before pin 5 (cs) is pulled low to avoid an extra internal clock pulse.

Current Sources. The Universal Sensor Interface uses an REF200 precision current reference to form a pair of 100- μ A current sources and an uncommitted current mirror. Constant-current sources are highly useful for the excitation of resistive sensors. Figure 5 shows various ways in which the current source outputs and the current mirror can be connected to form two 100- μ A sources (A), one 200- μ A source (B), one 300- μ A source (C), one 400- μ A source (D), one 100- μ A source and one 100- μ A sink (E), or one 200- μ A sink (F). The accuracy of those sources/sinks is typically better than $\pm 1\%$, and the voltage compliance is 3.6 volts.

Digital I/O. The digital I/Os available at J2 are direct pass-throughs of the unused lines of the printer port. The four digital input lines are acquired through bits 4, 5, 6, and 7 of the LPT status port (hex address 379 for LPT1:). Note that in the standard parallel port, bits 1–3 of the status byte do not convey line-state information. In addition, digital input 2 (bit 6 of the status port) can be used to drive interrupt-driven acquisition programs.

The two digital output lines are controlled through bit 3 of the LPT control port (hex address 37A for LPT1:) and bit 7 of the LPT output port (hex address 378 for LPT1:).

Construction. The Universal Sensor Interface was assembled on a four-

Times Are Tough...



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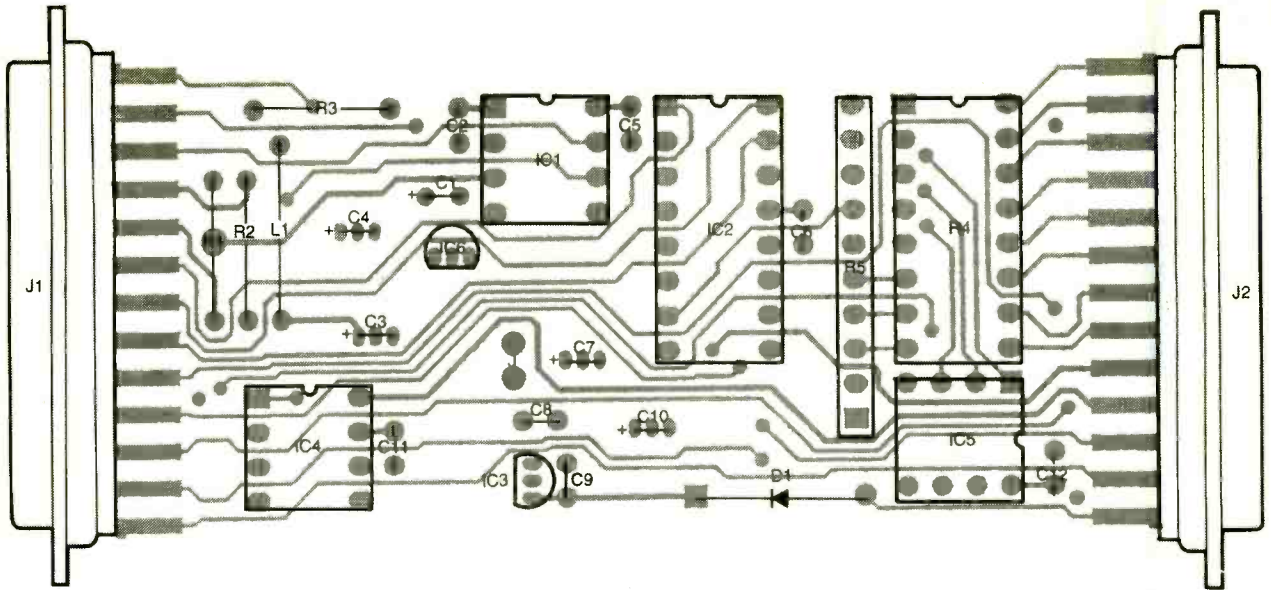


Fig. 7. Assemble the printed-circuit board guided by this parts-placement diagram. Be sure to pay close attention to the proper orientation of the polarized components (ICs and diodes, as well as the electrolytic and tantalum capacitors) when assembling the board.

layer printed-circuit board, measuring $3 \frac{1}{8} \times 1 \frac{3}{8}$ inches. Full-size templates of the interface's multi-layer printed-circuit pattern are shown in Fig. 6. The template in A is the component-side of the board, B and C are the embedded layers, and D is the solder-side of the board. Those foils can be copied from the page and used to etch your own board (assuming that you are familiar with

multi-layer, printed-circuit-board production). If you're not familiar with multi-layer, printed-circuit-board production or simply have no desire to involve yourself with the etching process, a complete kit of parts or the printed-circuit board only can be purchased from the source listed in the Parts List.

Once you've obtained all the parts, construction can begin. A

parts-placement diagram for the interface's printed-circuit board is shown in Fig. 7. Start by sliding the edges of the printed-circuit board in between the solder-cup terminals of the DB-25 connector until they are aligned with the printed-circuit board fingers of J1 and J2. After that, install the passive components (resistors, capacitors, etc.), followed by the semiconductors. Note that all of the components for this project are soldered directly to the circuit board. Because of that, it is extremely important when assembling the board that strict attention be paid to the proper orientation of the polarized components (ICs, diodes, as well as electrolytic and tantalum capacitors). In addition, remember to install only the components needed for the ADC power option selected.

Once you've completed the assembly, it is wise to verify that all components are placed correctly, and that soldering did not short adjoining traces. As an added precaution, be sure to thoroughly deflux the board after soldering. Flux deposits can short adjacent circuit-board traces, rendering the circuit inoperative. Deflux the board with a toothbrush under warm, running tap water or use flux remover, and air-dry thoroughly.

Use a sharp blade to cut the
(Continued on page 75)

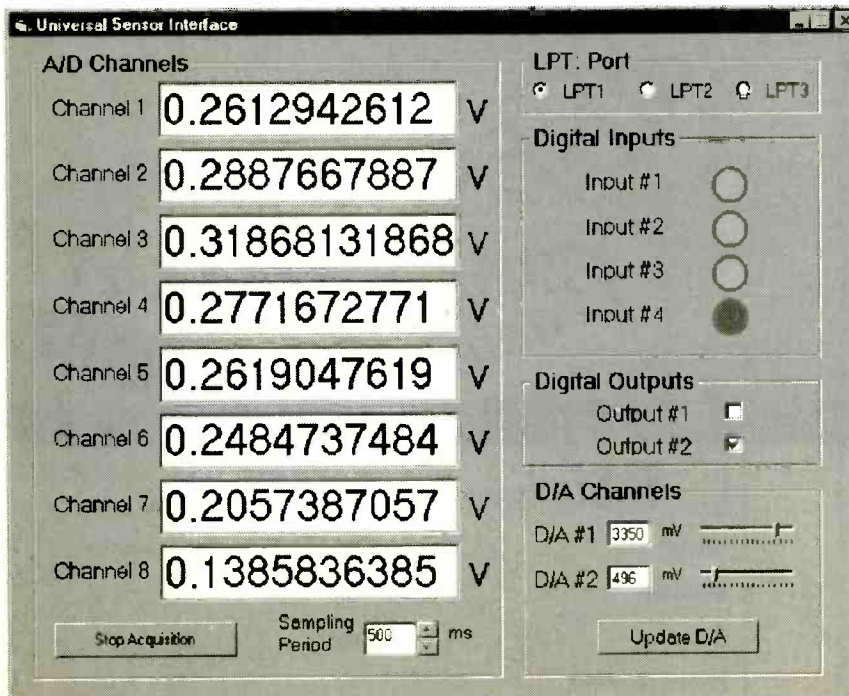


Fig. 8. Virtual instruments such as this 8-channel DVM based on the Universal Sensor Interface can be easily built using VisualBASIC.

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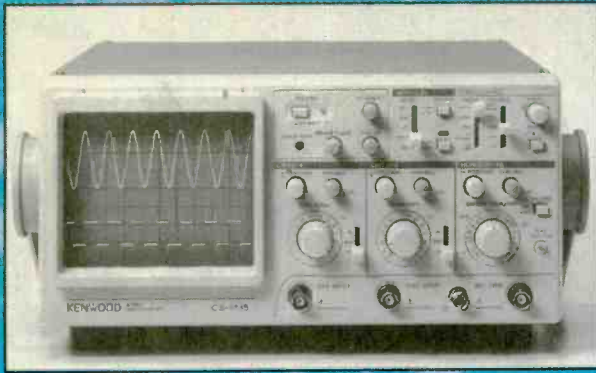
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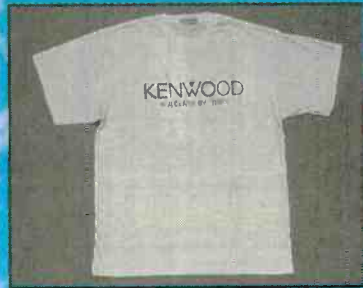
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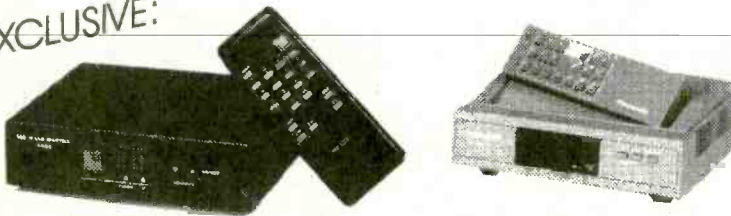
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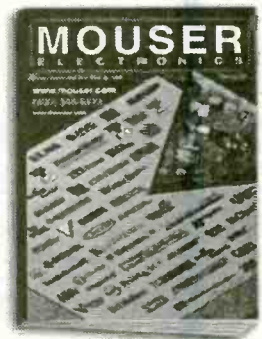
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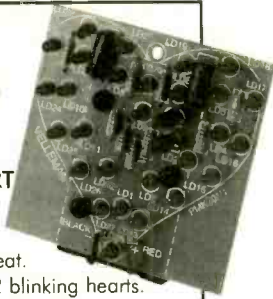
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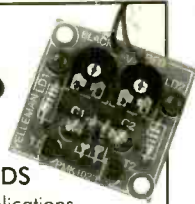


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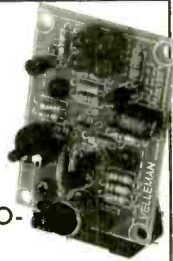


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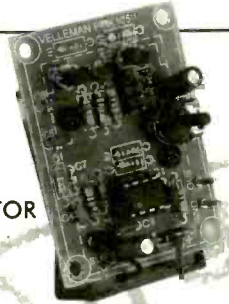


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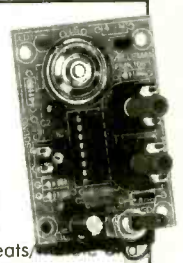


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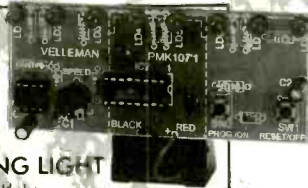


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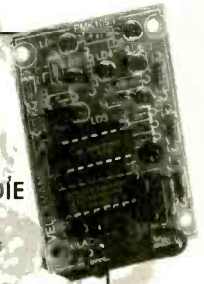


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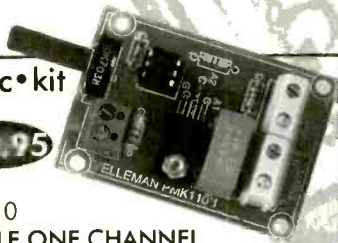


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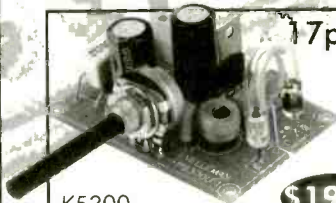


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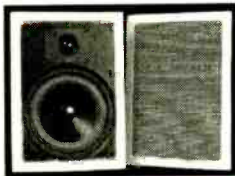
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341-426	1304-10	.10"	10'	2.95	2.70
341-440	1802-25F	.06"	25'	6.80	6.30
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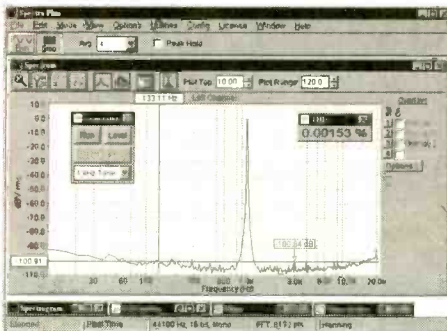
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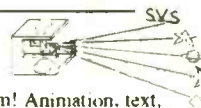
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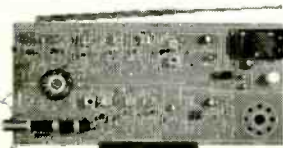


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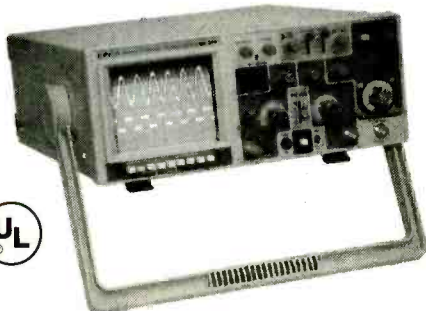


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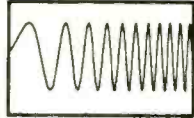
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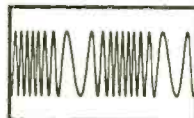
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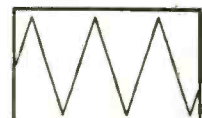
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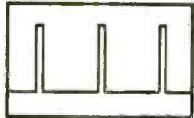
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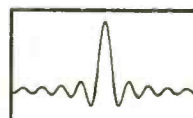
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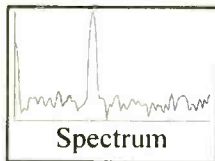
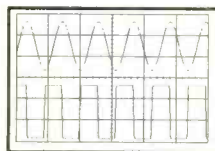
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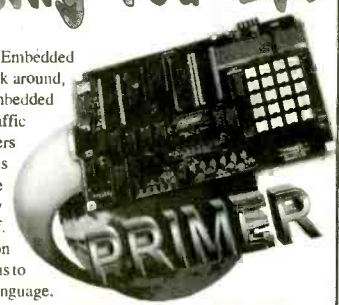
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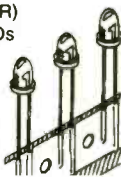


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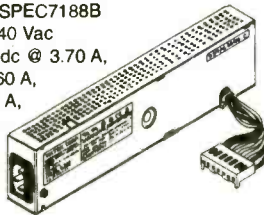
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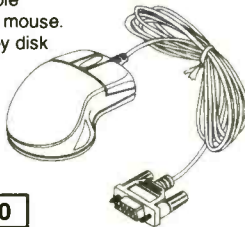
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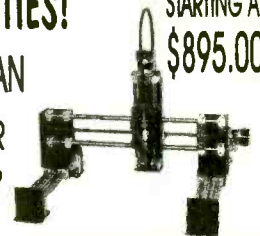
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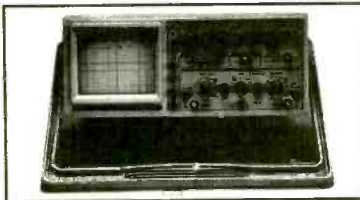
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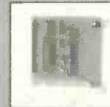
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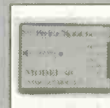
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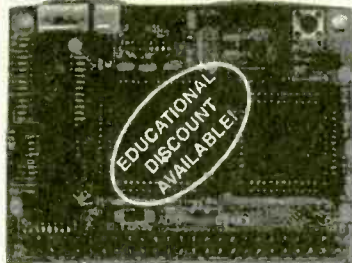
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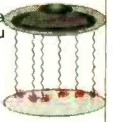
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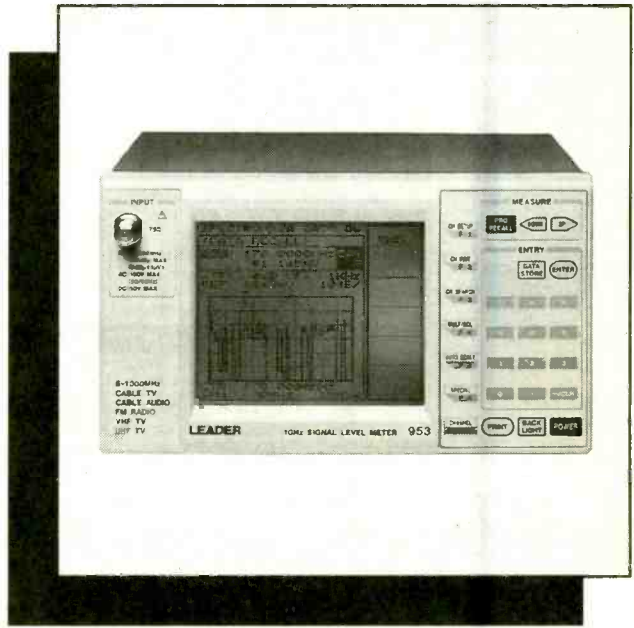
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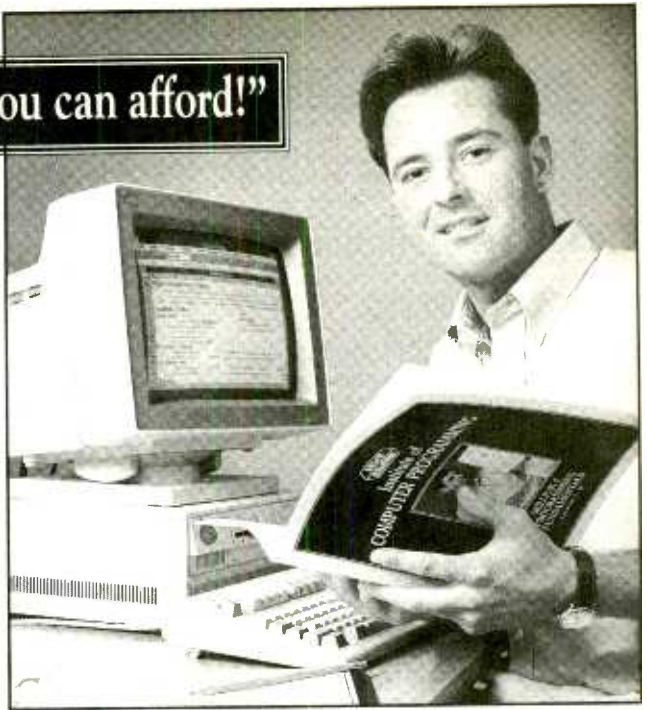
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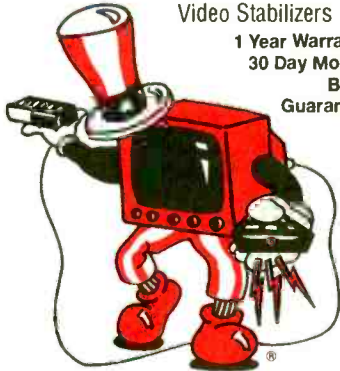
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DX LISTENING

In Enemy Hands

DON JENSEN

It was another war, pre-CNN. It was a time long ago, before we could get video direct from Baghdad of a captured American flyer only a day or two after he parachuted from his crippled plane into Iraqi hands.

In World War II, and during the Korean conflict soon after, months, sometimes years, passed before loved ones at home gained even an inkling of whether their missing-in-action GI had survived as a POW. And often, when there was good news, it was delivered by a shortwave listener.

Many listeners, men and women around the free world, tuned in to Axis SW broadcasts, which sometimes, for propaganda reasons, offered the names of prisoners held by the enemy. These volunteer SWLs listened regularly to "Axis Sally" with the hope of hearing her read POW names, ranks, and serial numbers, and sometimes hometown addresses and the names of family members. With these details, the listeners would send a postcard or letter to the families with the welcome good news that their loved ones were alive.

Thus was the case of Army Sgt. Frank Davis, a paratroop platoon leader, wounded and captured during the Battle of the Bulge. The military informed his family that he was missing in action, his fate unknown.

Then a few months later, early in 1945, listeners to Axis Sally's English-language propaganda broadcast from Berlin heard a report that Sgt. Davis survived as a prisoner of war. Thirty-eight SWLs in places like Patchogue, NY; Prairieton, IN; and Reading, PA independently sent cards and telegrams to the Davis family with the good news that meant the world to them.

There were untold numbers of similar cases.

(CREDITS: Brian Alexander, PA; Jerry Lineback, KS; Nikolai Pashkevich, Russia; David Ross, ONT; Ed Tilbury, AK; Dan Zielkowski, NY; North American SW Association, 45 Wildflower Road, Levittown, PA 19057; World DX Club, c/o Richard D'Angelo, 2216 Burkey Drive, Wyomissing, PA 19610.)



Impressionist art decorates the cover of a recent Radio Vlaanderen International program schedule.

Lt. Stewart Cooper, a B-17 bombardier was shot down over Germany in September 1943 and was badly injured. Two months later, a German doctor arranged for Cooper's name and hometown to be read on one of the propaganda broadcasts. It was picked up by Sanford Lowe in New York City, who sent a message to Cooper's mother in Cedar Grove, NJ, the first word she had that her son was alive. Cooper contacted Lowe after the war to thank him and learned that the SWL had sent 10,379 letters to families of POWs.

These wartime SWL activities have gone largely unheralded until, last year, former POW Davis, now living in Stanton, DE, began a one-man crusade to honor those whose humanitarian efforts brought so much joy to so many families.

A few years ago, Davis came across those 38 old cards and letters among his mother's personal effects and attempted to contact the writers. "It was the first time I laid eyes on them and it was amazing," Davis told author Thom Wilborn, who recounted the story in the pages of the Disabled

American Veteran's *DAV Magazine*.

Despite the passage of a half century, he got three replies, one from Irene Walters, an elderly New York woman who during the war years had monitored information and sent postcards to families of more than a thousand POWs. The other responses were from surviving relatives of other wartime SW monitors.

Mrs. Walters remembers the many appreciative letters she received at the time. One Texas father even donated several hundred dollars in her name to the American Red Cross.

Davis has asked for Congressional assistance to remember the efforts of all the wartime volunteer listeners. Delaware Sen. Joseph Biden has agreed that "it is important to 'save' this significant portion of World War II history."

Biden and his fellow Delaware Sen. William V. Roth Jr. have asked the DAV to help in documenting a "nation-wide sampling of these World War II 'Homefront Heroes'." Anyone with information about POW monitoring efforts may contact Davis at PO Box 6207, Stanton, DE 19804, or by fax at 302-994-0109.

AN HONOR ROLL

My own pre-teen shortwave listening began in 1947, too late to participate in such WWII SW monitoring, but soon enough after the war to have heard of and envied such exploits.

Perhaps the most celebrated of these listeners was the late Arthur Cushen of New Zealand, who died in 1997 at the age of 73. Arthur began his listening in 1935, and over the years became one of the most admired figures in the DX world.

During WWII, Art extensively monitored Allied prisoner-of-war messages broadcast by enemy stations, passing along this information to POW families. After a lifetime of deteriorating eyesight, he became blind in 1954, but continued both his listening hobby and civic activities to aid other visually

handicapped people.

In 1970, for his humanitarian efforts, including his wartime SW monitoring, Great Britain's Queen Elizabeth personally awarded him the M.B.E., Member of the Most Excellent Order of the British Empire.

I remember other then-well-known SWLs who also were active in monitoring POW information, Australians Graham Hutchins, Dorothy Sanderson and Rex Gillett, and a goodly number of Americans, now all deceased, including Ken Boord of West Virginia, Albert "Ab" Saylor of Virginia, Grady Ferguson of North Carolina, Charles Sutton of Ohio, and Californian August Balbi.

Mostly, though, I remember William N. Roemer of Bowling Green, KY, who befriended me when I was a young DX listener. Bill not only monitored many WWII messages, but continued his efforts during the Korean War when Radio Moscow, on occasion, aired names, information, and sometimes even recorded messages from American servicemen held prisoner in North Korea.

In 1951, he heard the message, broadcast by Moscow, of a captured American major to his wife back home in Wisconsin. Bill passed the word along to her, the first news she had that her husband was alive and well.

The major survived captivity and, when hostilities ended in Korea, he was released. But the Army filed court-martial charges against him, alleging bad conduct for voluntarily taping a message used for anti-American propaganda purposes.

It was Roemer, whose deposition was offered during the court martial, who provided evidence that the broadcast in question contained nothing disloyal but only a personal message to his wife. The major was cleared of the charge, and the incident helped change the military's code of conduct to better reflect the extreme psychological and physical duress American POWs face in captivity.

In 1954, the ex-POW, en route to Florida, turned up at Bill's front door.

"I just wanted to shake your hand," the officer said, meeting Roemer for the first time, "for what you did for my wife and me!"

BIG LITTLE STATION

Like its lowland neighbor, the Netherlands, little Belgium always has

ABBREVIATIONS

DX, DXer: Distant broadcasting stations; one who listens to such stations as a hobby.

kHz: kiloHertz, unit of frequency measurement.

SW: Shortwave, the frequencies from 3000 to 30,000 kHz.

SWL, SWLing: Shortwave listener; shortwave listening.

UTC: Universal Coordinated Time, a standard used by most international SW broadcasters and SWLs. It is equivalent to Eastern Daylight Time plus 4 hours, CDT plus 5 hours, MDT plus 6 hours, or PDT plus 7 hours.

had a shortwave voice far bigger than its size might dictate. For more than a half century, the Belgians have had a significant presence in the SW bands.

In the late 1940s, its station was known as ORU, the International Goodwill Station, a back-home successor to the WWII era SW outlet in the Belgian Congo. The powerful Africa station gave Belgium's exile government an international voice during the darkest days of Nazi occupation of the homeland.

Today the shortwave operation is called Radio Vlaanderen International (RVI), the world service of the Belgian Radio and Television (BRTN) network. Its mission is to be the cultural ambassador of the Flemish community.

Using 100- and 200-kilowatt SW transmitters near Wavre, plus leased-time relays from transmitters outside Belgium, RVI usually offers solid reception to listeners in North America. Programming is in six languages, Dutch, German, French, Spanish, Arabic, and English.

During the summer months, a good time to hear a transmission directly from Belgium is at 0730 UTC—frequencies to try are 7,290 and 9,940 kHz. The English language program begins with news and a review of the Belgian press. This is followed, Monday through Friday, by *Belgium Today*, focusing on a variety of subjects and, depending on the day of the week, *The Arts*, *Tourism*, *Focus on Europe*, *Living in Belgium*, *Green Society*, *Around Town*, *Economics*, and *International Report*. Weekend broadcasts include *Music from Flanders* on Saturday, and a listener response show, *PO Box 26*, on Sunday.

English programming is beamed to North America from a transmitter on the Dutch island of Bonaire, off the northern coast of South America. At this writing, I believe this transmission should be heard at 2130 UTC. Try a frequency of 13,670 kHz.

Radio Vlaanderen International responds to reports with a verification card. Letters may be sent to PO Box 26, B-1000 Brussels, Belgium.

DOWN THE DIAL

Here are some other shortwave goodies to tune for:

AZERBAIJAN—9,165 kHz, Voice of Azerbaijan in this independent country once part of the Soviet Union is reported on this somewhat out-of-the-way frequency with English programming from 1700 to 1730 UTC.

DOMINICAN REPUBLIC—4,960 kHz, Radio Cima has distinctive Dominican music around 0030 UTC, with lots of salsa and merengue. Announcements are in Spanish.

EQUATORIAL GUINEA—15,185 kHz, Radio Africa is noted with English-language recorded religious programs from before 2230 until 2255 UTC signoff.

MEXICO—4,800 kHz, XERTA is audible for you night-owl SWLs on this frequency during the late night period, 0500 past 0800 UTC, with lots of Mexican music and occasional Spanish-language identifications.

SARAWAK—4,895 kHz, RTV Malaysia, besides broadcasting from the mainland Asia Malay Peninsula, also operates a station at Kuching on the island of Borneo, a part of which also is Malaysian territory. Don't expect English programming, but you may find here about 1230 UTC.

SINGAPORE—15,360 kHz, British Broadcasting Corp. relay transmissions from this southeast Asian transmitter site are noted at 0230 UTC, with an English newscast.

SOUTH KOREA—9,570 kHz, Radio Korea International, Seoul, has English programming during the pre-0900 UTC hour, then switching to Korean. It identifies in English on the hour.

MOVING TIME

As part of the reorganization of PE and our sister magazine, this column will be moving to *Electronics Now*. Look for *DX Listening* in the July issue of *EN*. ■

Circuit Circus

Motor-Control Circuits

CHARLES D. RAKES

Hi Circuiteers, I'm really excited about the circuits that we're going to share with you this month and, hopefully, by the time we're finished with our discussion, you'll discover an application for at least one of the circuits presented.

This month we're going to introduce you to several DC-motor voltage-reversal circuits. There are many applications for motor-reversal circuits, such as robotics or almost any application in which it may be necessary to reverse the direction of rotation of a DC-operated motor.

The reversal circuits presented this month came about when a friend, who was having trouble with a complicated "H"-type DC-motor driver circuit, asked for an easier way to reverse the rotation of a low-power 12-volt DC motor.

MANUALLY OPERATED MOTOR-REVERSAL CIRCUIT

Our first circuit, take a gander at Fig. 1, is a manually operated motor-reversal circuit that uses four single-pole, single-throw (SPST) switches to control the polarity of the voltage applied to the

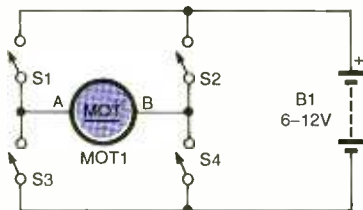


Fig. 1. The Manually Operated Motor-Reversal Circuit is comprised of four single-pole, single-throw (SPST) switches that are used to control the polarity of the voltage applied to the motor.

PARTS LIST FOR THE MANUALLY OPERATED MOTOR-REVERSAL CIRCUIT (FIG. 1)

S1—S4—SPST switch
MOT1—6- to 12-volt DC motor
B1—6- to 12-volt battery
Printed-circuit or perfboard materials, wire, solder, hardware, etc.

motor. Note that since all of the switches are open, the voltage across the motor is zero. Making point A positive and point B negative, by closing S1 and S4, causes the motor to rotate in one direction. By opening S1 and S4 and then closing S2 and S3, the voltage across the motor (points A and B) is reversed, which in turn reverses the motor's direction of rotation.

GROUNDING-INPUT MOTOR-REVERSAL CIRCUIT

Our next circuit, see Fig. 2, is designed to operate a low-current 6- to

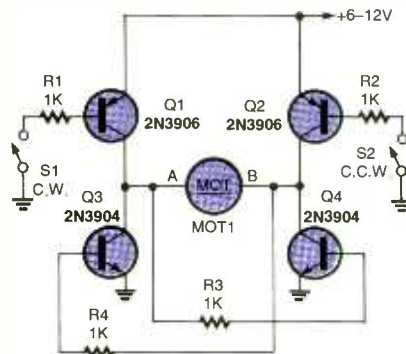


Fig. 2. The Grounded-Input Motor-Reversal Circuit, which is built around complementary pairs of bipolar junction transistors (BJTs) and is activated by a low input, is designed to operate a low-current 6- to 12-volt DC, 100-mA (or less) motor.

PARTS LIST FOR THE GROUNDING-INPUT MOTOR-REVERSAL CIRCUIT (FIG. 2)

SEMICONDUCTORS
Q1, Q2—2N3906 general-purpose PNP silicon transistor
Q3, Q4—2N3904 general-purpose NPN silicon transistor

ADDITIONAL PARTS AND MATERIALS
R1—R4—1000-ohm, 1/4-watt, 5% resistor
S1, S2—SPST switch
MOT1—6-12-volt, low-current DC motor
Printed-circuit or perfboard materials, wire, solder, hardware, etc.

12-volt DC, 100-mA (or less) motor. The circuit, which is built around complementary pairs of bipolar junction transistors (BJTs), is activated by a low input (ground).

The motor rotates in the clockwise direction when the base of Q1 is grounded through S1 and counterclockwise when the base of Q2 is taken to ground through S2. Although the Fig. 2 circuit is manually controlled through a pair of mechanical switches, in most robotics or logic-driven circuits, solid-state circuitry would be substituted for S1 and S2. The operation of this rather basic reversal circuit is pretty simple. Closing S1 turns on Q1, which connects point A to the positive-supply rail of the battery. That also forces the base of Q4 high, thereby turning it on. With Q4 turned on, point B is grounded, causing the motor to rotate clockwise.

On the other hand, when S2 is closed, Q2 turns on, pulling point B to the positive supply rail. At the same time, the positive voltage at point B is applied to the base of Q3, turning it on.

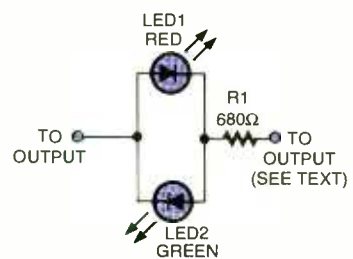


Fig. 3. This dual LED circuit can be added to any of the voltage reversal circuits to serve as a voltage-polarity/rotation-direction indicator.

PARTS LIST FOR THE ADDITION CIRCUIT (FIG. 3)

SEMICONDUCTORS
LED1—Red light-emitting diode
LED2—Green light-emitting diode

ADDITIONAL PARTS AND MATERIALS
R1—680-ohm, 1/4-watt, 5% resistor
Printed-circuit or perfboard materials, wire, solder, hardware, etc.

As was the case when Q4 turned on, turning on Q3 grounds point A, causing the motor to rotate counter-clockwise.

Note: Switches S1 and S2 should never be closed at the same time. Although the circuit can survive momentary closures of both switches, doing so for extended periods could cause one or more of the transistors to fail.

ADD-ON CIRCUIT

The dual LED circuit in Fig. 3 can be added to any of the voltage reversal circuits to serve as a voltage-polarity/rotation-direction indicator. The indicator circuit connects across the motor or any load that's connected to the voltage-reversal circuit.

POSITIVE-INPUT MOTOR-REVERSAL CIRCUIT

The reversal circuit in Fig. 4 is very similar to the one shown in Fig. 2; however, unlike the previous reversal circuit, this one is activated by a positive input.

In the Fig. 4 circuit, two feedback

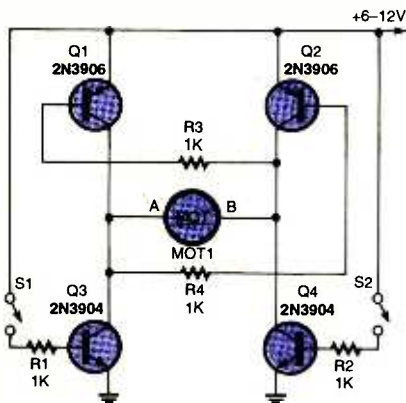


Fig. 4. This Positive-Input Motor-Reversal Circuit is very similar to the one shown in Fig. 2.

PARTS LIST FOR THE POSITIVE-INPUT MOTOR-REVERSAL CIRCUIT (FIG. 4)

SEMICONDUCTORS

Q1, Q2—2N3906 general-purpose PNP silicon transistor
Q3, Q4—2N3904 general-purpose NPN silicon transistor

ADDITIONAL PARTS AND MATERIALS

R1—R4—1000-ohm, 1/4-watt, 5% resistor
S1, S2—SPST switch
MOT1—6- to 12-volt, low-current DC motor
Printed-circuit or perfboard materials, wire, solder, hardware, etc.

resistors (R3 and R4) connect the bases of the PNP transistors (Q1 and Q2) to points A and B. That arrangement grounds the base of Q1 when Q4 is turned on by closing S2; Q2 behaves in an identical manner when Q3 is turned on by closing S1. Unlike the Fig. 2 circuit where closing S1 tied point A high and point B low causing the motor to rotate in a clockwise direction, closing S1 in Fig. 4 takes point A low and point B high, causing the motor to rotate in the counter-clockwise direction.

NPN REVERSAL CIRCUIT

Our next circuit, based solely on NPN BJTs (see Fig. 5), could come in handy when you need a voltage-reversing circuit, but don't have complementary PNP units on hand. The

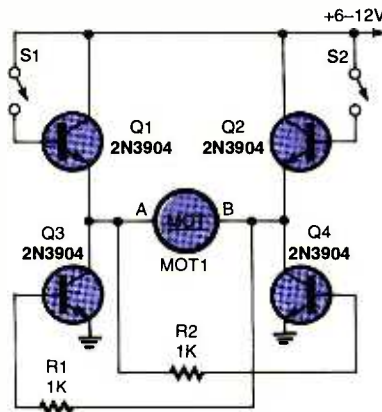


Fig. 5. Although less efficient than the previous entries, this reversal circuit, based solely on NPN BJTs, is ideally suited to those times when complementary PNP units are not readily available.

PARTS LIST FOR THE NPN REVERSAL CIRCUIT (FIG. 5)

Q1—Q4—2N3904 general-purpose NPN silicon transistor
R1—R2—1000-ohm, 1/4-watt, 5% resistor
S1, S2—SPST switch
MOT1—6- to 12-volt low-current DC motor
Printed-circuit or perfboard materials, wire, solder, hardware, etc.

efficiency of this circuit isn't as good as the two previous circuits, but it will function just fine, albeit with a slightly greater loss in the voltage supplied to the load. The complementary-transistor pairs that comprise the two previous circuits are the most efficient way to transfer power to a load. Using the same type of transistor in series pairs,

as in this circuit, creates a greater loss in the two transistors, which are connected in an emitter-follower configuration. The power loss across Q1 and Q2 is greater than the loss across Q3 and Q4. Other than that, the circuit works just fine.

PNP REVERSAL CIRCUIT

A PNP-only voltage-reversal circuit is shown in Fig. 6. In that circuit, there is a greater loss in transistors Q3 and Q4 for the same reason as in the previous circuit. The NPN-only circuit

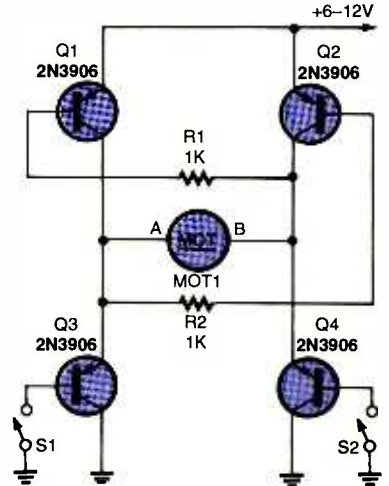


Fig. 6. This circuit is little more than a PNP-based version of the circuit presented in Fig. 5.

PARTS LIST FOR THE PNP REVERSAL CIRCUIT (FIG. 6)

Q1—Q4—2N3906 general-purpose PNP silicon transistor
R1, R2—1000-ohm, 1/4-watt, 5% resistor
S1, S2—SPST switch
MOT1—6- to 12-volt low-current DC motor
Printed-circuit or perfboard materials, wire, solder, hardware, etc.

requires a positive input to activate the motor, while the PNP version requires a negative input.

Now that we've looked at several different, but functionally similar voltage-reversal circuits, it's time to jack up the circuit's power-handling capabilities.

HIGH-POWER MOTOR-REVERSAL CIRCUIT

The high-power circuit in Fig. 7 replaces the low-power complementary transistor pairs used in the previous circuits with power transistors.

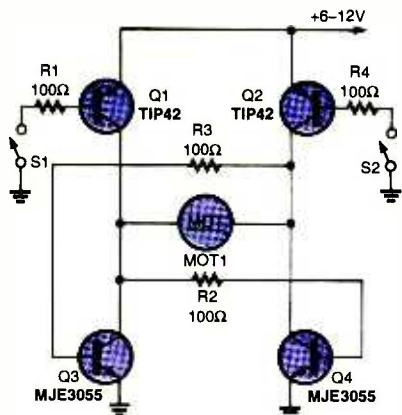


Fig. 7. The High-Power Motor-Reversal Circuit replaces the low-power complementary transistor pairs used in the previous circuits with power transistors.

PARTS LIST FOR THE HIGH-POWER MOTOR-REVERSAL CIRCUIT (FIG. 7)

SEMICONDUCTORS

Q1, Q2—TIP42 PNP silicon power transistor
 Q3, Q4—MJE3055 NPN silicon power transistor

ADDITIONAL PARTS AND MATERIALS

R1—R4—100-ohm, 1/2-watt, 5% resistor
 S1, S2—SPST switch
 MOT1—DC motor, see text
 Printed-circuit or perfboard materials, wire, solder, hardware, etc.

With TIP42 PNP power transistors replacing Q1 and Q2 of the previous circuit, and MJE3055 NPN power units replacing Q3 and Q4, the maximum current that the complementary pairs can handle is 10 amps (with a big heatsink). With the component values given in Fig. 7, the circuit can handle load currents of up to 2 amps. Increasing the base current to each of the four transistors increases the maximum-load current capabilities. That can be accomplished by reducing the values of R1—R4.

Another more efficient method, however, which can be used to increase the maximum load current, is to replace Q1—Q4 with complementary Darlington power transistors. That approach requires much less drive current and allows the circuit to be driven by low-power devices.

Like the circuit in Fig. 2, the reversal circuit in Fig. 7 requires a low or ground to activate the motor. But the circuit can be configured to operate with a positive

input by replacing the transistors in Fig. 4 with the four power transistors used in Fig. 7 and replacing the four 1000-ohm resistors in Fig. 4 with 100-ohm units. The NPN-only circuit in Fig. 5 can also be converted to a high-power circuit by replacing the four 2N3904 transistors with MJE3055 power transistors and replacing R1 and R2 with 100-ohm resistors. The PNP-only circuit in Fig. 6 can easily be converted by changing all four transistors to TIP42 power devices and replacing R1 and R2 with 100-ohm resistors.

SCR-AUGMENTED MOTOR-REVERSAL CIRCUIT

Our last voltage-reversal circuit for this visit (see Fig. 8) is based not on complementary transistor pairs, as were some of the previous circuits, but instead combines SCRs and transistors. In this circuit, transistors Q3 and Q4 have been displaced by a couple of SCRs. Transistors Q1 and Q2 are the same PNP units that were used in the Fig. 4 circuit. The circuit in Fig. 4 requires a constant input signal for the motor to run continuously, while the Fig. 8 circuit calls for only a momentary closure of either switch for continuous operation.

The operation of the Fig. 8 circuit differs somewhat from the previous ones. Briefly closing S1 applies a positive voltage to the gate of SCR1, turning it on, thereby pulling point A to ground. At the same time, Q2's base is pulled to ground, turning it on. That causes the voltage at point B to rise to the positive supply rail, causing the motor to rotate in the counter-clockwise direction.

The motor's direction of rotation is easily reversed by briefly closing S2, which turns SCR2 on, SCR1 off, and Q1 on, pushing the voltage at point A toward the positive supply rail and pulling point B to ground. Before SCR2 is turned on, the charge across C1 rises toward the supply voltage level, with its positive end at the junction of Q2 and SCR2 and its negative end at the junction of Q1 and SCR1. When SCR2 turns on, its anode takes the positive end of the capacitor to ground. The capacitor is rapidly discharged driving the voltage at the anode of SCR1 negative, turning it off, and allowing its anode voltage to rise to near supply level. Transistor Q1 turns on, and the

motor reverses its direction of rotation.

The same circuit action occurs when switch S1 is briefly closed to reverse the motor's rotation. To stop the motor from turning, S1 must be operated to interrupt the circuit's operating current.

Between now and next month, try to

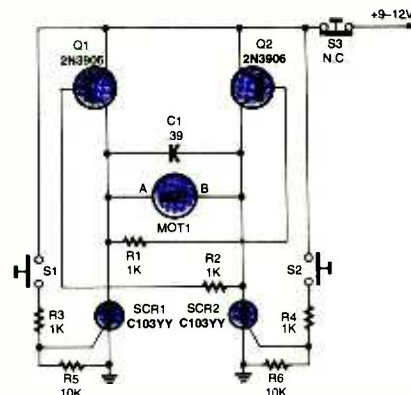


Fig. 8. The SCR-Augmented Motor-Reversal Circuit is based not on complementary transistor pairs, as were some of the previous circuits, but instead combines SCRs and transistors.

PARTS LIST FOR THE SCR-AUGMENTED MOTOR-REVERSAL CIRCUIT (FIG. 8)

SEMICONDUCTORS

Q1, Q2—2N3906 general-purpose PNP silicon transistor
 SCR1, SCR2—C103YY, 2N5061, or similar low current silicon-controlled rectifier

RESISTORS

R1—R4—1000-ohm, 1/4-watt, 5% resistor
 R5, R6—10,000-ohm, 1/4-watt, 5% resistor

ADDITIONAL PARTS AND MATERIALS

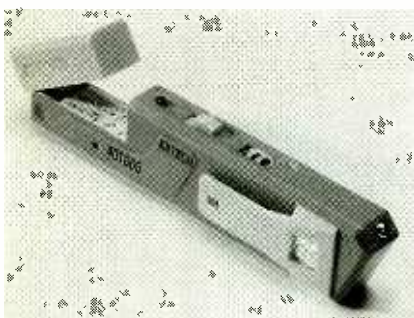
C1—0.39-μF, ceramic-disc or Mylar capacitor
 S1, S2—Normally open momentary contact, pushbutton switch
 S3—Normally closed momentary contact, pushbutton switch
 MOT1—6- to 12-volt low current DC motor
 Printed-circuit or perfboard materials, wire, solder, hardware, etc.

come up with a couple of applications for our voltage-reversal circuits. When we return next month, we'll look at several add on circuits, which hopefully will open up even more interesting applications. Until then, may all of your circuits function perfectly the first time you turn them on.

NEW PRODUCTS

VOLTAGE/METAL DETECTOR

This *Non-Contact Voltage/Metal Detector* combines several instruments in one: through-wall metal detector, fuse checker, electrical tester, and EMF checker. As a metal detector, its functions include locating metal conduits, piping, nails/screws, and wiring in walls. As an electrical detector, it can be used to check sockets, fuses, and light bulbs/lamps, and to verify polarity. Other electrical-tester functions include locating live wires, checking AC power, verifying DC voltage and polarity, checking appliance grounds, verifying diodes and continuity, and checking batteries.



The attached sensor heads (2), continuity tester, and battery power, as well as its small size (5.5 × 1.1 × 0.6 inches), permit testing anywhere. The detector provides an LED status indicator and audible confirmation, and it comes with batteries and a pocket clip.

The Non-Contact Voltage/Metal Detector costs \$15. For more information, contact Extch Instruments, 335 Bear Hill Road, Waltham, MA 02451; Tel. 781-890-7440; Web: www.extech.com.

CIRCLE 80 ON FREE INFORMATION CARD

RF FIELD ANALYZER

Designed for the mobile telecommunications market, the *RF-3200 Field Strength Analyzer* fills the maintenance and installation needs of everything in this field, including cellular and cordless phones; C.B. radios; paging systems; and cable, TV, and satellite receiving equipment. This handheld (9 × 4 × 1¼ inches) instrument has

wide-band reception ranging from 100 kHz to 2060 MHz.

Features include the ability to analyze Narrow Band FM (N-FM), Wide Band FM (F-FM), AM, Single Side Band (SSB) modulated signals, and PLL tuning systems. Up to 160 channels can be displayed simultaneously. The built-in frequency counter, built-in speaker, and RS 232C interface make the RF-3200 versatile.



The RF-3200 Field Analyzer costs \$2100. For more information, contact A.W. Sperry Instruments, Inc., 245 Marcus Blvd., Hauppauge, NY 11788; Tel. 516-231-7050.

CIRCLE 81 ON FREE INFORMATION CARD

PASSIVE PREAMP

The *PR41 Passive Preamplifier* provides a way of connecting up to six sources—CD player, tuner, etc.—to a power amplifier. Because the circuitry is completely passive, no distortion is added to the music signal. The unit is compatible with most components with line-level outputs and with most power amplifiers, either tube or solid state.

The front panel houses the three controls: select, balance, and volume. The stepped attenuator volume control has 46 steps of attenuation of 1.25 dB each, and the step attenuator of the balance control has steps of 0.6 dB. The input selector switch can select from six input channels.

The PR41 Passive Preamplifier costs \$895. For more information, contact Marchand Electronics Inc., PO



Box 473, Webster, NY 14580; Tel. 716-872-0980; Web: www.marchandelec.com.

CIRCLE 82 ON FREE INFORMATION CARD

RMS MULTIMETER

A sophisticated electronic diagnostic tool, the *Craftsman Professional True RMS Computer Interface Multimeter* is designed for the hobbyist. This multimeter checks transistors, radio and TV components, computer power supplies, and voltage and continuity on motors, among other things, with an accuracy of 0.1 percent. It measures AC and DC voltage and current, continuity, capacitance, frequency and inductance, as well as testing diodes and duty cycle.



Other features include an audible warning when the test lead connections do not match the function setting, automatic shutdown, and a large backlit LCD. The multimeter records eight measurements for later recall, in addition to remembering the lowest and highest readings, and can export the readings to Windows-based computer programs for storage and comparison. A case, test leads with clips, a serial cable, and software are included.

The Craftsman Professional True RMS Computer Interface Multimeter (#82326) has a suggested retail price of \$169.99, available from Sears Roebuck, Inc. For information, call 800-390-8792; to order, call 800-377-7414.

CIRCLE 83 ON FREE INFORMATION CARD

POWER LINE MONITOR

Combining AC-line monitoring functions, data logging features, and flexible reporting capabilities, the *PLM-120 Power Line Monitor* offers complete, "moment-to-moment" power-line quality information. The monitor provides everything needed to resolve daily engineering issues ranging from proper conditioning operation and proper UPS changeover functioning to fault and improper "load mix" identification in building and facility power feeds.



The PLM-120 captures, logs, and alarms for all power quality violations up to and even after a complete power outage. The "information-at-a-glance" front panel displays current values and alarm status. At the same time, the additional RS-232C remote access pathway provides extended data display and analysis capabilities.

The PLM-120 Power Line Monitor costs \$650. For more information, contact Dorrough Electronics, 5221 Collier Place, Woodland Hills, CA 91364; Tel. 818-998-2824.

CIRCLE 84 ON FREE INFORMATION CARD

TEST LEAD KIT

The *Basic TL80* electronic test lead kits consists of two test leads (one red, one black) that are one meter in length, each with a safety shrouded, right angle banana connector on one end and a stainless steel test probe on the other end. Rated up to 10A, these silicone-insulated leads are more flexible than standard test leads.

The kit also includes two each (one red, one black), insulated probe tip extenders, rated up to 3A, and insulat-

ed alligator tips rated up to 5a. The basic kit is compatible with multimeters that accept safety-shrouded, standard-diameter-banana connectors, and it comes with a soft case for storage.



The Basic TL80 costs \$39. For more information, contact Fluke Corp., PO Box 9090, Everett, WA 98206; Tel. 800-44-FLUKE or 425-356-5500; Web: www.fluke.com/handheld/access.

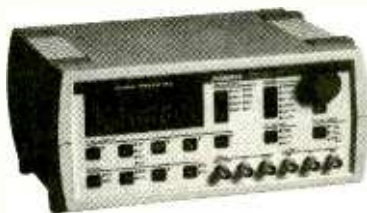
CIRCLE 85 ON FREE INFORMATION CARD

PURE WAVE GENERATOR

Designed for test and measurement applications, the *PW2120 (20MHz) "Pure Wave" Function Generator* delivers an accurate output with a frequency stability of 0.1% and a total harmonic distortion of less than 1%. The microprocessor-controlled unit features a 40-MHz, 5-digit LED external frequency counter. It provides linear and log-sweep operation and an AM/FM modulation and burst mode.

The unit comes standard with an RS232 interface, a variable duty cycle, and DC offset controls.

The PW2120 (20MHz) "Pure Wave" function generator costs \$715. For more information, contact Global Specialties Instruments, 70 Fulton



Terrace, New Haven, CT 06512; Tel. 800-572-1028 or 203-466-6103; Web: www.globalspecialties.com.

CIRCLE 86 ON FREE INFORMATION CARD

CODE PRACTICE OSCILLATOR

The *MFJ-554 Code Practice Oscillator* has powerful audio—perfect for classroom use—and it produces a true pure sine wave. Five milliseconds of symmetrical rise and fall time shapes the keyed oscillator wave form to remove all traces of harsh key clicks so users can concentrate on learning the code without distraction. Users get low distortion CW—typically less than .2% total harmonic distortion from its BTL (Bridge-Tied-Load) amplifier. The MFJ-554 delivers a full one-watt into its internal 3-inch speaker. An external speaker can also be plugged in.

The oscillator measures a compact $4\frac{3}{4} \times 1\frac{1}{2} \times 5$ inches. It has a volume control and an adjustable tone control from 400 to 1000 Hz; an on/off switch; a power-on LED; and key, speaker, and power-input jacks.



The MFJ-554 Code Practice Oscillator costs \$79.95. For more information, contact MFJ Enterprises, Inc., PO Box 494, Mississippi State, MS 39762; Tel. 800-647-1800 or 601-323-5869; Web: www.mfjenterprises.com.

CIRCLE 87 ON FREE INFORMATION CARD

"SMART" CORDLESS PHONE

Cendis is a smart cordless phone that combines the functions of the cordless phone with the power of the PC to network homes without wires. The compact headset ($6\frac{1}{8} \times 2\frac{1}{4} \times 1\frac{1}{4}$ inches) provides call waiting, caller ID, call routing, or conference calling, and Web access capabilities, as well as a way to distribute information to any room in your house. In addition, Cendis steers traffic, whether from a PC, fax, DSS system, or cordless handset, to the open line.

With the built-in 56K modem in the Cendis base, the wireless, battery-operated, compact Netdisplay touchscreen ($6\frac{1}{2} \times 8\frac{3}{4} \times 1$ inches) serves as a Web browser without being connected to a PC. However, when it is linked to your PC, users can access



information from either the touch-screen or handset, all while the PC is storing this information.

Cendis comes packaged as two handsets and costs \$499, and the touchscreen costs \$225. For more information, contact Global Converging Technologies, 4514 Travis St., Suite 326, Dallas, TX 75205; Tel. 214-528-6697; Web: www.globalconv.com.

CIRCLE 88 ON FREE INFORMATION CARD

COMPUTER MONITOR

The *Optiquest V75* 17-inch (16-inch viewable) monitor is designed for the small office/home office user, or desktop publisher, or web designer. This monitor offers an ultra-bright CRT with bright, crisp colors. Its super fine 0.26-mm dot pitch ensures clear, sharp images, even at its highest resolution of 1600 × 1200. Its fast 77-Hz refresh rate at that resolution provides flicker-free performance.



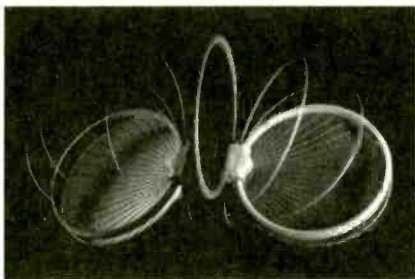
The menu-driven "OnView" system enables users to adjust screen images for brightness, contrast, pincushion, trapezoid, and more, with the touch of a button. Easy-to-use "ViewMatch" color controls allow users to accurately match colors with printer output. Plug & Play+ supports the Windows 95 auto-installation for easy setup, and the monitor is PC and Mac compatible.

The *Optiquest V75* Monitor has an estimated street price of \$419. For more information, contact Optiquest, 483 Cheryl Lane, Walnut, CA 91789; Tel. 800-843-6784 or 909-869-9216; Web: www.optiquest.com.

CIRCLE 89 ON FREE INFORMATION CARD

PASSIVE FM ANTENNA

The *Model 246 Wavefinder* from Parsec, a division of Recoton, is a passive antenna with a sculptured look. Its matte black body is a circle standing on its edge, with a face scored with radiating lines—a design that blends in with any decor. A pivoting ring, which houses the antenna element, is mounted just ahead of the circle.



This antenna is easy to use. With the ring in its vertical position, *Wavefinder* operates in the directional mode. Simply by turning it, users can precisely orient it for optimal reception of a favorite station. To use *Wavefinder* as an omnidirectional antenna, the ring is swiveled downward until it's parallel with the surface it is placed on, eliminating the need for manual aiming.

The *Model 246 Wavefinder* costs \$12.99. For more information, contact Recoton, 145 E. 47th Street, New York, NY 10022; Tel. 800-732-6866; Web: www.recoton.com.

CIRCLE 90 ON FREE INFORMATION CARD

TELEPHONE LINE ANALYZER

The *TE-4200 Single Line Telephone Analyzer* monitors the integrity of your phone line for slight voltage and current variations caused by RF interference, telephone repair line-powered handsets, off-hook extensions, or tampering. This unit will display your phone line voltage readings numerically both on and off hook. It also flashes an LED, sounds an audible alarm, and automatically mutes your phone when it detects a problem.

The *TE-4200 Single Line*

Telephone Analyzer costs \$399. For more information, contact Torfino Enterprises, Inc., 3500 Fairlane Farms



Road, Suite 3, West Palm Beach, FL 33414; Tel. 800-867-3466 or 561-790-0111; Web: www.torfino.com.

CIRCLE 91 ON FREE INFORMATION CARD

LIGHT METER

Featuring a remote sensor with built-in UV color correction, the *Mini UV Light Meter, Model 401340*, has a wavelength range of 290 to 390 nm. The meter weighs under 8 ounces and measures 5.2 × 8 × 1 inches.



The user may select from two measuring ranges: 1999 $\mu\text{W}/\text{cm}^2$ and 19990 $\mu\text{W}/\text{cm}^2$. Results are displayed on a 3½-digit (1999 count), half-inch LCD, with over-range and low-battery indications. The unit comes with a 9-volt battery and the remote probe.

The *Model 401340 Mini UV Light Meter* costs \$179. For more information, contact Extech Instruments Corp., 335 Bear Hill Road, Waltham, MA 02451; Tel. 781-890-7440; Web: www.extech.com.

CIRCLE 92 ON FREE INFORMATION CARD

SENSOR INTERFACE

(continued from page 46)

printed-circuit traces on the solder side of the board that join the opposing pins of R4. Those traces are easily recognized since they are not coated by the solder-mask layer (assuming that you've purchased the board from the source in the Parts List).

TO J2 OF UNIVERSAL SENSOR INTERFACE

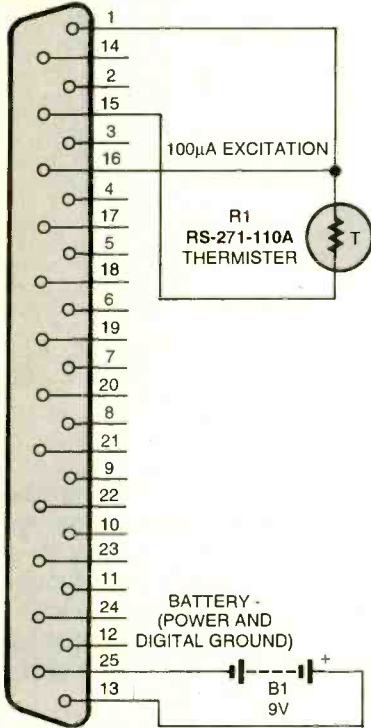


Fig. 9. Resistive sensors such as the thermistor shown here can be read by injecting a known current into the sensor and measuring the voltage developed across the sensor.

Software. The software for the Universal Sensor Interface is too extensive to be presented here. However, it is freely available for download from <ftp://ftp.gensback.com/pub/PE/>. Look for the file USI.ZIP.

Figure 8 shows the control panel for LPT8_DVM.VBP—an application program written in VisualBASIC (v5.0)—which we'll use to illustrate how to develop a virtual instrument to acquire analog and digital data, as well as to control the analog and digital outputs of the Universal Sensor Interface. A 32-bit I/O DLL (Dynamic Link Library) is used to allow input and output operations to be performed through the printer port under the command of VisualBASIC.

In addition, the archive also contains several programs written in QuickBASIC. One of the programs, ACQUIRE8.BAS, implements an 8-channel oscilloscope/4-channel logic analyzer. In that program, the sampling rate is regulated by inserting for-to loops to introduce delays between samples. The number of loops required to reach the correct delay is based on a calculation of the time that it takes the computer to complete a single data acquisition and display operation, as well as on the delay introduced by the addition of a for-to loop.

The performance of the program depends on the PC's processor speed, the resources available to the processor, the access speed to the video card, etc. Some typical acquisition rates achieved by the program are shown in Table 4. Another program, DTOA.BAS, implements the serial protocol to write values to the DACs.

Testing and Calibration. If, in building the Universal Sensor Interface, you were careful with parts handling and placement, the circuit should be ready to use as soon as it's assembled. If, on the other hand, you run into trouble, use a DMM to troubleshoot the circuit. With the DMM, check that while running ACQUIRE.BAS or LPT8_DVM.VBP at least 3 volts is present at pin 8 of IC1.

TABLE 4—ACQUISITION RATES

ACQUISITION COMPUTER	1 ANALOG CHANNEL + 4 DIGITAL INPUTS	8 ANALOG CHANNELS + 4 DIGITAL INPUTS
486, 66 MHz	834 Samples/s	205 Samples/s
Pentium, 133 MHz	2260 Samples/s	523 Samples/s
Pentium, 166 MHz	2314 Samples/s	561 Samples/s
Pentium, 200 MHz	2766 Samples/s	743 Samples/s

If not, that could indicate that your PC has different printer-port-address assignments or that the OS shell is not allowing the programs to access the printer port hardware. The former is easy to overcome—just select a different port until the device starts to

PARTS LIST FOR THE UNIVERSAL SENSOR INTERFACE

SEMICONDUCTORS

- IC1—LTC1285CN8 12-bit analog-to-digital converter, integrated circuit
- IC2—MAX398CPE 8-to-1 analog multiplexer, integrated circuit
- IC3—MC78L05CP positive 5-volt, 100-mA, micropower fixed-voltage regulator, integrated circuit
- IC4—LTC1446CN8 12-bit, dual voltage-output digital-to-analog converter, integrated circuit
- IC5—REF200 precision current reference, integrated circuit
- IC6—LM385BZ2.5 precision 2.5-volt reference diode, integrated circuit
- D1—1N4001 1-amp, 50-PIV silicon rectifier diode

RESISTORS

- (All fixed resistors are 1/4-watt, 5% units.)
- R1, R3—8200-ohm
 - R2—10-ohm
 - R4—See text
 - R5—See text

CAPACITORS

- C1—2.2- μ F, 16-WVDC, tantalum
- C2, C5, C6, C8, C9, C11, C12—0.01- μ F, monolithic
- C3, C7—10- μ F, 16-WVDC, miniature electrolytic
- C4, C10—100- μ F, 16-WVDC, miniature electrolytic

ADDITIONAL MATERIALS

- L1—18- μ H coil
- J1—DB-25 connector, male
- J2—DB-25 connector, female
- Printed-circuit material, enclosure, wire, solder, hardware, etc.

Note: The following items are available from ECOS, 439 This Way St., Lake Jackson, TX 77566, Tel: 409-297-8631, Web: www.tgn.net/~adnav: A complete kit of parts for the Universal Sensor Interface (including assembly manual and expanded software allowing logging to disk and spectral analysis) for \$59; multi-layer printed-circuit board only for \$19; assembled DB-25 to field-wiring accessory module \$30. Please add \$6 for shipping and handling within continental US. Texas residents must add sales tax. Major credit cards accepted.

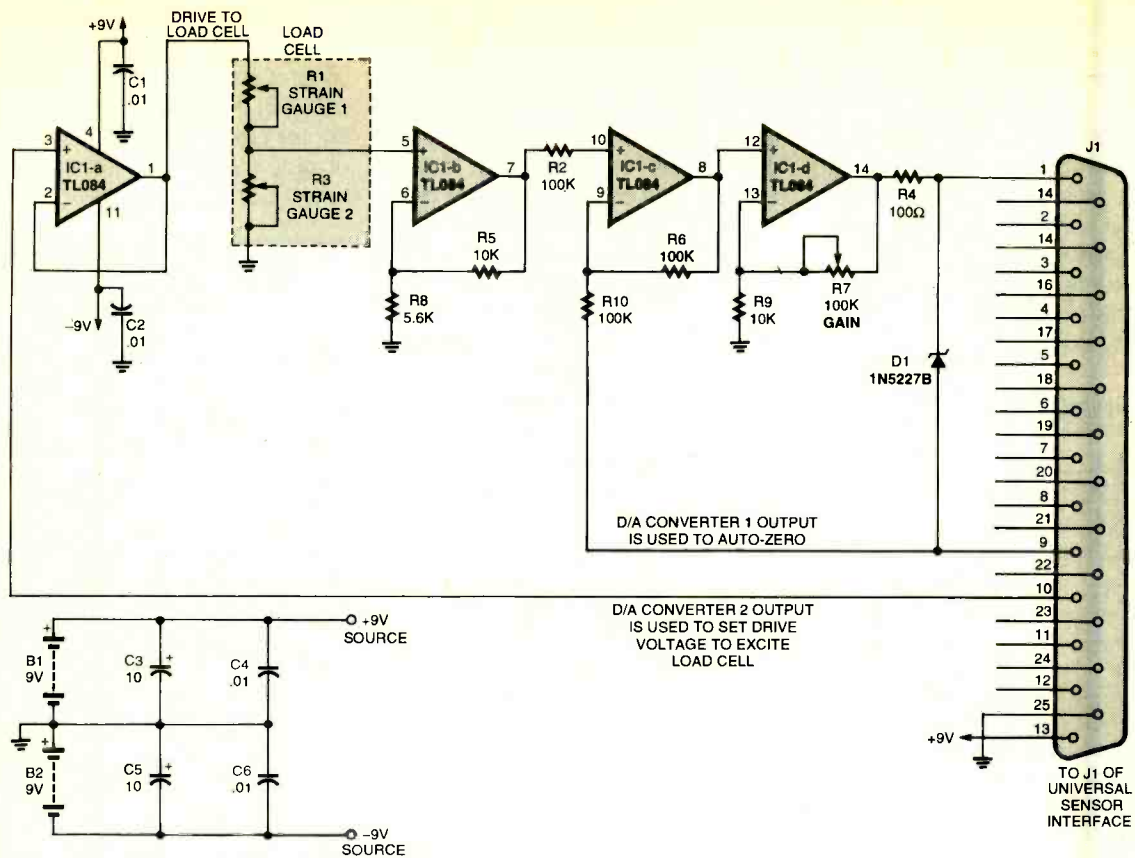


Fig. 10. A very precise scale for the PC can be built from the load cell of an inexpensive kitchen scale and a simple signal-conditioning circuit.

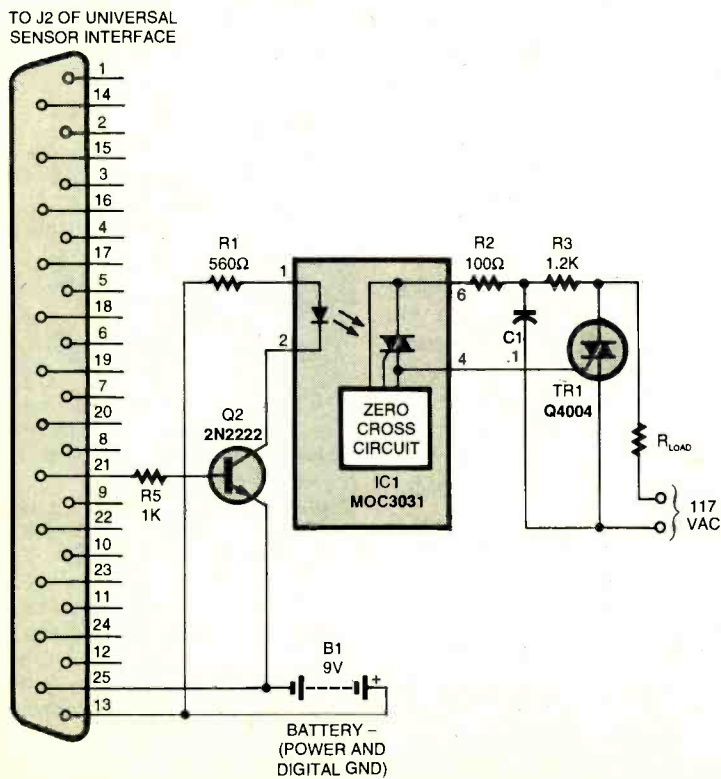


Fig. 11. The digital-output lines of the Universal Sensor Interface can be used to control AC loads in response to sensor inputs. The line-control interface is suitable for turning on or off relatively light AC loads.

work. The latter problem commonly occurs when attempting to run the program from within Windows NT or in (I don't have a workaround except for setting up your machine for dual- or triple-system bootup modes and using the device under Windows 95 or DOS).

For most applications, the component values specified for this project should suffice; i.e., the circuit should require no calibration. For improved performance, however, a precision power supply should be used to generate voltages within the 0 to 2.5-volt range, and a routine should be written to calculate correction factors to be applied to your measurements.

Other Applications. Sensors that do not directly produce output voltages can also be measured by the Universal Sensor Interface. For example, Fig. 9 shows the typical setup for reading a resistive sensor (in this case, a thermistor). In that setup, the thermistor (RadioShack Catalog No. 271-110) is excited by one of the 100- μ A sources. The voltage developed across the thermis-

TO J2 OF UNIVERSAL
SENSOR INTERFACE

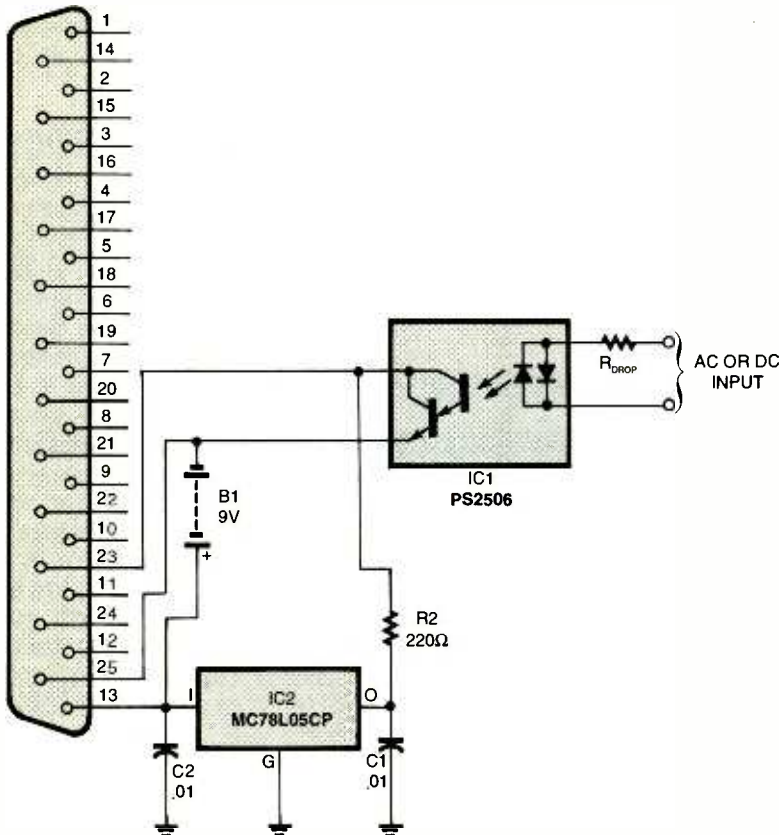


Fig. 12. This circuit can be used to safely isolate and translate external AC or DC levels (e.g., power switch closures) to signals that can be read by the digital input lines of the Universal Sensor Interface.

tor by the constant-current excitation is related to temperature. THER-MOM.BAS, a QuickBASIC program also in the FTP archive, can be used to read temperature in °C and °F. Other resistive sensors such as piezo-resistors, resistive position indicators, resistive humidity sensors, photoresistors, etc. can be measured in the same way.

Figure 10 shows how the Universal Sensor Interface can be used for reading sensors that require automatic baseline cancellation. For example, a strain-gauge load cell from an inexpensive digital kitchen scale can be excited from an op-amp (IC1-a) driven by DAC 2. When the scale is not loaded, the output is a voltage that floats somewhere in the range of 0 to the drive voltage generated by DAC 2. That output voltage is slightly amplified by IC1-b (gain = 1.78), while IC1-c is used to cancel the load cell's baseline level by offsetting the output of IC1-b by the amount established by DAC 1.

The signal developed by a real load is further amplified by IC1-d before being fed to analog input 1. Resistor R4 and Zener diode D1 protect the ADC input from output voltages produced by IC1-d that may be beyond the acceptable input range.

SCALE.BAS is a QuickBASIC program that implements an auto-zeroing digital scale by controlling the sensor's output offset. The Universal Sensor Interface is also ideal for implementing low-cost process control systems. For that kind of application, the device's digital outputs are often required to switch AC loads such as heaters, lamps, or motors. As shown in Fig. 11, the digital outputs of the Universal Sensor Interface can be used to control an AC load connected to the power line through an optically isolated triac. In that circuit, the digital output signal is used to drive a 2N2222 transistor which, in turn, controls IC1's internal LED. In this application, a zero-crossing triac-dri-

ver optoisolator/coupler is used to drive a power triac (TR1). The Q4004 triac in our example can be used to switch light loads.

(WARNING: Be extremely careful when using the Universal Sensor Interface to control line-powered devices. Life-threatening voltages and currents are present in such circuits. Properly isolate and fuse all circuitry in the power line path.)

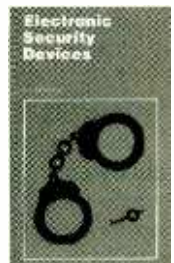
Digital inputs can also be isolated. Figure 12 shows how a PS2506 Darlington output optoisolator/coupler can be used to safely sense an AC or DC voltage to signal a digital input line. Resistor R1 should be selected to produce no more than $\pm 20\text{mA}$ of current through the LED of IC1.

Conclusion. Unlike ordinary data-acquisition setups, the Universal Sensor Interface offers a great degree of flexibility and portability. Virtually all PCs come equipped with a parallel printer port, and connecting this interface system to the computer typically does not require delving into the enclosure. Moreover, since the use of the printer port is standardized, the same software will run on any PC without the need for reconfiguration.

As long as the signals to be converted are correctly scaled and sampled, the Universal Sensor Interface should have you experimenting with the new generation of sensors in no time at all. ■

ELECTRONIC SECURITY DEVICES

A great book for project builders. It is quite common to associate the term "Security Devices" with burglar alarms of various types. However in fact it can refer to any piece of equipment that helps to protect people or property. The text is divided into three basic sections: Chapter 1 covers switch-activated burglar alarms and includes exit and entry delays. Chapter 2 discusses other types of burglar alarms and includes Infra-Red, Ultrasonic and Doppler-Shift Systems. Chapter 3 covers other types of security devices such as Smoke and Gas Detectors; Water, Temperature and Baby Alarms; Doorphones, etc. Most circuits are simple, and stripboard layouts are provided.



To order Book BP56 and send \$5.99 includes shipping and handling in the U.S. and Canada only to **Electronics Technology Today Inc.**, P.O. Box 240, Massapequa Park, NY 11762-0240. Payment in U.S. funds by U.S. Bank check or International Money Order. Please allow 6-8 weeks for delivery.

NET WATCH

(continued from page 13)

will be views from anywhere that you move inside, from front row to the boonies, giving you a rough idea of what it will be like to buy tickets in a certain area of an arena.

Now for the down side—the site still doesn't let you pinpoint where your seat will be located. While you can virtually move around, say, Madison Square Garden, you can't get an idea of where section 232 is, for instance. The best you can do is look at a seating chart and approximate with a little moving around in the virtual version located at My Ticketmaster. It would be a lot nicer if you can just enter a section number or, even better, a seat, and get the view from there. Still, I have to applaud the virtual feature of the site. Having covered VRML technology when it first came out years ago, I am happy to finally see it being used at a commercial site.

HOT SITES

CitySearch

www.citysearch.com

Internet Travel Network

www.itn.net

My Ticketmaster

my.ticketmaster.com

Other e-commerce sites are sure to use VRML soon for letting customers arrange their own combination-orders of items. Intel showed, at a recent trade show, how business owners can customize an office setup and view, in 3 dimensions, their new combination of desk, chair, and other furniture, for example.

USEFUL LINKS

As mentioned in this column's introduction, My Ticketmaster's not really a single site. It links you to some other useful spots on the Web, one of which has an innovative feature of its own.

We'll start with the best of the bunch. Ticketmaster's official travel link is to the Internet Travel Network. Like PreviewTravel and other similar sites, it lets you create a free account (your My Ticketmaster account is automatically valid here) and search for the best prices on airline tickets as well as hotels and car rentals. Unlike the other

travel e-shops, though, ITN provides you with the ability to choose your own seat assignments. This is a really cool feature, especially for tall folks like me (I need a bulkhead or exit-row seat). To choose a seat, just click on the Seating Reservation logo and a little applet will pop up. Choose from a menu to the left that contains the legs of your journey. A seating map of the particular plane for each flight will appear, letting you choose your spot visually. Nice.



The Ticketmaster Event Ticker keeps you informed of the type of events you're interested in, as well as general entertainment news.

Once you make your arrangements to get out of town, you'll probably realize there's a lot more to do in a given city than just attend a single concert or show. Link up to CitySearch and check out all your destination of choice has to offer. Get up-to-date information on a city's arts and entertainment events, community activities, recreation hot spots, businesses, shops, professional services, and even local news (including sports and, most important to travelers, weather).

That about does it for this month. As always, I'd love to hear from you. Send 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.

SCANNER SCENE

(continued from page 14)

generally factory-supplied in single-channel radios.

IMMIGRATION SERVICE

Ed V., of San Antonio, Texas, and Fred S., of Atlanta, Ga., asked about frequencies used by the U.S. Immigration and Naturalization Service (INS), and Border Patrol (BP). These are basically two separate activities of the same agency. As we understand the agency's communications system, the nation is divided into four separate geographic operational zones, each designated a group of discrete frequencies. The reported repeater output and simplex frequencies for each of the zones is:

Zones A and B: 163.625, 163.675, 163.725, 163.775, and 165.875 MHz.

Zone C: 162.90, 163.625, 163.65, 163.70, 165.2375, and 168.975 MHz.

Zone D: 162.85, 163.625, 163.675, 163.75, 163.775, 165.2375, and 165.925 MHz

Note that some frequencies are for communicating with stations of other agencies. CTCSS tones include 100.0, 123.0, and 151.4 MHz. A variety of input frequencies (not given here) in combination with these CTCSS tones is used to access the repeaters. To determine which zone you are in, check which group of frequencies is active in range of your station.

Hope you'll let us hear from you! Questions? Ideas? Frequencies? Our postal address is *Scanner Scene*, Popular Electronics, 500 Bi-County Blvd., Farmingdale, NY 11735. Our direct e-mail address is: Sigintt@aol.com.

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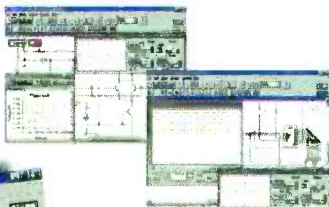
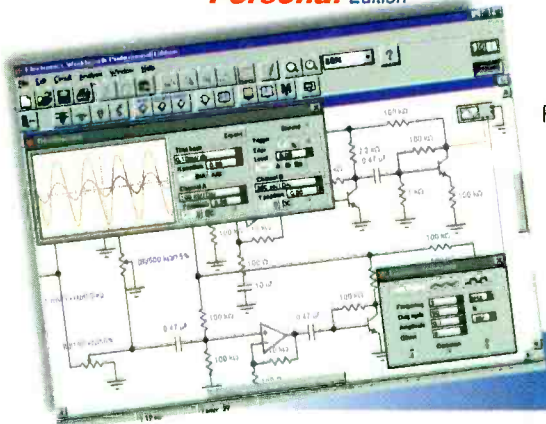
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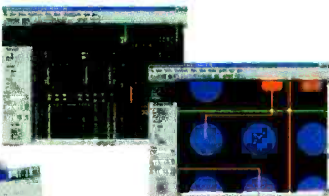
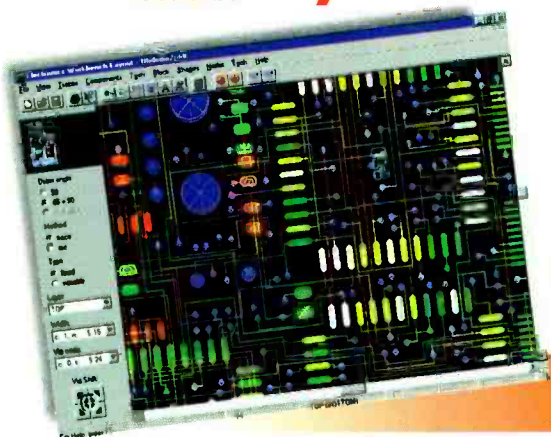
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