BASIC ELECTRONIC CIRCUITRY

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Downloadable Circuits
see page 55

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July 2002, Vol. 3, No. 7

Electronics Now · Popular Electronics

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AND MORE

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WHAT'S NEW?

Haven't we all been missing a touch of variety in our news media? To say that most media outlets have been concentrating on the same story would be a safe statement. The news I personally miss the most is science and technology news. The average person can go to the library or sit at home on the Internet and search through the same stale press releases and news features, but I remember when television and print would bring news of new inventions.

Two areas that need some updating are nanotechnology, and the closely related *Robofly* project. Most of the Web Portals that I browsed on this subject haven't updated these subjects in six months. It is hard to believe that both of these subjects have been stagnant for over half a year. No doubt they are sitting second and third fiddle to the multi-faceted fervor currently found in the cloning industry. When we last heard from the nanotech realm, scientists were wagering amongst each other that a *nanocomputer* would be created by 2011, and in turn this *nanocomputer* would power a *nanoassembler*, which would then set into motion an army of self-replicating *nanomachines*. And who can remember the hype behind *Robofly*? This little bugger was to be the size of a house fly and capable of flying around by flapping tiny Mylar wings. The prototype would be powered by a chemical engine that worked using gas emission, and would also feature video and olfactory sensors in order for "the Man" to vicariously see and sniff his way around.

Now here's the bitter irony. The media still claims to cover science and technology, yet the stories they run aren't truly categorized. Case in point, one popular Web Portal boasts a Technology category, as well as a Science category. The Technology category is an endless list of corporate acquisitions, legal battles, and goof-ball product endorsements. It almost reads like a stock trends report. There was no sign of *Robofly* anywhere. The Science category was equally barren of treasured content. There were a few "studies" that were obvious lobbyist ploys and pleas, and there was a slew of typical "evil cloning scientists versus the good cloning scientists" stories. Oh well, at least we can all still turn to **Poptronics**. So, if the six o'clock network news has left you nauseous, and the cable news is creeping you out, then perhaps its time to crack us open and immerse yourself in some electronics. We try to keep a variety within these pages you now hold in your hands. Hopefully the content will inspire, inform, and of course, entertain.

Please note the absence of two columns this month: "All About..." and "Amazing Science." Contributing Editors Rudolph Graf and William Sheets have just returned from separate vacations, and the three of us had the opportunity to discuss some exciting projects that are in the works at their North Country Radio lab. Author John Iovine will return, along with the conclusion of his Biped Robot. Now it's time to read and relax.

Tallyho,

Chris La Morte
Managing Editor

LETTERS

mailto: letters@gernsback.com

Recalling The Late Hugo

I have been reading the article about Hugo Gernsback in the February issue of **Poptronics.** As a Gernsback Publications subscriber since **RadioCraft** (about 1950), this brought back memories of many of his articles and accomplishments. I do not remember hearing of his last invention (mentioned in the article) of a device to detect the charge on an electret, but I do remember the first time I heard of electrets.

Mr. Gernsback published an article, in the middle or late 1950s, about making an electret and giving a few uses for them. I had never heard of them and thought this article might be another April Fool's article, but it was serious. Now, of course, electrets are common, usually as the polarizing voltage source for capacitance microphones.

The first installment of "All About" is great. We can all use refreshers (or new coverage) of the basics. The subject of this month's column (power supplies) is quite timely for me. Just recently I was looking for the circuits of doublers, triplers, etc., and couldn't quickly find them. I am going to keep this month's "All About" for future reference. Sam Goldwasser's articles on switch-mode power supplies are also quite useful.

[From Another Letter] I see a couple of mistakes in schematics in the May issue of **Poptronics**. In Fig. 1 in the "Basic Circuitry" column on page 60, the collector of Q1 should go to the junction of the relay coil and D1, not to +12 volts. In Fig. 1 in the "Headphone Ambience Processor" on page 30, the positive terminal of the bridge rectifier is shown going to ground. It should go to pin 1 of U1 (the layout in Fig. 4 is correct).

BILL STILES
Hillsboro, MO

Mr. Stiles, as always thank you for your watchful eye, readership, and constructive criticism.—Editor

Digging Through The Archives

You might refer Al Williams, who wrote in your February issue expressing interest in a 6–8 MHz DDS frequency generator, to my two-part article "Making Waves With NCOs," which appeared in the December 1997 and January 1998 issues of *Circuit Cellar Ink*. There I described a bench-top instrument with a 1-Hz to 9.999-MHz output that used thumb-wheel frequency control. There is sufficient information in the article to enable the reader to adapt the hardware and software to give the desired 1-Hz resolution. (I believe the 10-bit HI5721DAC I used is now obsolete; the 12-bit HI5731 is the nearest equivalent.)

Mr. Williams might also find my article "Getting Inside An NCO," in your October 2000 issue, of interest. Unfortunately, the TTL Technology I used there can't be pushed much beyond a 1-MHz output.

TOM NAPIER
North Wales, PA

Technology In A Box

As a devoted reader of **Poptronics**, I find myself looking forward to your "Gizmo" pages for new and exciting electronic gadgets. I am writing to tell you that your work is deeply appreciated and to also ask you if you had any type of catalog with all the Gizmos you have and are thinking of presenting. If not, do you know of anywhere I might get a catalog of all the latest electronic gizmos? I am a student in the Electronics field, and at the current time I don't have access to all the latest developments in technology—I want to make a good assessment into what branch of the electronics field to focus my studies. Any help you can give me would be sincerely appreciated.

FREDDY R. LAZZU
Mercer, PA

*I'll let you in on an industry secret…we find our Gizmos and Gadgets via a host of press releases and catalogs. Here are two indispensable Web sites for lovers of electronic doohickeys—*www.hammacher-schlemmer.com *and* www.sharperimage.com. *—Editor*

A Case of Computer Excess

My first computer was a Texas Instruments 99/4A. Second was a Commodore 64. Next, an IBM with an 8088 processor—all three at one computer station. My current computer is a Pentium II. With no room left at the old computer station, the current computer is in the living room. But I am running out of space after adding a new printer, scanner, and new software. I still enjoy the old programs from the old computers. Is there a way to convert the programs from the T1 and Commodore to run on the Pentium II and other Pentium III or IV? I know that the disk drive format is different on the Commodore, and the T1 programs are on a plug-in cartridge.

LARRY DONALDSON
Logan, OH

I was just browsing some emulator Web sites that you might find helpful. Try these for the C64: www.c64games.com *and* www.computerbrains.com. *The Texas Instruments sites I've found useful are* www.99er.net *and* www.enter.net/~bsnyder/links.html. *Good luck.—Editor*

KEEP IN TOUCH

We appreciate letters from our readers. Comments, suggestions, questions, bouquets, or brickbats … we want to hear from you and find out what you like and what you dislike. If there are projects you want to see or articles you want to submit—we want to know about them.

You can write via snail mail to:

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YESTERDAY'S NEWS

A PEEK INTO THE GERNSBACK ARCHIVES

1900

1910

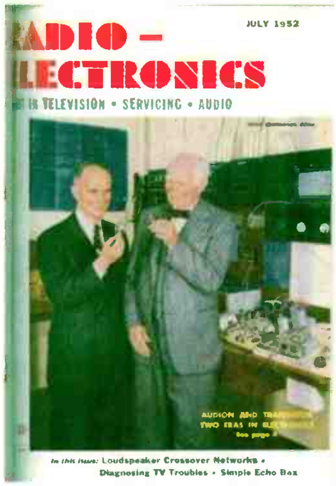
1930

1940

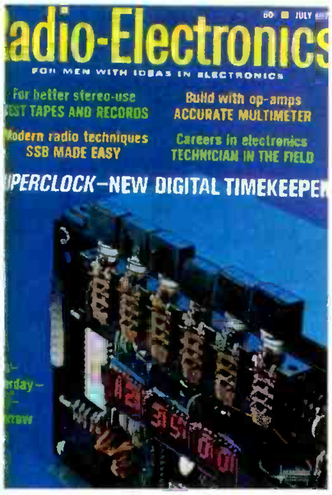
Dateline: July 1952 (50 years ago)

Looking towards the future, this issue of **Radio Electronics** features articles on the era of the transistor and where it was heading, along with how to chose the right radio school and continue into the field. If you're preparing for more projects, there is also an article on how to fill parts requirements from one store—so stock up! In anticipation of the next decade, Hugo Gernsback predicts that there will be 53 million television sets in American homes by 1960.

1952



1960



Dateline: July 1972 (30 years ago)

The average person today changes their job about 13 times throughout their life—exploring different fields. Just as people do today, readers of **Radio Electronics** looked for various technician roles as well. This issue features an article explaining the ins and outs, from radio/television/radar technicians to military applications and training. There is also a special analysis of video tape recorders—their history and future, along with where they fit into your home entertainment.

1972

1980

Dateline: July 1992 (10 years ago)

Today, many luxury cars house computers that provide directions and maps for travel. It was one decade ago that the GPS Navigation System was first introduced for personal and commercial navigation. This month's **Popular Electronics** discusses how it works, what its competition is, and what improvements need to be made. This issue also includes articles on how to build a portable 2-MHz frequency counter and a cordless telephone lock, as well as how to buy the best oscilloscopes, dollar for dollar.

1992

2000

GIZMO®

For more information go to page 80A
or e-mail: requests@berkshire-is.com

SD Audio Player/Recorder

Bypass your PC with the *SV-SR100* ultra-compact SD audio player ($399.95), which brings unprecedented convenience to SD audio entertainment. Just place a CD and an SD Memory Card in the unit and press a button to transfer music to the SD card in the AAC (Advanced Audio Codec) compression format. The device also plays back music recorded in MP3 and WMA formats and plays music directly from prerecorded CDs and CD-R/RW discs. Postage-stamp-sized SD cards, available in 8-, 16-, 32-, 64-, 256-, and 512-MB capacities, allow you to create personal music libraries containing hundreds of songs. You can use the keypad to enter song titles and artist names for easy access to your digital files.

Panasonic Consumer Electronics, One Panasonic Way, Secaucus, NJ 07094; 800-211-PANA; *www.panasonic.com.*

CIRCLE 50 ON FREE INFORMATION CARD

Mounting Magic

The *VP Elite* line of television wall and ceiling mounts ($21.99 to $119.99) feature contoured edges and a curved front profile, to blend flawlessly with most television styles. The wall mount support arm disappears behind the TV into an attractive mounting plate. Offered in black or white finish, the wall mounts can accommodate sets from 13 inches to 27 inches. The ceiling mounts, suitable for 19- to 27-inch sets, are easy to install without requiring attic access or reinforcement and can rotate a full 360 degrees. A matching VCR/DVD mount is also available.

Vantage Point, 10233 Palm Dr., Santa Fe Springs, CA 90670; 562-946-1718; *www.vanptc.com.*

CIRCLE 52 ON FREE INFORMATION CARD

Sleek Sound

The *HKTS 10* home-theater speaker system ($649) won't clutter up your room with big, clunky speakers. It delivers realistic surround sound from four small satellites, a compact center-channel speaker, and a 150-watt powered subwoofer that can be tucked unobtrusively out of sight. The system reproduces movie soundtracks and music with accuracy, clarity, and dramatic bass impact. Designed for easy, flexible installation, the speakers can be placed on a shelf, mounted on a wall with the included brackets, or placed on optional stands. All necessary cables are provided.

Harman Kardon, 250 Crossways Park Drive, Woodbury, NY 11797; 516-496-3400; *www.harmankardon.com.*

CIRCLE 51 ON FREE INFORMATION CARD

Diamond Stereo

The *World Design Stereo's* ($269.95) unique diamond-shaped main unit features two independent CD drives with motorized doors that open at the touch of a button. The digital tuner stores 20 AM and 20 FM stations. The main unit can stand on a table or can be mounted on a wall. Adjustable pedestals are included, as are interchangeable speaker grilles in dark and medium blue. The system features an alarm clock, electronic equalizer presets, a sleep timer, and a remote control.

The Sharper Image (stores in 28 states and Washington, DC); P.O. Box 7031, San Francisco, CA 94120-9703; 800-344-4444; *www.sharperimage.com.*

CIRCLE 53 ON FREE INFORMATION CARD

Digital Video Converter

Want to exchange videotapes or DVDs with friends and relatives abroad? The *TR-1000Pro* ($1599) converts video to and from different TV systems, such as PAL, NTSC, and SECAM. The device features a complete video processor for picture improvement, a multi-system bar generator, and a built-in time-base corrector for maximum stability. Available in both desktop and rack-mount versions, it is aimed at video professionals, as well as high-tech consumers.

TenLab, 27346 Oak Summit Rd., Agoura Hills, CA 91301-3612; 818-706-8120; *www.tenlab.com.*

CIRCLE 54 ON FREE INFORMATION CARD

Direct Photo Printer

You can make high-quality color prints of images captured on Canon PowerShot digital cameras using the *Card Photo Printer CP-100* ($349). With all print settings made directly from the camera's LCD, the device provides a fast and simple way to make prints up to 4 × 6 inches. The translucent blue printer measures just 6.7 × 7 × 2.4 inches and weighs just over two pounds, and the optional battery pack allows you to make prints anywhere. Credit-card-sized prints take just 40 seconds, while 4 × 6-inch prints take about twice that long. A clear UV overcoat is applied for extended longevity. The printer can also make labels and photo stickers, and you can choose between bordered or borderless prints.

Canon U.S.A., Inc., One Canon Plaza, Lake Success, NY 11042; 800-OK-CANON; *www.usa.canon.com.*

CIRCLE 55 ON FREE INFORMATION CARD

Room-Rockin' MP3

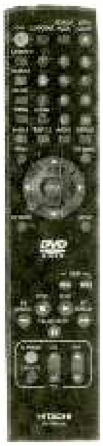
Get room-rocking sound from your portable MP3 or CD player by connecting it to the *Octave speaker system* ($319), which consists of a compact subwoofer, two ultra-slim speakers, and a remote control. Dual Directional Output technology radiates sound from both the front and rear of the speakers, filling all four corners of the room equally with rich, undistorted sound.

Axyys Corporation, 9133 So. La Cienega Blvd., Suite 250, Inglewood, CA 90301; *www.axyys.com.*

CIRCLE 56 ON FREE INFORMATION CARD

Progressive-Scan DVD

The *UltraVision DV-P725U DVD player* ($189.95) features progressive-scan processing that deinterlaces a DVD's video content and produces a 480p output for a more film-like display. It sports a new industrial design and has a dual laser pickup that's compatible with DVD, DVD-R, VideoCD, CD, CD-R/RW, and MP3 playback. The player offers a front-panel shuttle dial, virtual surround sound, and a multi-brand remote control (pictured here).



Hitachi America Ltd.; 1855 Dornoch Court, San Diego, CA 92154; 800-HITACHI; *www.hitachi.com.*

CIRCLE 58 ON FREE INFORMATION CARD

Road Warriors

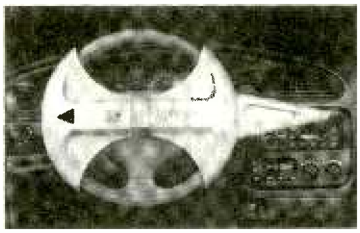
Combining the performance of separate components with the convenience of a point-source configuration, the *V-Mag 602* mobile speakers ($169/pair) are designed for direct drop-in replacement of factory-installed car speakers for improved performance. The speakers incorporate technical and material advances that include light and robust microcellular butadiene rubber surrounds that provide excellent linearity and are UV-resistant; Kapton voice-coil formers for increased power handling; low-mass magnesium-alloy cones for fast transient response; and ¾-inch magnesium composite dome tweeters for smooth high-frequency response.

Cerwin-Vega, 555 Easy St., Simi Valley, CA 93065-1805; 805-584-9332; *www.cerwin-vega.com*

CIRCLE 57 ON FREE INFORMATION CARD

Wrapped to Go

Designed to deter vehicle and airbag theft, the *Wrap* ($159.95) locks onto the steering wheel and provides three layers of protection: mechanical, audible, and visual. Built of unbreakable resin reinforced with a stainless-steel frame and equipped with a tubular seven-pin keyed locking system, the device limits steering-wheel movement with an anti-rotation arm. A motion sensor sets off a 110-dB siren, backed by LED warning lights and a flashing strobe.



Blockit & Lockit Systems, 1211 Mullowney Ln., Billings, MT 59101; 888-656-6156; *www.wrap1.com.*

CIRCLE 59 ON FREE INFORMATION CARD

PC GIZMO®

Palm GPS

Boasting a slim and lightweight design geared toward the mobile professional, the *Navman GPS m Series* ($199.95) is the first GPS device available for Palm's m500, m505, m105, and m125 handhelds. The package includes a GPS receiver, Rand McNally StreetFinder Deluxe Travel Navigation software, a vehicle mounting kit, and a vehicle power adapter. The helical antenna connects you to as many as 12 satellites, ensuring precise information on your location; and the software provides detailed street-level mapping for the United States (excluding Alaska), customizable maps, and address-to-address directions via the Internet. More than one million businesses, points of interest, and Mobil Travel Guide restaurant and hotel listings are included.

Navman USA, Inc., *www.navman.com.*

Single-Board Computer

The *OP6800 MiniCom* C-programmable operator interface and single-board computer ($249) offers Ethernet connectivity, plenty of industrialized I/O, and a graphic LCD/keypad. Its compact (4.5 × 3.6-inch) form factor makes it ideal for use in designs and areas with size constraints, and the device provides comprehensive integrated control, display, and networking capabilities via Internet/Ethernet or serial communications. (The non-Ethernet version costs $199).

Z-World; *www.zworld.com.*

Microphone Preamp

Because *the Model 401* high-performance microphone preamp ($183) was designed specifically to drive a computer sound card's line input, the output noise had to be kept very low compared to the line-in maximum signal level. With a dynamic range of nearly 70 dB at the full gain of 60 dB, the unit achieved the designers' goal. The preamp is useful in any application where very low noise gain is needed to condition a low-impedance sensor's output. The internal rechargeable batteries provide complete isolation from the power mains, and the cast-aluminum enclosure minimizes unwanted interference.

TDL Technology, Inc.; *www.zianet.com/tdl.*

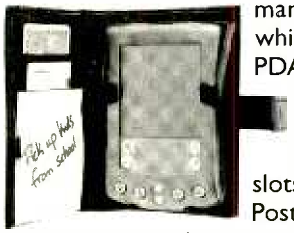
DVD Recordables

Fujifilm's new lineup of recordable DVD media includes *DVD-RAM, DVD-RW, DVD+RW, DVD-R,* and *DVD-R (for authoring) discs.* DVD-RAMs are available in single-sided 4.7GB (120 min) capacity with and without cartridge, and double-sided 9.4GB (240 min) with cartridge. Compatible with DVD-RW and DVD+RW recorders respectively, the DVD-RW and DVD+RW discs each offer 4.7GB data storage capacity for up to 120 minutes of recording time. The write-once DVD-R discs also offer 4.7 GB and are compatible with general-use DVD-R drives and recorders. The DVD-R (for authoring) discs, for authoring DVD-R drives and recorders, have the same capacity and are intended for mastering and post-production recording applications.

Fuji Photo Film U.S.A., *www.fujifilm.com.*

Strongman PDA Case

Keep your PDA safe and sound with the *Strongman PLT-8* ($24.95). Made of leather-like Koskin material and designed to secure a variety of PDA brands and sizes, the case features the durable molded plastic Strongman Attachment System, which holds and protects a PDA without Velcro or annoying fabric straps. The sleek, stylish case features business card slots, a stylus holder, and Post-It notes secured by a convenient elastic strap.



Case Logic; *www.caselogic.com.*

G

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A LOOK AT
TOMORROW'S TECHNOLOGY

PROTO

Business Buzz

MICRO MEDICAL CABLE
Calmot Wire & Cable has introduced an insulated, ultraflexible wire only 0.005 inches in diameter. The company manufactures multiples of the individual conductors into some of the smallest cables available today. Used extensively in the medical market, the cables are custom-made as either reusable or disposable types. They are offered in a variety of conductor and insulation materials, including non-electrical components. Manufacturing tolerances are maintained through laser gauging and digital micrometer measuring devices.

DVD-AUDIO TAKES TO THE ROAD
At the SAE-CEA Digital Car Conference in Detroit, Panasonic unveiled its first mobile DVD-audio systems—both aftermarket and factory installed. DVD-Audio is advanced digital recording format featuring high-resolution, multi-channel sound with as many as six channels, for enveloping surround sound. DVD-Audio players can also play back DVD video discs and CDs. Mounted for display in a Cadillac Seville, they featured a new generation of DVD-ready speakers, multi-channel amplifiers and in-dash receivers, and were accompanied by a wealth of new software titles from leading music companies.

SECURE MEMPLUG ADAPTER
The MemPlug SD/MMC from Portable Innovation Technology (*www.pitech.com*) is the first Security Digital/MultiMedia Memory Springboard module for the Handspring Visor that provides up to 256MB storage using a SD/MMC memory card. It comes with a built-in vibrating alarm, a feature not provided on the handheld unit. The latest in a growing list of SD/MMC adapters, it comes with seven built-in applications and can increase the Visor's memory by hundreds of megabytes. With MemPlug, users can view JPEG images recorded on a compatible digital camera and directly execute Palm read-only applications and databases stored on a SD/MMC card. It allows instant memory backup at the touch of a button, reading of entire e-books, and playback of up to an hour of 16-bit gMovie color video using a 512MB SD/MMC card.

Don't Leave Home for Groceries

Everyone has picked up the phone to order a pizza delivery. Some of us have even begun using the Internet to order rental DVDs. Now Philips has introduced a device that takes that concept a big step forward, allowing consumers to order their groceries, for delivery or pickup, from the comfort of their homes.

The HSD4000 Home Shopping device is a handheld unit that lets you compile a digital shopping list of grocery items by simply scanning the bar codes of the items directly from the pantry or fridge. Then, via an Internet connection, it downloads the list to a local retailer.

Time-pressed shoppers have a couple of other options. They can do most of their scanning at home. Think how easy it would be to scan an empty container before throwing it out—and how difficult to train the kids to do so. The handheld device can be carried from room to room, allowing you to check the bathroom to see if you're low on toilet paper or toothpaste, the laundry for detergent and bleach, and the pantry for dry goods. Then they could stop at the store to add other items and download the entire list. Or they can walk briskly up and down the store aisles, unencumbered by a cart, and scan items for later delivery.

Philips Homeshopper is a hand-held device that lets you do your grocery shopping without leaving home.

Designed for ease of use, the device offers a touch-screen display, bar-code scanner, and docking station for charging the battery pack. No technological know-how is required on the part of the user. The Homeshopper can store up to 30,000 bar codes and product descriptions. It can be used to scan coupons and even nutritional information. After the product is scanned, the device displays the description and price.

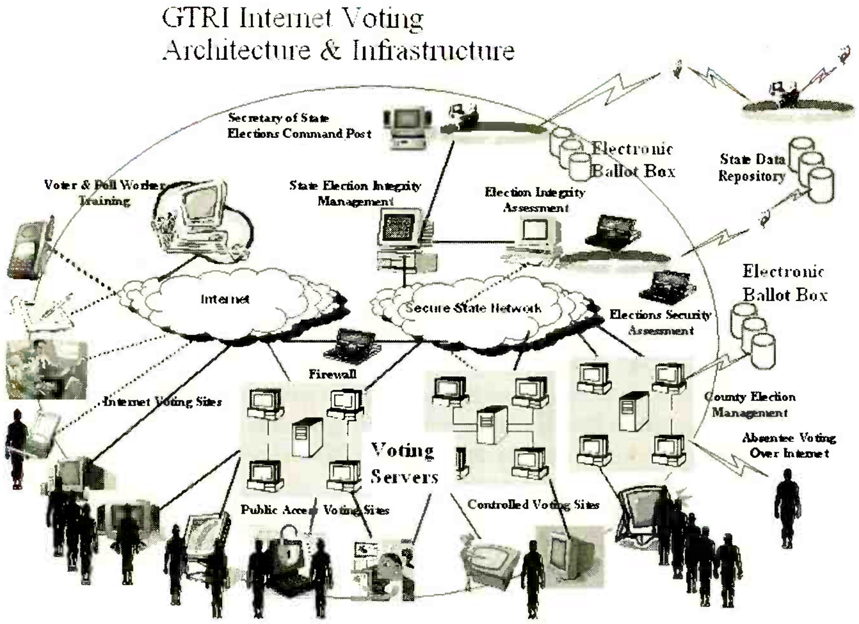
"This e-pliance has the potential to change the entire grocery shopping experience for the consumer," commented Wim Lemay, Business Development manager at Philips Components. "Philips is ready to supply grocery chains with this innovative product, and we are already in discussions with a number of retail chains—our research has shown that consumers will adopt this application and we want to get it to them through the retailers as soon as possible." PT

Internet Voting

The 2000 presidential election brought demands for drastic changes in the election process. One commonly voiced suggestion was "If I can safely purchase items over the Internet, why can't I use the Internet for voting?"

The *Georgia Tech Research Institute's* (GTRI) Internet Voting Research Team is now studying the technical and social issues related to Internet voting. At a recent workshop hosted by the team, participants from academia, government, and industry agreed that Internet voting could provide a more convenient, efficient, and accurate elections process—and also concluded that its widespread use is still many years away.

These experts expect that Internet voting will occur in phases. They predict that military personnel will be the first to cast absentee ballots via the 'Net, probably within the next few years. Internet voting will be adopted by a few states by 2008. Next, they forecast, those



The switch to Internet voting would have widespread social, political, and judicial effects.

states that already use only mail-in ballots (such as Oregon) will be the first to adopt Internet voting by 2012.

The GTRI team is working to re-engineer the voting part of the election process, and to fully understand the impact of such change on the other parts of the process, including the training of poll workers and the tallying of votes. Bob Simpson, a GTRI principal research scientist, notes, "... things are more complicated than they appear on the surface."

Tasks include the development of data models for information systems, privacy techniques to ensure secret balloting, and a test bed for Internet voting experiments. One technical issue is the need for common hardware, software, networking, authentication procedures, training systems, and support tools. A major hurdle, of course, is cost. Today, elections are not really that expensive because the costs have been driven down over time. Counties use the same equipment for an average of 20 years. Computers, however, become obsolete so quickly.

One of the primary social-science issues related to Internet voting is the "Digital Divide" that separates those who have Internet access from home or work and those who don't. In the future, this could become a divide between those with broadband access and those who still use dial-ups. One solution could be the capability to cast ballots at ATMs and at kiosks in post offices and malls. More complicated is the question as to whether all citizens would be comfortable with Internet voting.

Yet another social-science issue being researched at GTRI is how Internet voting will affect voter turnout. Will different segments of the population turn out differently? Could this new voting technology possibly change the composition of the voting population, thus significantly affecting the outcome?

Internet voting could make it easier for seniors and the disabled. Besides bringing the "voting machine" to the voter, it offers the potential to satisfy individual needs and preferences. For instance, visually impaired voters could increase the font size on their ballots. "It's not uncommon for disabled persons to have to give up their secret ballot to be able to participate," said Simpson. "Also, any separate equipment for disabled voters is usually less maintained

Research Notes

CHEAP CHIP TALK

Engineers at The Johns Hopkins University have speeded up the way microchips "talk" to each other. The research team uses microchips in which silicon is layered onto thin slices of synthetic sapphire, a cost-effective material that allows light to pass through it. A signal that originates in a wire is transformed into light and beamed through the transparent sapphire substrate via a tiny laser. Microlenses and other optical components collect the light beam and guide it to another place on the microchip or, using an optical fiber, to another chip. The light then enters a high-speed optical receiver circuit that transforms the stream of photons into electrons that travel through electrical wires connected to other computer components. Such signals could travel 100 times faster than those moving along a metal wire.

THE FLY ON THE WALL

Ron Miles, professor of Mechanical Engineering at Binghamton University, is developing the world's smallest microphone, modeled on a tiny structure in a fly's ears. His "ormiaphones," named for the *Ormia ochracea* fly, is expected to help millions of Americans with hearing loss. Miles' design also precisely pinpoints sounds—something that most hearing aids cannot do. Possible military applications include a "smart dust" that could detect sounds and determine the direction of troop or equipment movements.

NEXT-GENERATION DVD

Nine electronics manufacturers—Hitachi, LG Electronics, Matsushita, Pioneer, Philips, Samsung, Sharp, Sony, and Thomson—have unveiled the next generation of DVDs. Called the Blu-ray Disc, it will store more than 13 hours of video, more than 50 times today's DVDs. The discs allow the recording, rewriting and playback of up to 27 gigabytes of data on a single-sided, single-layer disc using a short wavelength blue-violet laser. Because the Blu-ray Disc uses standard MPEG-2 compression, the disc can record high-definition video while maintaining other data received with the video.

and efficient. Internet voting would make it possible for them to participate like other voters."

Legal issues abound as well. Because Internet voting must comply with the *Voting Rights Act*, as well as other state and federal voting laws, extensive judicial review would be required. Undoubtedly, some laws would have to be changed.

GTRI researchers hope that more studies of Internet voting will get under way when government and/or private funding becomes available. Designers of Internet voting systems must also consider the needs of election officials, candidates, elected officials, and poll workers.—by **Bill Siuru** PT

➤Emergency Calls

The events of September 11 revealed some problems in communications systems in both New York City and Washington, D.C. First, with so many people trying to use cell phones at the same time, some emergency workers were unable to communicate with each other. Second, the concrete and steel that comprise tall buildings cause radio interference, preventing fire commanders from reaching firefighters on upper floors of the Towers.

VoiceStream Wireless has unveiled a new cellular phone system to tackle the first problem. The priority-access system would ensure that emergency workers would be able to complete calls during an emergency. Certain officials would have cell phones with calling priority—making it somewhat more difficult for you or me to get our calls through, but assuring that 5000 top officials in New York and Washington will be in the clear, using phones that automatically receive priority status. Eventually, once the technology is in place, those officials will be able to get priority using regular cell phones by dialing a special prefix.

Where does that leave the average Joe? VoiceStream says the effect on his ability to make a connection during a crisis will be "nominal." The FCC, which approved VoiceStream's priority-calling system application on April 3, did not require the company to notify its customers of the possibility of decreased service during an emergency.

As for radio communications in the approximately 600 high-rises dotting New York's skyline, the NYFD has asked the Federal Emergency Management System for $60 million dollars to outfit the buildings with repeaters. These radio "boosters" would provide clear channels of communication in buildings over 20 stories tall, and would benefit police and EMS teams as well as firefighters.

Ironically, the Twin Towers were outfitted with repeaters, as were many of the rescue vehicles that responded to the scene. The devices in the buildings were destroyed during the initial attacks, and most of the vehicles were crushed by falling debris. PT

Cool Magnetic Technology

We've all got magnets *on* our refrigerators, holding up photos, kiddy art, recipes, and reminders. Now, some of us may be getting magnets *in* our refrigerators, thanks to a new technology developed by the U.S. Department of Energy's Ames Laboratory and Astronautics Corporation of America. The Madison, Wisconsin-based company recently demonstrated a prototype of their latest magnetic refrigerator, which puts to practical use the magnetocaloric effect—the striking ability of certain metals to become hot when magnetized and cool when demagnetized.

Today's gas-compression refrigerators repeatedly compress and expand a gas. As it expands, its temperature drops, and the chilled gas is circulated around an insulated compartment to keep the food cool. Traditional cooling systems are inefficient, wasting energy and emitting gases that have been linked to global warning. Their magnetic counterparts, which, in effect work by continuously switching on and off a magnetic field, would be more efficient and environmentally friendly—and would run virtually silently.

The concept of magnetic refrigeration isn't new. It's been used in laboratories to cool objects to within one degree above absolute zero. However, such magnetic cooling devices depended on superconducting magnets (which must themselves be cooled to very low temperatures) and expensive rare-earth compounds—neither of which was practical for commercial applications.

The Ames/Astronautics team tackled both problems. Ames scientist Karl Gschneider developed an efficient and inexpensive alternative compound using gadolinium (a metal used in VCR recording heads), and Astronautics researchers designed a prototype using a permanent magnet that creates a field nearly as strong as that generated by a superconducting magnet. They expect these innovations to make magnetic refrigeration competitive with conventional gas-compression technology.

Besides higher efficiency, cost-savings, and noise-reduction, magnetic refrigeration eliminates, in many cases, the hazardous materials used for heat transfer. Instead of CFCs or ammonia, the magnetic unit uses water as a heat-transfer medium for the refrigeration temperature range and a water-antifreeze mixture to reach below freezing.

Commercial applications could include large-scale refrigeration, food processing, heating, and air conditioning; liquor distilling; grain drying; and waste-separation and -treatment systems. Further development could lead to the production of cheap liquid hydrogen, an environmentally safe alternative fuel source. Because magnetic refrigeration can efficiently span the large temperature difference needed to produce liquid hydrogen, even a small improvement in efficiency could result in tremendous energy savings. PT

Visionary Computers

Researchers at UCLA's Henry Samueli School of Engineering and Applied Science are working to develop computers with human-like "eyesight." Brain surgery, endoscopies, and other medical procedures could be performed faster and more safely using computers that could see as well as people can.

The research team is examining how people use vision to interact with others and with their surroundings. They are using that information to design systems that will allow computers to perform in similar ways. "We use senses to build models of the world around us that allow us to walk through our environment and interact with it safely," said Stefano Soatto, assistant professor at UCLA's computer science department and head of the UCLA Vision Lab. "I want a machine to be able to do the same thing."

In the rapidly growing field of image-guided surgery, doctors use sophisticated imaging technology to help them perform surgical operations. One such technology merges multiple images to create a 3D map of a patient's brain, for instance. However, the images are often as much as a day old, and if the patient's condition changes, or if the procedure itself alters conditions, the images become useless. There are only a handful of MRI machines in use around the world that provide updated images during surgery—and these still require people to grip or manipulate the surgical tools.

Soatto believes that a computer that can understand and act within its environment can recreate and constantly update a 3D model of the brain—and then can use what it "sees" to perform tasks previously done by surgeons. Instead of a person interpreting visual data from the computer to then manually guide a catheter through the body or gather tissue samples, the computer could perform the entire task. Such "virtual surgeons," endowed with the ability to study images as they change over time and use that information to perform assigned tasks ("dynamic vision"), would eliminate the need for doctors to travel from afar to perform operations.

Soatto explains that "the world has certain physical properties—shape, motion, material properties of objects, and so forth. Humans have developed, over the course of evolution, a particular way of representing their environment that has been crucial for humans to survive—detecting prey, recognizing familiar objects, for example."

Computers can also be made to interpret the physical world and interact with it, whether that environment is a nuclear reactor or the human body. To interact with a changing environment, a computer needs to gain information about certain measurable spatial properties, including shape, motion, distances, and angles. By taking photographs from many points of view, a three-dimensional representation of the world can be created. Such a machine could act immediately based on what it sees, rather than later, after the data has been analyzed by people. This would allow the computer to do more than just pre-assigned tasks based on previously gathered data. It could continuously update its knowledge of its surroundings and truly interact with a changing world. PT

Calling Diver Dan

France Telecom R&D and French communications company Amphicom have invented the first system to allow telephone communications with divers working underwater. The easy-to-use system ensures a clear connection from a fixed or wireless phone to a person underwater at any depth. Consisting of a buoy fitted with a GSM phone relay that handles two-way communications with an underwater terminal, it resembles a personal underwater phone booth. The terminal is wired to the buoy and is equipped with a phone-like dial pad, a special mouthpiece, and a light and a buzzer to alert divers to incoming calls.

The parties are able to talk because of the ability of human bones to conduct sound under water. The sound wave from the surface travels through the system to the mouthpiece. The diver bites down on the mouthpiece and pushes a button to "unhook the handset." Sound vibrations are transmitted to the ear via the skull, which acts as a resonance chamber. The diver is able to clearly hear the caller and to talk back, in half duplex mode. Using the dialing pad, the diver can also place outgoing calls.

The system significantly improves safety for professionals working underwater. It was tested by archeologists at the Alexandrine Research Center in Egypt, which is in charge of underwater excavations at the presumed site of the Alexandria Lighthouse. Direct, instantaneous communications between divers and excavation managers facilitated interactive research, eliminated the need for frequent returns to the surface (and the risks of decompression), and reduced the loss of information inherent in diving such as directional problems on the sea floor and forgetfulness.

Frederic Tenron, France Telecom R&D engineer (left) presents the company's submarine telephone system to Jean-Yves Empereur of the Alexandrine Research Center at Alexandria, Egypt. Empereur's archeological team will use the system to aid in their search for the ancient Alexandria Lighthouse.

The underwater communications system, which is expected to be commercially available by the end of the year, has applications in scientific research, shipyards, oilrig platforms, salvage operations, and civil security. France Telecom researchers are exploring ways to eliminate the wire link between the buoy and the submerged terminal, using ultrasound waves or weak electrical currents, so that divers can be totally independent and members of a team diving in the same area can call each other. PT

REID GOLDSBOROUGH

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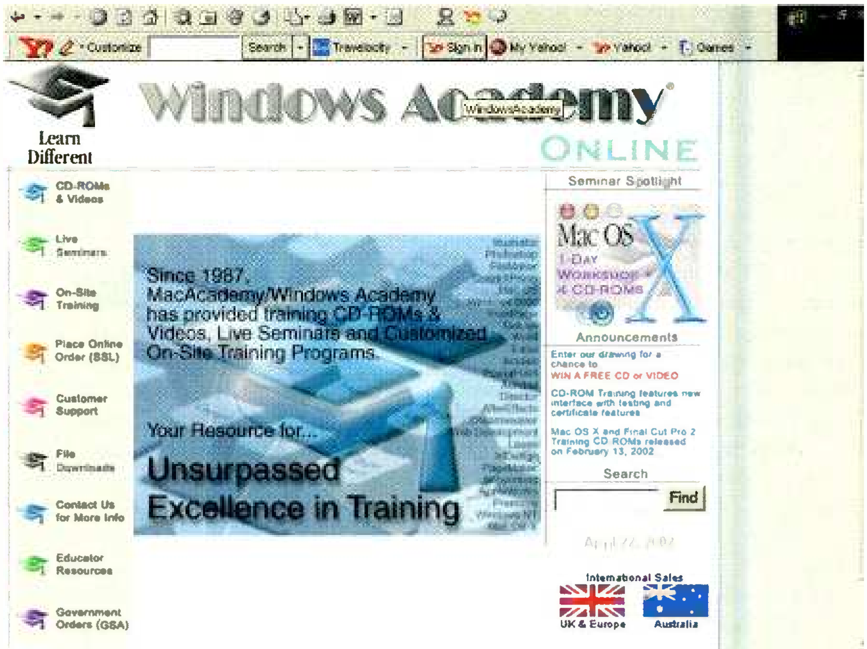
Mastering The PC Domain

Research has shown that those who are least comfortable with computer technology have the least knowledge of it. Those who have undergone training or taught themselves are less stressed and better able to take advantage of PCs—makes sense.

Even experts don't know all the tricks. What follows are ways—some commonsensical, some not—that beginners as well as advanced users can bone up on personal computers.



Only in a virtual world can two behemoths such as Macintosh and Windows coexist. This academy Website is designed to convert even the most technologically inept subjects into full-fledged computer users.

EDUCATE YOURSELF

Read the manual. Hardware and software manuals are both better and shorter than they used to be. Most people still don't read them. Taking a few minutes to at least browse through the manual can save a lot of time later by familiarizing yourself with a product's core features.

Go through the tutorial. Many programs include teaching aids that hold your hand in learning basic procedures. Another option is to buy a third-party tutorial on video or CD-ROM. Video tutorials are better if you're a beginner and uncomfortable in using a computer in the first place. CD-ROM tutorials let you interactively try out what you're learning. Top tutorial makers include KeyStone Learning Systems (800-748-4838; *www.keystonelearning.com*) and MacAcademy/Windows Academy (800-527-1914; *www.macacademy.com*).

Use the online help system. Hitting F1 or pulling down the Help menu provides quick help. Some software companies offer "intelligent agents" that anticipate help you may need in carrying out tasks. While useful for beginners, these help assistants can grate over time. Fortunately, you can turn them off. Using a program's help system manually by browsing through its contents or launching a targeted search can be a great way to get up to speed on your terms.

Check out the manufacturer's Web site. You can often find answers there to commonly asked questions along with other tips, bug fixes, and software downloads. Web sites are usually listed in manuals or as part of the help system. You can also find links to the sites of thousands of computer manufacturers at the Guide to Computer Vendors (*http://guide.sbanetweb.com*).

Explore third-party Web sites. You'll find free advice and software updates at sites such as Paul Thrust's SuperSite for Windows (*www.winsupersite.com*), Macintosh Watering Hole (*http://mac.map.com*), and Internet 101.org (*www.internet101.org*). Yahoo lists other popular computer help sites in its Technical Guides and Support section (*http://dir.yahoo.com/Computers_and_Internet/Technical_Guides_and_Support*).

Subscribe to a computer magazine. Magazines offer lots of well-written, well-organized tips, reviews, and commentary for beginners and experts alike. Sample those that look interesting by picking up newsstand copies. There are a range of different types out there. If you find one that talks to you, subscribe. Some computer magazines are a bit too fervid in enticing you to buy the latest and the greatest, though it's not difficult to filter this out.

Buy a computer book. If your computer came with its manuals on disk and you'd like something more tangible, or if you're dissatisfied with the quality of an existing manual, a computer book can be a good solution. Some are written for beginners, others for advanced users. Browse through any book before you buy it. Some computer books are put together hastily, so they can be published at the same time a program is released.

Take a class. Being among others, asking questions, and listening to the answers to other questions can aid the learning process. Classes are offered through local Ys, high school evening programs, community colleges, universities, computer stores, and computer training organizations. The "Computers-Training" section of your local Yellow Pages has particulars.

Hire a tutor. One-on-one training is more expensive than classroom training, but the personal attention can be worth it. Personal recommendations are best. Tutors are also listed under "Computers-Training" in the Yellow Pages. You can also find a tutor by contacting the Independent Computer Consultants Association (800-774-4222). At the group's Web site (*www.icca.org*), you can search for tutors by geographic area and expertise.

Join a computer user group. These volunteer groups abide by the principle, "Users helping users." User groups typically meet once a month, and members or sometimes guests give presentations on new products or how to best use existing products. During the rest of the month, members often volunteer to answer questions by phone or e-mail from fellow members. You can search for a user group near you at the Web site of the Association of Personal Computer User Groups (*http://database.apcug.org/database/loclist.asp*).

Personal computers can be amazing tools in helping you be efficient and productive. The key to making a PC work for you is learning how to best take advantage of it.

THE POWER OF THE INTERNET

Once you are familiar with the PC, there is no doubt you will become an avid user of the Internet. Mastering the navigation of the World Wide Web will most likely have a profound affect on your life.

We active online users like to think of ourselves as savvy, hip, and influential. We have access to the latest information technology, and more importantly, know how to use it to its full potential. Sure, when we take things to an extreme, we become nerds, isolated from other spheres of life. Used in perspective, PCs and the Internet are empowering. Just how empowering? Both more so and less so than you might think.

Through their skillful use of communications, the 11 million heavy online users in the U.S. influence the buying decisions of 155 million consumers both online and offline, according to research by Burson-Marsteller, a public relations firm headquartered in New York City. The company describes these active Internetters as opinion-leaders and has coined a name for them: "e-fluentials."

"An e-fluential is the rock that starts the ripple," says Leslie Gaines-Ross, the company's chief knowledge officer and architect of its research. "Each one communicates with an average of 14 people, so word travels in ever-widening circles, growing exponentially with each successive wave."

THE UPS AND DOWNS OF ELECTRONIC COMMUNICATION

Burson-Marsteller's research points to the importance of companies maintaining an easy-to-use, continually updated Web site and being responsive to e-mail. "Remarkably few companies respond very well or very often," she says.

Despite the advent of upstart tools such as instant messaging, e-mail is still the most widely used electronic communications medium. How influential is it? Not very. You'll likely get more satisfaction using a more traditional medium.

Say you're having a problem with a new product you just bought. You could send the company an e-mail message, spelling out your gripe. Or you could visit a "grievance site" such as PlanetFeedback, at *www.planetfeedback.com*, or Complaints.com, at *www.complaints.com*. These sites typically post your complaint to their site and forward it via e-mail to the company that made the product.

Too often, however, when a company receives your complaint via e-mail, you'll just receive an impersonal, canned e-mail message in response.

Similarly, don't expect to reach a human being when e-mailing your senator or representative if you have a gripe or would like to communicate your views about an issue. Sometimes your e-mail isn't even acknowledged, and when it is, the acknowledgement is typically automated and canned.

The reasons are clear. E-mail is so easy to send, and so easy to send in quantity, that companies and congressional offices alike are inundated with it. With e-mail, it's also easy to hide or fake who you are. For these reasons, some congressional offices have stopped disclosing e-mail addresses to the public.

Nonetheless, the Web sites of both the U.S. Senate and House of Representatives let you quickly locate contact information for your elected representatives, at *www.senate.gov/contacting* and *www.house.gov/writerep* respectively.

If you want a response, you're often better off using a slower and less efficient communications medium—the Postal Service. (Recent anthrax concerns have caused slowdowns in mail to Washington, DC, so it can be faster to send mail to local congressional offices.) Though you still may receive only a canned response, chances are better that someone will actually read your words.

POINT AND CLICK

Association of Personal Computer User Groups
http://database.apcug.org/database/loclist.asp

Complaints.com
www.complaints.com

Guide to Computer Vendors
http://guide.sbanetweb.com

Independent Computer Consultants Association
www.icca.org

KeyStone Learning Systems
www.keystonelearning.com

MacAcademy/Windows Academy
www.macacademy.com

Macintosh Watering Hole
http://mac.map.com

Paul Thrust's SuperSite for Windows
www.winsupersite.com

PlanetFeedback
www.planetfeedback.com

U.S. Congress
www.house.gov/writerep
www.senate.gov/contacting

STATING YOUR VIEWS VIA E-MAIL

Trying to leverage information technology, many congressional offices do allow you to communicate by filling out forms at the legislator's Web site, a process that's only slightly slower than sending e-mail.

Sen. Arlen Specter (R - PA) is one of a number of politicians who've come up with a fairly balanced approach. If you send him e-mail, you'll get back an auto-reply, though an impersonal one thanking you for taking the time to write.

Your views are then forwarded to the legislative correspondent who deals with the issue you've written about, according to Bill Reynolds, Specter's communications director. "We look at this information as a tally of how constituents feel about particular issues," he says.

In the auto-reply from Specter, you're also directed to the senator's Web site if you want a personal reply or more information. There, as long as you provide your address, you can fill out a form stating your views about one of 35 different issues, from abortion to veterans' affairs. Knowing you are who you say you are, a legislative correspondent responsible for that issue can contact you via e-mail, postal mail, or telephone.

To be most empowering, information technology needs to be used responsibly. Senders need to use the technology, not abuse it. And recipients need to take seriously the messages others send, which at the very least, means reading them.

Reid Goldsborough is a syndicated columnist and author of the book *Straight Talk About the Information Superhighway*. He can be reached at reidgold@netaxs.com or *www.netaxs.com/~reidgold/column*. P

FASTER NETWORKING

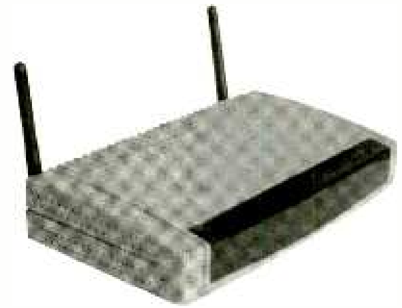
Networking your home or small business has gotten a lot easier over the last year or two. In many cases, the utility that this ease of implementation offers has also been somewhat reduced by the speed limitation that many easy-to-do networks impose.

The reason for this is that although setting up a network is easier than ever to do, applications have become so bloated that operating over a slow network can be more of a chore than simply not having any network at all.

We don't want to discourage anyone from putting up a network. If you have more than a single PC, having a home or small-office network is, most of the time, a joy. Sharing files, even applications, is simple to do, and the usefulness of a broadband Internet connection is greatly enhanced when family members can share in it.

Just what type and mode of network is right for you depends on several things. The most obvious choice that you have to make is whether or not you are willing to run cabling around the house or office. If you are not, then your choices become more limited—you will have to consider either wireless, home phone line, or the new power-line network approaches. We've played around with some of the initial power-line network offerings, and at 2 Mbps, they are only worth considering if wireless Ethernet won't work in your environment.

Wireless Ethernet is a robust and excellent choice for many home and small-office networks. The two most common protocols at the moment are 802.11b, or WI-FI, and 802.11a. Several vendors are also touting 802.11g, but so far we haven't seen any networking equipment that actually uses this protocol, at least on store shelves.



This is the D-LinkAir DI-714. This wireless gateway, which includes a four-port switch, allows users to share broadband access within 1000 feet. For those who'd rather forgo extensive cabling and sacrifice bandwidth, wireless is the way to go.

Of the two wireless protocols, 802.11a is both the newer and the faster. At close range, it operates at up to 54 Mbps versus the 11 Mbps speed that 802.11b can move data. Neither of these wireless protocols, however, comes all that close to wired Ethernet. The slowest version of wired Ethernet, 10BaseT, moves data at a maximum speed of 10 Mbs, but does so in full duplex (both directions), effectively doubling the speed. 100BaseT, which is the most common wired protocol, has a more or less constant 100 Mbps speed. As with 10BaseT, most 100-BaseT adapters can operate in duplex mode, again almost doubling the effective speed. Wired Ethernet transmission speed remains pretty constant over moderate distances (out to about 1000 feet), unless a lot of users are simultaneously on the network.

A NEED FOR SPEED

Just as 10BaseT has pretty much been replaced by 100BaseT, the new kid on the block threatens to displace 100BaseT. That protocol is 802.3, commonly referred to as Gigabit Ethernet. As you might guess from its name, Gigabit Ethernet runs at speeds up to 2000 Mbps in full duplex mode. And it does this over standard Category 5 4-pair unshielded twisted pair cabling, which you can buy almost anywhere. When we wired the house last year, we purchased the cable at a local Home Depot. Our local store also had the jacks, plugs, and even wall boxes.

Before you start thinking that pulling Category 5 cable is too difficult, consider that my twin sons, Bryan and Scott, pulled the cable throughout a large three-story colonial home using nothing more than an electric drill, long drill bit, and a cable stapler that was also purchased at Home Depot. At the time, they were just shy of their 15th birthday. They also managed to install the wall boxes, jacks, and wire up patch cords, and troubleshoot problems when something did not work as expected.

In doing so, they uncovered a number of tips that will make the process easier. The first is to start with the highest quality cable you can afford. It does make a difference, and is less likely to break internally when you are pulling it through tight places and around corners. If we were doing it all over again, we'd spend the extra money and buy Category 5 E (enhanced) cable, rather than the generic Cat 5.

Finally, spend the money on a LAN cable tester. They aren't very expensive, costing well under $100, and can save you hours of troubleshooting time. The one we use at the moment is the LinkMaster from Ideal Industries. You can find them on the Web (*www.idealindustries.com*) or call them at 800-425-0705. This is a terrific tool,

(Continued on page 18)

PETER PIETROMONACO

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The Versatile Visual Basic

Correction

The computer program in last month's "Computer Bits" column contains an error. The 8th line of type should read as follows:

inches=12*feet;

Visual Basic is a highly versatile, complex, and powerful application development system that has gained much popularity, especially in recent years. As with last month's introduction of C++, I will try to provide a general overview of the program to give you a broad working knowledge base.

Visual Basic is a fun program to learn, and it can be very useful as well. Once you've read through the article, and you feel you want to learn more about Visual Basic and how to use it to its full capacity, I encourage you to find a book you are comfortable with to learn it. There are many texts out there—just be sure it is easy to follow and caters to your level of overall computer comprehension. For example, if you fumble through simple software programs, don't buy a book that assumes too much prior knowledge on programming.

There are many other ways to access instruction and information on Visual Basic. Here are a few helpful resources:

- Visit *www.msdn.microsoft.com*, the Microsoft Developer's Network Web site. It contains links to news sources, technical articles, product information, source code, and downloads.

- Read the *Visual Basic Programmer's Journal*, a monthly magazine devoted to up-to-date programming information.

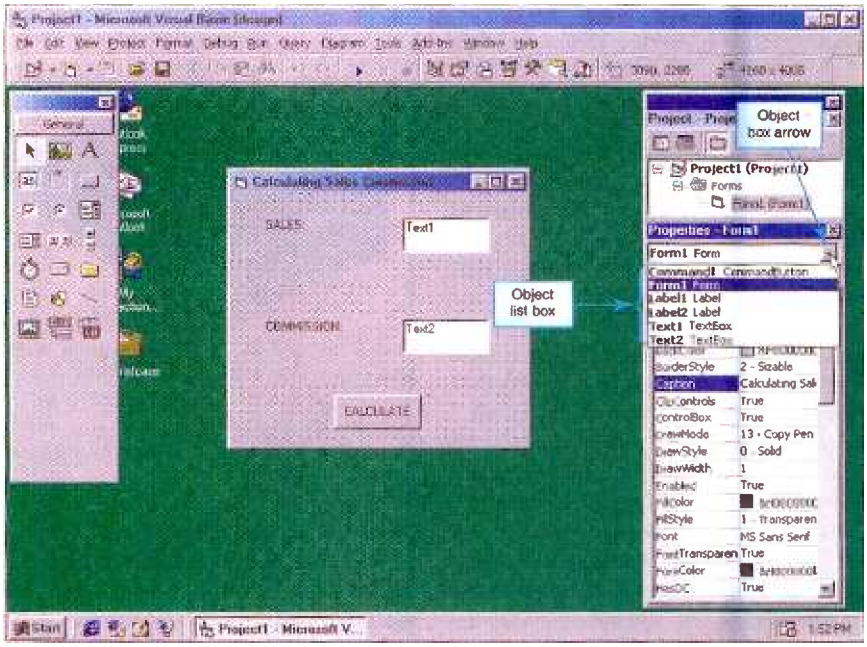


Fig. 1. Here is a screen shot of the Visual Basic program, including the ToolBar, Form, Object Box, and Properties List.

- Do a search for Visual Basic newsgroups. Some of them offer useful tips regarding user interface, syntax, etc.

- Take a class. This is a great way to get a jumpstart if you are not confident enough or just don't want to sift through tutorials and learn by trial and error.

- There are some online training opportunities that may prove to be worthwhile. Though I didn't examine any of them in depth and I would hesitate to recommend one specifically, I suggest you surf through a few of them—there could be a gem out there.

- Ask fellow programmers. Networking, or subtle "bothering," is sometimes the best way to get quick answers to simple—or not so simple—questions. A little guidance from a connoisseur can be the best medicine.

AN OVERVIEW

Visual Basic is a Windows application that helps you build your own customized applications and components for the Windows operating system. You can create professional-looking applications using the graphic user-interface of Windows—and you don't need any prior experience with computer programming. It is a pretty easy program to learn and use, and it is especially useful for quick application development by novices in the field or those in the world of business.

Visual Basic version 6 uses ActiveX technology, a set of software technologies, which allows for the integration and creation of software components called controls. ActiveX can be integrated into many different software products, and more than 2000 are currently available.

Ultimately derived from BASIC (*B*eginner's *A*ll-Purpose *S*ymbolic *I*nstruction *C*ode), Visual Basic 6 is based on the Visual Basic Programming Language. There are four editions to Version 6—Control Creation, Learning, Professional, and Enterprise. The Control Creation edition allows users to create new ActiveX controls as well as tailor existing ones. The Learning, Professional, and Enterprise editions have more advanced application development features, as well as Control Creation capability.

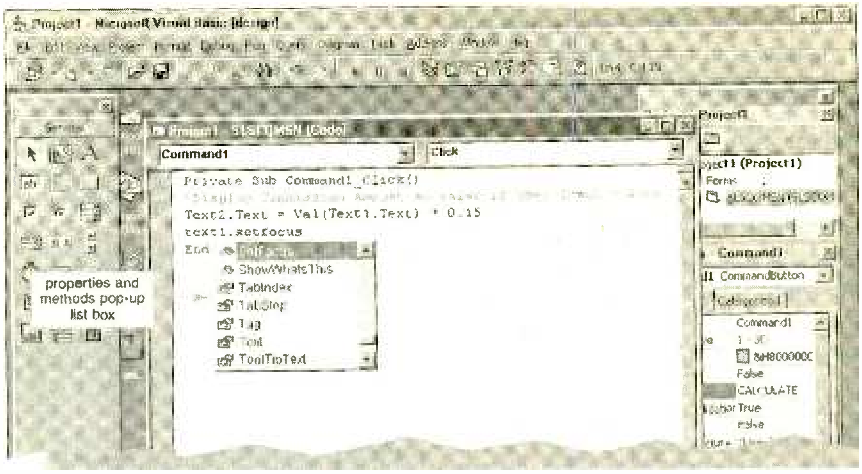


Fig. 2. This screen shot shows a block of code called a subroutine. Coding is made up of many subroutines, and each subroutine is attached to an object. For example this particular subroutine is taking the value of one textbox—or object—and multiplying it by 15%. Visual Basic programming uses dot notation to identify the objects and their properties.

IS IT OBJECT-ORIENTED?

We discussed object-oriented programming in last month's article on C++. To review this intricate concept, object-oriented programming is the set of interactions among objects and operations that form the plan of the computer program. The building block of object-oriented programming is an object—every object has properties attached to it in which you store data and operation functions that manipulate the data. An object could also be a set of multiple objects.

There has been some debate over whether Visual Basic is object-oriented or not. It is essentially event-driven and object based, but Visual Basic is not object-oriented in the true sense of the phrase. It doesn't have all of the features of a full-fledged object-oriented programming language. A principal distinction is that it uses subclassing through what is called aggregation and containment, and not through inheritance.

It isn't strictly a Visual programming language, either. In Visual Basic, only the interface is created visually—the rest is created by code.

UNDERSTANDING USER INTERFACE

User interface is the way a computer program accepts instructions from the user and then presents the results. Typically, most applications have a graphical user interface which provides visual features such as small pictures, or icons, to help the user give the instructions to the computer. As an example, Windows is the most widely used graphical user interface for PCs. A graphical user interface allows you to use text and graphical images cooperatively to communicate with the computer.

BUILDING AN APPLICATION

There are virtually limitless applications you can create with Visual Basic. Some common and pretty easy uses include:

- Creating your own personal telephone book
- Calculating mortgage payments, monthly sales, commissions, etc.
- Setting up conversion tables, like dollars to foreign currency.
- Tracking spending or investments.

Here is an example of an application where Visual Basic may come in handy. You are a programmer working for a retail store, and you are asked to develop a program for the salespeople to use that would calculate discounts and taxes on purchased items. The form should be neat and easy to use, and the sales personnel should be able to enter the list price of an item as well as the tax rate. The program should display the necessary information, including the net and gross price. Visual Basic provides all the tools needed to build this application.

You create applications with Visual Basic in a Three-Step Process—designing the form, setting the properties, and writing the code. Using the composition and syntax of BASIC, you must write the procedures that bring the components together. Visual Basic is inclusive of numerous built-in functions that can be applied to objects and controls, but you still have to write many of the procedures from scratch to customize your application.

Some of the specific steps involved, from beginning to end, include:

- Setting options for the SDI Interface.
- Setting the size and location of the form.
- Adding Label, Textbox, and CommandButton controls to the form.
- Adding controls by drawing and double-clicking.
- Setting Caption, Text, Locked, TabStop, and Name properties.
- Writing an event procedure.
- Adding comments to a procedure.

Describing the actual process in detail and taking you through every step of an application would literally take many pages. The best way to create your own application is to follow a step-by-step project outlined in a tutorial or other book you have chosen. If you complete each phase correctly, your application should run smoothly. Take your time, and if you run into errors—which you probably will on your first time out—then read on.

DEBUGGING YOUR PROGRAM

Basically, there are three types of errors you may run into when writing and trying to run your program. These errors, called compile errors, result from incorrect code such as mistakes in syntax; run-time errors that occur when a statement attempts an operation that is not possible; and logic errors when program produces unexpected outcomes.

Visual Basic actually furnishes you with several tools to analyze and troubleshoot your program. You can check the value of variables, step through code, and set breakpoints. Also included is an edit-and-continue feature that allows you to change code as your program is running. You can stop the operation of your program by selecting Break from the Run menu or clicking on the break button in the toolbar.

YOU'RE ON YOUR WAY!

Now that you have an idea of Visual Basic's uses and capabilities, you should be ready to take a crack at developing an application for either personal use or for your business or profession. The concepts aren't as complex as most other programs out there, so you shouldn't expect to get overly frustrated in the learning process. Good luck, and remember to use the built-in Help functions when things don't go as planned!

PEAK COMPUTING

(continued from page 15)

and shows you miswired connectors, shorts, and open wires. The instructions that come with the tester even show you the correct order to place the pairs into the RJ-45 modular connector. The LinkMaster is useful on all network-cabling projects, not just Gigabit over Copper.

SOURCE INFORMATION

D-Link
www.dlink.com

Ideal Industries
www.idealindustries.com

Netgear
www.netgear.com

NOT AS FAST AS POSSIBLE

Before you run out to buy a Gigabit over Copper switch and Ethernet adapter cards, realize that you probably won't get anywhere near full-duplex Gigabit Ethernet speeds with your current PCs. We have a mix of standard 100BaseT and Gigabit adapters in various PCs on our network. The PCs with 100BaseT adapters plug into a D-Link 8-port switch that has a Gigabit uplink. This uplink is plugged into the 8-port Netgear Gigabit switch.

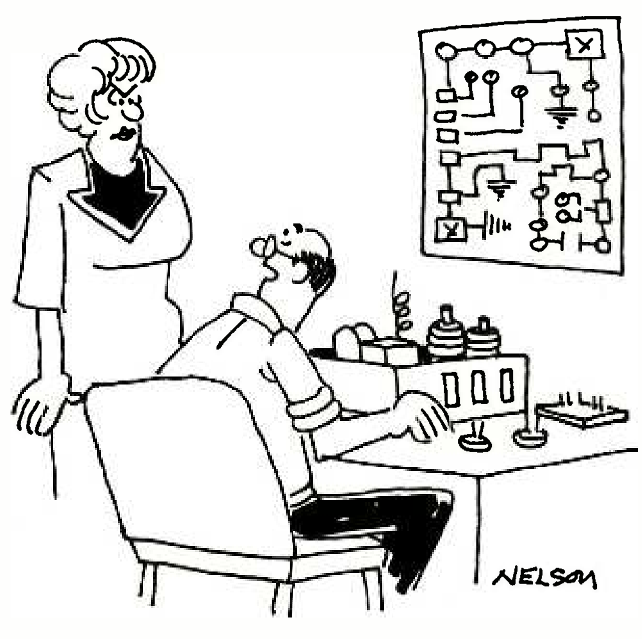
We have six PCs with Gigabit LAN adapters, three of them with Intel cards, two with Netgear adapters, and one with a D-Link card. Only two of these PCs, however, actually run at anywhere near Gigabit speeds. That's because the standard 32-bit PCI slots in most PCs can't provide the data bandwidth that a Gigabit Ethernet adapter needs to function at its rated speed. That task requires a 64-bit PCI card slot.

Standard PCs don't have these kinds of slots. But the Monster Workstation with the terrific dual-Xeon Tyan motherboard that we built a few issues back does. So does another PC we built more recently, which also has a Tyan motherboard. This is a dual Athlon MP 2000+ system with a Tyan Tiger MP motherboard. It's a terrific system, much less expensive than the "Monster," and also has a 64-bit PCI slot for the Gigabit Ethernet adapter.

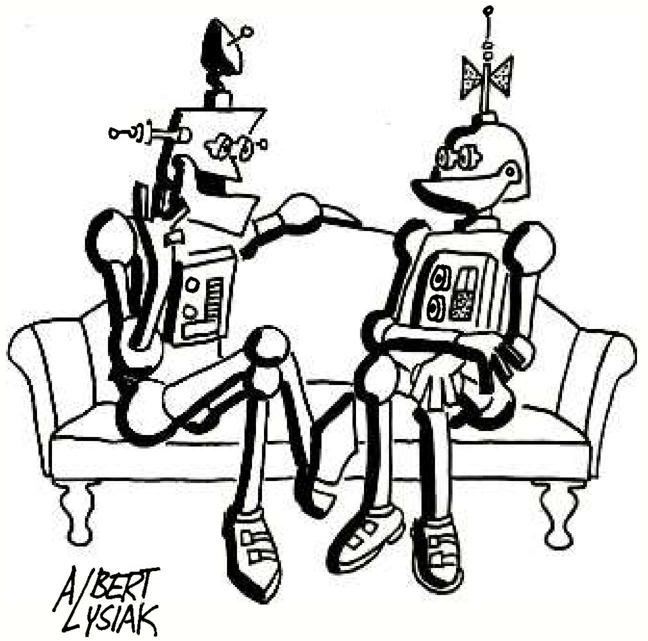
Both these system transfer data very fast, especially between each other. There is still some overhead involved, which slows things down a bit. Even the Gigabit cards mounted in the 32-bit PCI slots transfer data noticeably faster than those PCs on the network with 100BaseT adapters.

We definitely recommend jumping to Gigabit Ethernet over Copper as soon as you feel you can afford it. This is especially true if you have a very high bandwidth Internet connection or play a lot of the newest games over your network.

If not, use standard 100BaseT, secure in the knowledge that an upgrade to Gigabit Ethernet won't require a major re-cabling job.



"It's a hobby. It's supposed to take a lot of time."



"Well that's my programming in a nutshell. Tell me about your programming."

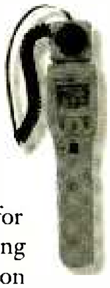
NEW GEAR

For more information go to page 80

or e-mail: requests@berkshire-is.com

USE THE FREE INFORMATION CARD FOR FAST RESPONSE

Digital Lightmeter



With a detachable 45-inch sensor flexcord designed for hard-to-measure locations, the *LM631 Multipurpose Digital Light Meter* ($99.95) appeals to a broad range of plant engineers, electricians, contractors, home inspectors, and business interior designers. It is perfect for verifying plant and office lighting to meet workplace illumination standards and OSHA requirements. Weighing only one pound and measuring two and a half inches, it easily slips into a pocket or holster.

WAVETEK METERMAN
P.O. Box 9090
Everett, WA 98206
877-596-2680
www.metermantesttools.com

CIRCLE 60 ON FREE INFORMATION CARD

Attenuator-Amplifier

The *Model 439 Two-Channel Attenuator-Amplifier* ($317) has a gain range of 118 dB in 1-dB steps (-78dB to +40dB), which is set by a front-panel rotary encoder and displayed on an LCD. Each channel's gain can be set independently or together, depending on the position of the Set Gain switch. A power amplifier is included to drive a stereo headphone for audiometric testing or other use. The design uses low-noise op-amps, which eliminates clock noise.

TDL TECHNOLOGIES
5260 Cochise Trail
Las Cruces, NM 88012-9736
505-382-3173
www.zianet.com

CIRCLE 62 ON FREE INFORMATION CARD

Power Packs

These versatile, rechargeable *Power Packs* (starting at $48) provide convenient 12-volt DC power wherever you need it. The sealed lead-acid battery is leak-proof and maintenance-free and combines high power with long run time. Ideal for powering tools, lighting, computers, radio equipment, and more, the packs feature a built-in circuit breaker, a cigarette lighter socket, and come in a heavy-duty zippered nylon case.

JENSEN TOOLS
7815 South 46th St.
Phoenix, AZ 85044
800-426-1194 or 602-453-2542
www.jensentools.com

CIRCLE 61 ON FREE INFORMATION CARD

Clamp Meter

Measuring AC current to 1000A and AC voltage to 600V with a 1.2% accuracy, the *Model 380974* ($149) is a unique combination of a clamp meter and phase-rotation tester. It also measures resistance, frequency, and capacitance and includes diode and continuity testing. Measurements are displayed on a 3¾-digit (3999) count LCD with data hold, peak hold, and a 40-segment bar graph. It comes complete with three test leads, a 9-volt battery, and a case.

EXTECH INSTRUMENTS
285 Bear Hill Road
Waltham, MA 02451-1064
781-890-7440
www.extech.com

CIRCLE 63 ON FREE INFORMATION CARD

Soldering Station

The *Weller Silver-Series Dual Digital Soldering Station* ($389) permits the use of two soldering irons, each with its own independent temperature setting. Tip temperature is electronically controlled through a temperature range of 100° F to 850° F. A pushbutton temperature control with an LED readout displays both temperature settings and tip temperature. The power base features a static dissipative housing to prevent ESD damage. The station operates on 120 V_{AC} and comes with a 3-wire power cord.

CONTACT EAST
7815 South 46th St.
Phoenix, AZ 85044
800-225-5370 or
602-453-2542
www.contacteast.com

CIRCLE 64 ON FREE INFORMATION CARD

Soldering Iron

Ideal for quick hobby repairs, the *Antex G3/U Miniature Soldering Iron* ($24.75) heats up fast—to 750° in just 45 seconds—and recovers instantly after soldering each joint. Since the heating element is directly under the tip, the mini-iron is easy to use with a plastic handle that stays cool to the touch. It is available with over 40 different slide-on style tips for a variety of specialized soldering applications, measures only 6½ inches long, and weighs under ¼ oz.

M.M. NEWMAN CORP.
24 Tioga Way
P.O. Box 615
Marblehead, MA 01945
800-777-6309
www.mmnewman.com
CIRCLE 65 ON FREE INFORMATION CARD

Power Supplies

Ideally suited for driving modern transducers, digital panel meters, operational-amplifiers, and data-acquisition components, these *AC/DC Instrumentation Power Supplies* ($54) feature impressively low output noise. Perfect for powering sensitive instrumentation, they accept universal AC inputs and deliver +5V_{DC}, +12V_{DC}, and/or +24V_{DC} outputs from single, dual, or triple-output configurations. They are offered in 5W, 10W, or 16W power ratings and have up to 80% efficiency.

DATEL, INC.
11 Cabot Blvd.
Mansfield, MA 02048-1151
508-339-3000
www.datel.com
CIRCLE 67 ON FREE INFORMATION CARD

DC Power Supplies

Intended for manufacturing, laboratory, and education applications, the *AEMC AX500 Series* (starting at $395) offers a comprehensive line of digital DC linear power supplies. Designed around highly-efficient torodial transformers, they dissipate little heat, have low electromagnetic emission, and will operate continuously at full-rated output. Three models are available offering single, dual, and triple output capabilities.

AEMC INSTRUMENTS
200 Foxborough Blvd.
Foxborough, MA 02035-2872
800-343-1391 or 508-698-2115
www.aemc.com
CIRCLE 66 ON FREE INFORMATION CARD

Cordless Screwdriver

This heavy-duty *7.2-Volt Cordless Screwdriver* ($179.95) offers 80 inches/lb. of maximum torque, an adjustable 2-position handle, variable trigger speed of 0–500 RPM, reversing capability, and a quick-release ¼-inch hex chuck for positive bit retention. Other features include a 16-position clutch, a metal gearbox, metal planetary transmission, a fan-cooled motor, a 115V_{AC} charger, two screwdriver bits, and a heavy-duty carrying case.

JENSEN TOOLS
7815 South 46th St.
Phoenix, AZ 85044
800-426-1194 or 602-453-2542
www.jensentools.com
CIRCLE 68 ON FREE INFORMATION CARD

Tool Set/Workstation

Designed for today's professional automotive technician, this *129-Piece Metric Tool Set and Mobile Storage Cabinet* ($2999) was specifically selected to provide the ideal tool mix. Constructed of steel and high-impact plastic, the mobile workstation features roller-bearing drawer slides and an integrated locking system to prevent theft or accidental opening. Just some of the tools include chain nose pliers, combination wrenches, ratchets, and screwdrivers.

SK HAND TOOL CORP.
9500 West 55th St., Suite B
McCook, IL 60525-3605
708-485-4574
www.skhandtool.com
CIRCLE 69 ON FREE INFORMATION CARD

NEW LITERATURE

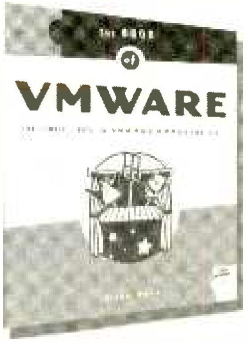
Wiring Device Catalog

from Leviton Manufacturing Co.
59-25 Little Neck Parkway
Little Neck, NY 11362
800-323-8920
www.leviton.com
Free

Now available on CD-ROM, this catalog showcases more than 1000 color photos and dimensional drawings to aid product comprehension and identification. It features an expanded technical and reference information section that helps define evaluation procedures and performance standards used to specify and select products. Both the printed version of the catalog and the CD-ROM use intuitive icons, information tiles, modular-specification tables, and color-coding techniques for logical presentation of the information.

The Book Of VMware

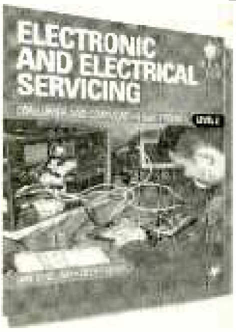
by Brian Ward
No Starch Press
555 De Haro St.
San Francisco, CA 94107
800-420-7240
www.nostarch.com
$39.95



This introduction to VMware Workstation is a comprehensive guide to everything from installation and device configuration to file transfers and networking. The book will show you how to get the most out of Windows, Linux, and FreeBSD; and set up VMware devices such as virtual disks, ethernet interfaces, USB devices, and more. You will also learn how to troubleshoot common problems and set up dual-configuration systems.

Electronic and Electrical Servicing: Level 2

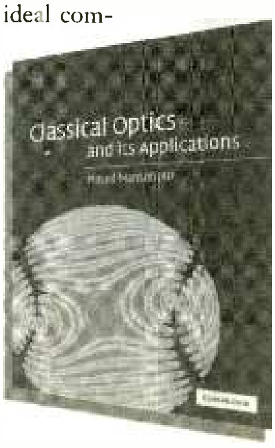
by Ian Sinclair and Geoff Lewis
Newnes Press, Butterworth-Heinemann
225 Wildwood Ave.
Woburn, MA 01801
781-904-2500
www.bh.com
$29.99



Designed to provide complete coverage of the five core units of the new Level 2 Progression Award from City & Guilds, this text gives a thorough grounding in the electronics and electrical principles required by service engineers (it's endorsed by the EEB). Topics include health and safety, alternating currents, combinational logic, DC technology, audio and television, semiconductor diodes, and more.

Classical Optics And Its Applications

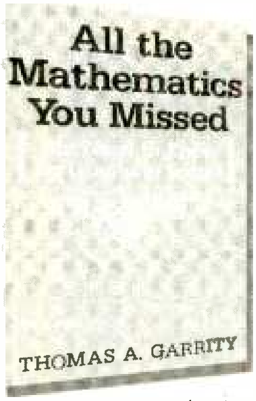
by Masud Mansuripur
Cambridge University Press
40 West 20th St.
New York, NY 10011
212-924-3900
www.cambridge.org
$45



Covering a broad range of the major topics in classical optics, this text is an ideal companion for graduate-level courses in optics, providing supplementary reading material for teachers and students alike. Industrial scientists and engineers developing modern optical systems will also find this book an invaluable resource. Mathematical content is kept to a minimum, as the book aims to give the reader insight into optic phenomena with the help of diagrams, graphs, and computer-simulation images.

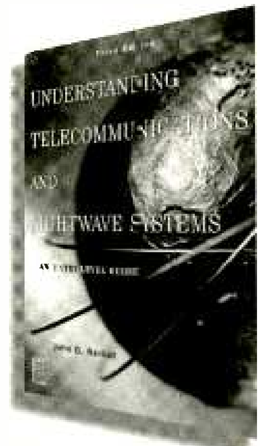
All The Mathematics You Missed But Need To Know For Graduate School

by Thomas Garrity
Cambridge University Press
40 West 20th St.
New York, NY 10011
212-924-3900
www.cambridge.org
$25



Are you considering a career in a math-related field, but feel you need to brush up in certain areas? This book is ideal for advanced undergraduate, and beginning graduate students in mathematics, physical sciences, engineering, computer science, and economics. It covers important topics in math, illustrating basic points and emphasizing the intuitions behind the subject. The content covers linear algebra, vector calculus, differential geometry, probability theory, complex analysis, and more.

Understanding Telecommunications and Lightwave Systems: An Entry-Level Guide, Third Edition

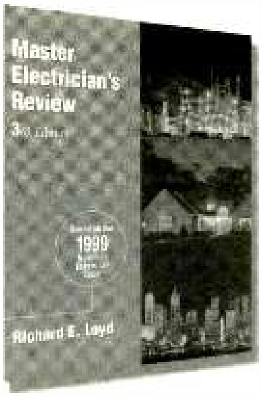


by John G. Nellist
John Wiley & Sons
1 Wiley Drive
Somerset, NJ 08875-1272
800-225-5945
www.wiley.com
$95

This guide to the basics of telecommunications and digital technology presents a nontechnical treatment of how voice, video, and multimedia simultaneously travel over modern systems. The author's examination of recent developments includes third-generation cell phones with microbrowser capabilities, changes in the global PCS network, satellite communications, and more.

Master Electrician's Review

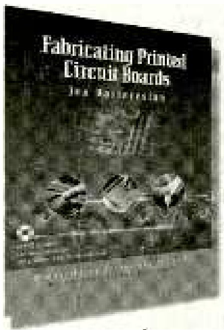
by Richard Loyd
Delmar, Thomson Learning
P.O. Box 8007
Clifton Park, NY 12065
800-998-7498
www.delmar.com
$66.95



Chock-full of knowledge and professional expertise, this study guide is ideal for aspiring licensed master electricians. It has new, realistic practice exams with the answers in the back and a math refresher for updating skills in fractions, decimals, square roots, and powers. Each chapter examines a specific topic on the master electrician licensing exam in detail, from general wiring methods and branch circuits to special conditions and communications systems.

Fabricating Printed Circuit Boards

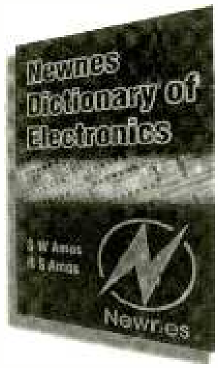
by Jon Varteresian
LLH Technology Publishing
3578 Old Rail Road
Eagle Rock, VA 24085
540-567-2000
www.llh-publishing.com
$29.99



Providing a complete overview of the printed circuit board design process, this text describes how to produce printed circuit boards in small quantities (ideal for prototypes) with an emphasis on safety. The author begins with the conversion of a schematic diagram into a board layout and proceeds to the fabrication of the board itself.

Newnes Dictionary Of Electronics

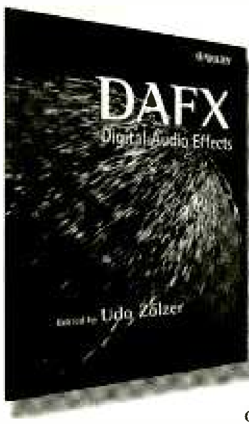
by S. W. Amos and R. S. Amos
Newnes Press, Butterworth-Heinemann
225 Wildwood Ave.
Woburn, MA 01801
781-904-2500
www.bh.com
$24.99



An essential item on the bookshelves of electronics engineers, managers, technicians, students, and enthusiasts, this book is written in a compact format that makes it an ideal working dictionary. The definitions are clear and concise and supported by numerous illustrations and circuit diagrams. It also features a substantial, handy section devoted to acronyms and abbreviations, like ADDER, LAP, FIB, and WORM.

DAFX: Digital Audio Effects

by Udo Zölzer
John Wiley & Sons
1 Wiley Drive
Somerset, NJ 08875-1272
800-225-5945
www.wiley.com
$95



Aiming to present the main fields of digital audio effects, this book introduces the reader to digital signal-processing concepts, as well as software implementations using MATLAB. Contributors analyze the latest findings and developments in filters, delays, modulators, and time-frequency processing of sound. The approach of applying digital signal processing to sound will appeal to sound engineers, as well as researchers and engineers in the signal-processing field.

BUILD "THE TUBESTER"

NICK CINQUINO AND GORDON MACMILLAN

Tube amplifiers have an almost supernatural reputation among electric guitar players because it is widely believed that a tube amp sounds better in some qualitative way, often described as warmer or fuller than a solid-state amp. Ever since transistor-based amplifiers took the place of their tube counterparts, controversy surrounds the relative merits of each. Some audio experts claim that there is no significant audio difference between a (properly designed) tube or transistor amp, and this is probably true so long as the amps aren't overdriven. Other audio experts say differences do exist, that tubes add different harmonic content and filtering possibly due to higher inter-electrode capacitances and/or mechanical vibrations (microphonics) and/or transformer inductances. Furthermore, when a tube is driven into severe distortion due to saturation or cutoff, the waveform is different from that of an overdriven transistor, e.g. less sharp squarewave edges. There have been many attempts to reproduce the tube-amp sound with solid-state devices. Maybe there's no shortcut—a tube must be used to incorporate all of its specific non-linear properties!

What's On Your Plate? In this very unusual construction project, we'll build the *Tubester*, a tube pre-amp/effects box for electric guitars that is connected between the guitar and power amplifier. The circuit is a bizzare combination of integrated circuits and tubes! If you play an electric guitar, know someone who does, or just always wanted to tinker with an old vacuum tube like Grandpa used to wrestle with, this project is for you! Some other big plusses include: no high DC tube plate voltages to throw you across the room; inexpensive, easily acquired components; simple design; and very low parts count. If you've ever taken a look at a typical tube circuit schematic, the plate voltage is often $100V_{DC}$ or higher (ouch!), and there are lots of specialized transformers between tube stages. Well, in our circuit, the tube selected gives good gain even at a non-painful $9V_{DC}$, and we've done away with annoying, expensive transformers by the use of modern ICs. The whole project should cost less than $30!

This project is an inexpensive, safe, and easy introduction into vacuum-tube electronics, audio pre-amps, and audio distortion.

Back To The Future...With Tubes! A quick review of vacuum-tube electronics is in order. Refer to Fig. 1 for the not-so-very-familiar schematic of an electron tube! The heater filament causes a cloud of electrons to form around the cathode. The plate is at a positive potential relative to the cathode, so those negatively charged electrons around the cathode want very badly to travel to the plate and the only factor stopping them is the grid voltage. The grid, which lies between cathode and plate, will repel the cathode electrons when negative and will allow current flow when positive. It sounds a lot like an FET, doesn't it? Thus, there is a cathode-to-plate resistance present that is controlled by the grid. When we add R1, the plate load resistance, we now have a voltage divider and can sample a grid-controlled variable voltage output, precisely what's needed!

Next, look at Fig. 2, which is a plot of grid voltage vs. plate divider voltage for our 6F5 tube test circuit with $9V_{DC}$ at the plate and variable grid voltage. Note the significant gain and also note the large, fairly linear range bordered on both ends by curved non-linear regions. Our circuit will apply the guitar audio to either the linear range for clean hi-fi sound or to the non-linear region to generate the tube-distortion sound. A tube is of course much bigger than an FET, but one interesting advantage of a tube is that it is relatively impervious to ESD (electrostatic discharge) and even EMP (electro-magnetic pulse)—just don't drop the bugger!

How It Works. An electric guitar's output of about 50mV is applied to IC1, a 741 op-amp with a gain of about 40. (Refer to Fig. 3.) Note that pot R1 is connected to U1 in the input offset null circuit, allowing slight changes in the DC voltage level at the output of IC1, which in turn affects the bias level of the tube's grid (similar to a gate or base transistor bias). This allows us to bring the audio wave closer to the "knee" of the tube's performance curve (see Fig. 2), a very non-linear region! The cleanly amplified output of IC1

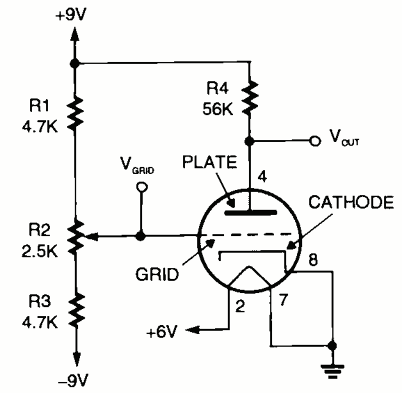


Fig. 1. An easy test circuit that will familiarize you with the characteristics of a 6F5 high-mu triode tube. Note pinout markings.

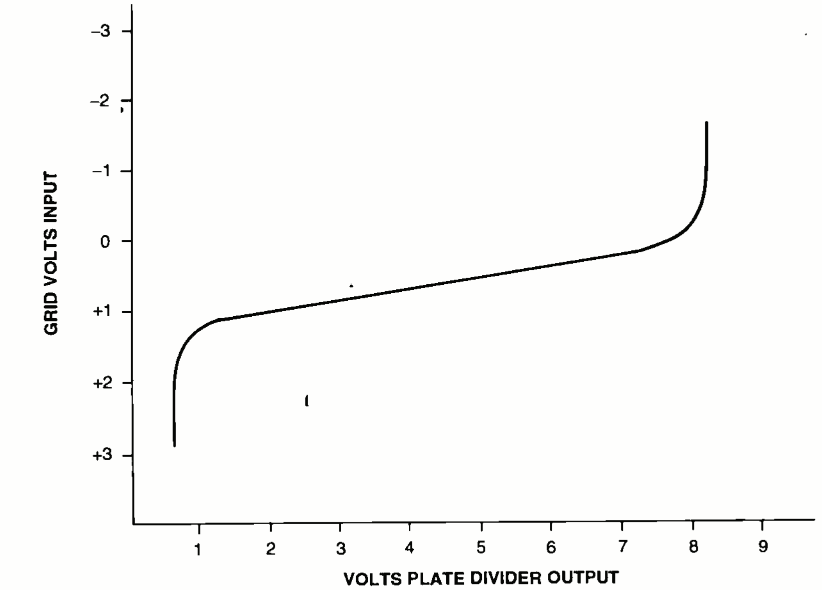


Fig. 2. A plot of plate-divider output voltage versus grid-input voltage, from the circuit of Fig. 1.

is variable via pot R2 from 0V to about 2 volts peak-to-peak, with a variable DC component as discussed previously. This waveform is direct-coupled to the 6F5 tube's grid, which amplifies the wave by about X5.

For low-amplitude inputs, the output will be undistorted, but high inputs will obviously "run out of headroom" and get "squashed" on one or both ends. The circuit is totally variable between these two extremes, from undistorted to significantly distorted and everything in between. This high-impedance audio output is sampled from the plate divider, and RC coupled via R10 and C1 to IC2, another LM741 set up simply as a buffer or voltage follower. It takes the place of a coupling transformer by taking in the high-z audio and outputting a relatively low-impedance audio wave. It has no effect on the amount of distortion from the tube. Pot R3 adjusts the output level from the 741 buffer to your audio power amp, which could be solid-state or tube. Note that we're dealing with two separate power supplies; a $\pm 9V_{DC}$ for the tube plate and op-amps and a $6V_{DC}$ (4 C batteries to deliver 150mA) for the tube filament or heater. You can even get away with 4 AA cells, if you don't mind changing them frequently.

Getting It Together. Review the items on the Parts List and acquire the items you don't have "in stock." Start by mounting the tube socket, pots, switches, LEDs and phono jacks into the medium-size project box. A 1-inch hole-cutting saw/drill probably gives the cleanest cut for the tube socket hole in a plastic enclosure.

Next, make the circuit board to hold the two op-amps and other components. Since this is an AF circuit, layout isn't critical—just avoid scrunching everything together too tightly. The unit pictured in Fig. 4 has a 2-inch piece of "matchboard" (laid out like a breadboard) holding the soldered components and input/output wires. Use Fig. 4 as a placement guide for mounting the items to the enclosure. Use a short piece of shielded cable to connect the output of IC1 to the 6F5's grid that is at the top of the tube. When soldering the leads to the tube socket, double-check the

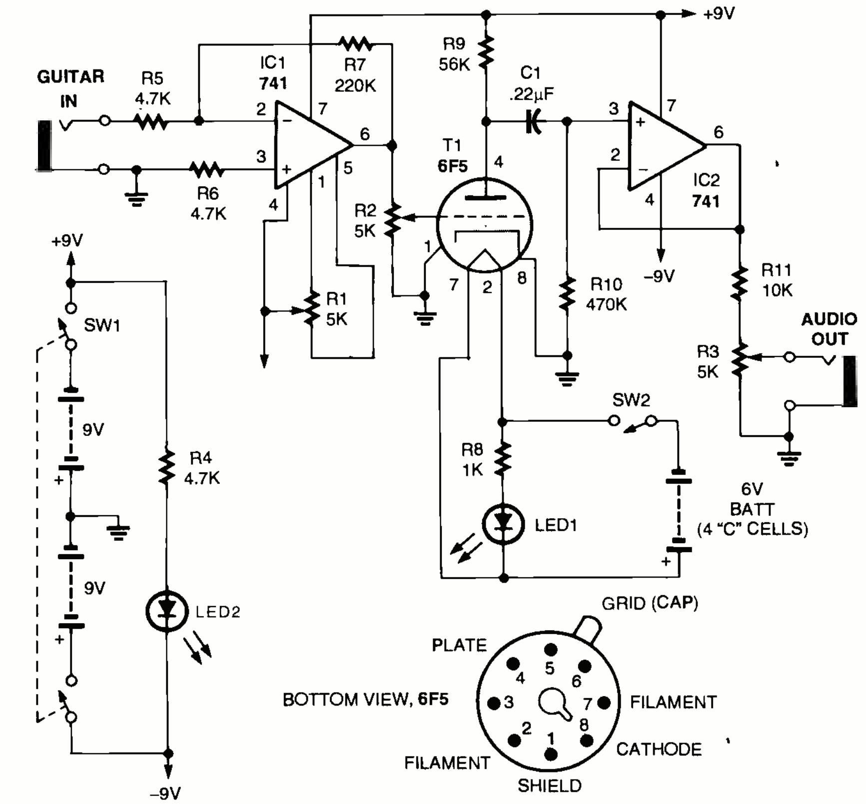


Fig. 3. The complete circuit schematic for the Tubester pre-amp, plus a bottom view pinout of the 6F5.

PARTS LIST FOR THE TUBESTER PRE-AMP FOR GUITAR

VACUUM TUBES
T1—6F5 high-mu triode

SEMICONDUCTORS
IC1, IC2—LM741 op-amp
LED1, LED2—T1 ¾, any color

CAPACITORS
C1—0.22-µF

RESISTORS
(All resistors are ¼-watt, carbon-film units unless otherwise noted.)
R1, R2, R3—5000-ohm linear potentiometer
R4, R5, R6—4700-ohm
R7—220,000-ohm
R8—1000-ohm
R9—56,000-ohm
R10—470,000-ohm
R11—10,000-ohm

ADDITIONAL PARTS AND MATERIALS
J1, J2—¼-inch mono phono jacks
B1, B2—9-volt batteries
B3—Four "C-cells" in series
SW1—Dpdt mini-switch
SW2—Potentiometer switch, add-on type
Octal tube socket, tube grid cap, 9-volt battery clips, holder for 4 C cells (6V), three pot knobs, medium project enclosure, 6-inch shielded cable

SOURCES
The 6F5 tube, grid cap and octal socket are available through:
TRIODE ELECTRONICS
www.triodeel.com
773-871-7459
or
ANTIQUE ELECTRONIC SUPPLY
480-820-5411
www.tubesandmore.com

The rest of the components/parts are available through RadioShack.

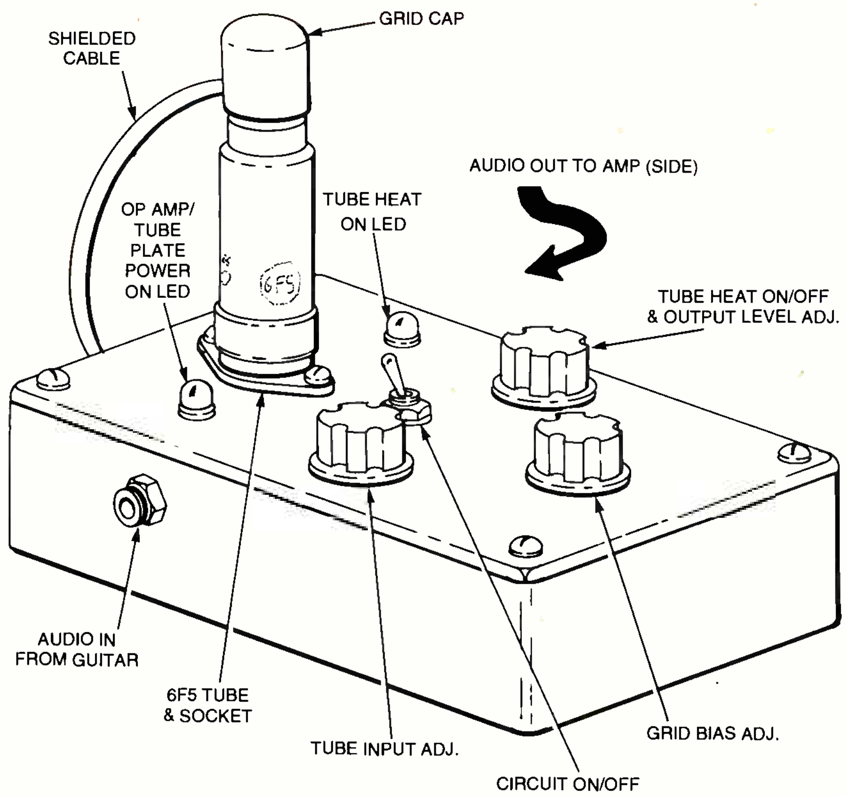


Fig. 4. A diagram of the completed Tubester project, with suggested layout of pots, tube socket and tube, in/out jacks, LEDs and switches. See the photo for another view. The 6F5 tube gives the project a funky, menacing appearance!

connections via the schematic to make sure everything is right, since working with tubes is so...different!

Double-check all PC board input/output wires, since there are quite a few of these running to the pots, etc. Finish off your tube pre-amp by plugging in the tube, connecting the grid cap, installing all the batteries, and adding the pot knobs.

Ready To Rock! Well, we're ready to wake up Jimi Hendrix with our own rendition of "Star Spangled Banner!" Okay, maybe not. At any rate, let's test the unit. Plug an electric guitar into the input jack, and plug the output into a musical instrument power amp. Switch on the power amp, then switch on your pre-amp's tube heat power and circuit power, and...Hey! Something's wrong. It's not doing anything! Welcome to the world of tubes, the little bugger needs about 30 seconds to warm up; you'll have to wait until your tube is good and ready to cooperate!

Ahhh, that's better—you hear the guitar now! There are some general guidelines to using your pre-amp. For clean sound, keep the tube input low (pot R2) while keeping the buffer output high (pot R3). For distortion, dial up the opposite, i.e. high tube input, low buffer output. For a cool 60's sound, boost your amp's treble and bass while attenuating midrange. Dial up just a little distortion on the pre-amp, and if your amp has reverb, lay it on thick, while picking close to the bridge! Note that the kind of distortion produced is not heavy-metal style, it's much gentler, warmer, and bassier than a typical "fuzzbox."

Adjusting pot R1 makes very subtle changes in the sound—have fun experimenting with that. Since the unit is essentially a pre-amp, it may be very helpful in pre-amplifying older electric guitars with weak pickup magnets. When LED 1 or 2 starts to dim, you'll know it's time for a battery change. Keep in mind that tubes do go bad—they're supposedly designed for 1000 hours of gentle use. If the circuit quits altogether or loses gain, and all batteries are OK, suspect the tube. You might want to dredge up Grandpa's old tube tester!

Finally, in the effort to increase microphonics, try keeping the effects box close to the magnetic fields and mechanical vibrations of the amp's speaker and circuitry; this may again cause subtle, tube amp style changes in the sound of your setup! Your tube pre-amp is cool, man, cool! ■

Amazing Grace

MARIA ORLANDO

It's a truly remarkable feat that a woman born at the turn of the century earned a Ph.D. in Mathematics from Yale University, programmed the first large-scale digital computer, and served in the U.S. Navy at the rank of Rear Admiral. That's just the beginning. Grace Hopper, or "Amazing Grace" as she was called by her close friends and comrades, had an extraordinary career in computer science, software development, teaching, the military, and business management. Dedicated to the advancement of computer technology, she created the first compiler, programmed the first computer, and developed the precursor to the COBOL programming language.

Grace was blessed with fiery ambition and a love for math and science, a combination that led to astounding success. She was also an eloquent speaker and gifted teacher, known for her inspirational lectures, of which she gave over 200 in her lifetime.

The Beginning. Grace Brewster Murray was born on December 9, 1906 in New York City, the eldest of three children. Both of her parents were huge sources of motivation. Her mother, Mary Van Horne Murray, had a passion for mathematics, which she passed on to her daughter. Walter Murray, her father, was an essential role model in her life. Though he was physically handicapped due to a double leg amputation, he continued to work as an insurance broker. Grace admired him for his fortitude and strong will. Because of his positive attitude and his ability to overcome such a hardship, she knew she was capable of anything.

"A ship in port is safe, but that is not what ships are for. Sail out to sea and do new things." – Grace Hopper

As a young girl, Grace had a keen curiosity for mechanics and the physical nature of machinery. She was known to fiddle with gadgets from time to time. At the age of seven, she dismantled seven alarm clocks in her family's house, then tried to put them back together—she wanted to know how things "ticked."

Walter and Mary Murray wanted their daughters to flourish in a society where, traditionally, females were discouraged from being educated, trained, and having lifelong careers. Both girls attended private schools, with expectations of attending college and becoming professionals.

In 1924 she attended Vassar College where she studied both math and physics. Grace then went on to study at Yale, where she finished a Master's and Doctorate program in Math. In her thesis "A New Criterion For Reducibility Of Algebraic Equations," she proved problems geometrically, which she said "upset everybody, but I always liked geometry better."

Fond of the world of academia, Grace accepted a teaching position at Vassar, and eventually became an Associate Professor. During her years of teaching she married Vincent Foster Hopper, a Professor of English at New York University. They never had any children and later divorced.

The Patriot. Grace's family had a history of serving in the Military. Her great grandfather was a Rear Admiral in the U.S. Navy, and his dignified appearance dazzled her as a child. She recalled "I was about three years old when I met him...He was tall and straight, and carried a black cane with a silver top on it...He was a very impressive gentleman!"

In keeping with the tradition, Grace resigned from Vassar in 1943 in the midst of World War II and joined the U.S. Navy. Enlisting was not so easy for her, however. The U.S. Government declared that math was crucial to the war effort, and felt she could be best utilized as a civilian. Besides that, Grace was underweight according to military standards—105 pounds. Taught by her father how to overcome obstacles, she fought back, and obtained a waiver for the weight requirement and special government permission. In December of that year she was sworn in to the U.S. Naval Reserve.

In 1944 she was commissioned a lieutenant and was assigned to the Bureau of Ordinance Computation Project at Harvard University. There she worked on the first full-scale digital computer—the 51-foot long, eight-

Captain Grace Hopper, Head of the Navy Programming Language Section, at her desk.

foot high Mark I.

Grace worked with a team of developers, led by Howard H. Aiken, who were responsible for programming the monster computer. Aiken first greeted her with "Where the hell have you been?", and then proceeded to say "Here, compute the coefficients of the arc tangent series by next Thursday." Always up for a challenge, Grace dove right into her work. She and her comrades were the first ever to program the Mark I. This was a rare and admirable accomplishment, especially for a woman of that era.

Grace receives congratulations from President Reagan at the White House following her promotion to the rank of Commodore.

During that time, the Mark I was being used to calculate angles for aiming Naval guns and self-propelled rockets. She and her teammates were required to put in long hours, transcribing and inputting codes to insure the system was running properly. Recognized for her hard work, Grace received the Naval Ordinance Development Award in 1946.

A Vision is Realized. Though she retained a position in the Navy reserves, Grace felt the need to move on. In 1949, the Eckert-Mauchly Computer Corporation hired her as a senior mathematician, where she worked with the BINAC, the Binary Automatic Computer. The BINAC was programmed using C-10 code instead of punch cards, which were used by the Mark series. The BINAC led the way to the UNIVAC I and II, the first commercial computers.

HONORS AND AWARDS

Here is a sampling of some of her Honors and Awards she received over her lifetime. There are over 65 of them in all.

1946—Naval Ordinance Development Award
1962—Fellow, American Association for the Advancement of Science
1964—Society of Women Engineers, SWE Achievement Award
1968—Institute of Electrical and Electronics Engineers, Philadelphia Section Achievement Award
1969—Data Processing Mgmt. Assoc., Computer Science "Man Of The Year" Award
1970—American Federation of Information Processing Societies, Harry Goode Memorial Award
1972—Wilbur Lucas Cross Medal, Yale University
1972—Fellow, Association of Computer Programmers and Analysts
1973—Distinguished Fellow of the British Computer Society
1976—Honorary Doctor of Science, Pratt Institute
1980—Navy Meritorious Service Medal
1983—Federally Employed Women Achievement Award
1983—Living Legacy Award, Women's International Center, San Diego

Grace Hopper was a visionary with perseverance, and one of her goals was to make computers more accessible to a wider range of people. Determined that programming could be more user-friendly, she wanted to develop a programming language that could be understood by the layman, something closer to "plain English." Most programmers scoffed at the idea of a computer comprehending anything but complex code, and so she stood alone in her philosophy.

That didn't have an adverse affect on Grace, however. Instead she was driven to prove herself right. She was sure that a programming language could be simplified, somehow.

Her persistence finally paid off. Three years later

Grace developed FlowMatic, the first English-language data processing compiler. FlowMatic was the only business language that existed at the time, and it served as the foundation for COBOL (*CO*mmon *B*usiness-*O*riented *L*anguage), which was released in 1959.

Her Career Progresses. Eckert-Mauchley was bought by the Remington Rand Corporation (who eventually merged with the Sperry Corporation to become Sperry-Rand), and they appointed Grace as Systems Engineer and Director of Automatic Engineering Development of the UNIVAC Division. During her time at Sperry-Rand, Grace stayed connected to the world of academia and the U.S. Navy as a visiting lecturer and consultant. She thrived on holding multiple jobs and keeping extremely active.

In 1967, however, she was recalled to active duty in the Navy, forced to take military leave from her job, and finally retired from Sperry-Rand in 1971 at the age of 65. When Grace retired from the Navy in 1986, she was the oldest active duty officer in the U.S., and she had reached the rank of Rear Admiral.

Her career was not yet over, as she still had some fire left at the age of 80. Digital Equipment Corporation hired her as a senior consultant, where she stayed until 1990.

Grace Hopper attends groundbreaking ceremonies for the Grace Hopper Navy Regional Data Automation Center.

In her honor, the USS Navy named one of their most capable warships the USS Hopper.

An Inspirational Teacher. Remembered as a charming, tiny, white-haired lady in a Navy uniform by her comrades and students, she was a feisty, brilliant leader with a passion for change. She is quoted as saying "Humans are allergic to change. They love to say 'We've always done it this way.' I try to fight that. That's why I have a clock on my wall that runs counter clockwise."

She was known to captivate her audiences with her inspirational lectures, where she spoke of advancements in the field of computer technology and the need for change in the future. Her favorite age group were the 17-20 year olds, who for her represented opportunity. They were the wave of the future, full of life, ready to take on new challenges, and she served as a source of encouragement to them.

Grace was a born leader with a positive outlook on life and the world of business. She believed people, especially young adults, need mentors in their lives. To quote her: "You manage things, you lead people. We went overboard on management and forgot about leadership. It might help if we ran the MBAs out of Washington."

A Futurist And Pioneer. Admiral Grace Hopper received many awards and commendations (see Sidebar) for her contributions and accomplishments in academia and developments in computer technology. She saw the potential of computer applications, and through her persistence and determination she was the driving force behind many advances in programming.

She died on January 1, 1992 in Arlington, Virginia, and was buried with full Naval honors at Arlington National Cemetery. Though most remember her for work with computers, it was teaching and service to her country that she was most proud of. P

Pinewood Derby Digital Race Timer

DOUG MALONE

If you have ever been involved with a Pinewood Derby you know how seriously the contestants (and some parents) take the races. You will probably want to do everything you can to make things run smoothly. This construction project is the result of my desire to do just that and comes from personal experience.

As the person responsible for running my son's Pinewood Derby races, I was very interested in fair and fun races for the contestants and their families. I had inherited a nicely made race-track and also an electronic end-of-race detector for two lanes. The detector was to indicate the winner of each heat so that the double-elimination tournament could proceed smoothly. However, there were four serious problems with the equipment and race procedures.

First, the end-of-race detector indicated a tie whenever the race was close. Second, when the two cars racing were very closely matched, it was very time consuming to keep switching them back and forth until one car had won in both lanes. Third, it was no fun dealing with the intricacies of insuring that each car raced an equal number of times, particularly when there was an odd number of contestants for a particular heat. Fourth, the end-of-race detector gave no indication to the crowd which car had won.

Ready, Set, Go. Design and build this digital timer for a fair and fun race

In addition, dealing with upset parents (due to the above problems) was very distressing. To avoid all of these problems, I decided to design and build the *Pinewood Derby Digital Race Timer* with an optional-remote display. The design criteria were that the unit would have enough timing resolution to avoid ties and that the remote display with large, easily read digits would inform the spectators of the race-elapsed time. Each car would run in the same lane, with the fastest time out of three trials counting. In view of the seriousness with which many contestants view the races, extra care was taken to insure reliable operation. Specifically, race-start and race-end sensors use Schmitt-trigger and other noise-reducing circuitry. Another design feature is that identical hardware and software are used in both the master timing unit at the scorer's table and the remote display. This means that if the timer fails on race day, the remote display can be pressed into duty for use as the race timer to keep the competition going.

Alternatively, there could be only one unit for use by the score-keeper. The resulting timer can accommodate races of up to 9.999 seconds in duration with either .001 seconds (1msec) or .00025 (250µsec) resolution, depending on the software version. Five 0.8-inch seven segment LEDs display the race-elapsed time that can be easily read from over 20 feet. To make it quick to set up (and break down for storage), both sensors and the master and remote units are interconnected by cable assemblies that use modular telephone plugs.

Circuit Description. As the circuit diagram in Fig. 1 shows, the master-timing unit (and optional remote display) is built around a Z80 microprocessor, IC7. The 3.072-MHz oscillator, IC2, orchestrates processor-instruction execution, serial communication, and race-elapsed time computation—see the Sidebar for an explanation on why this particular frequency was chosen. Program storage is provided by a 27C64 8K × 8 SRAM, IC6. The race-elapsed time is measured with a Z80 family CTC (Counter/Timer/Chip), IC3. Serial communication with the remote is accomplished through IC4, a Z80 family SIO (Serial Input/Output) IC. TTL level signals from the SIO are translated to RS232 levels by IC5. Race-elapsed

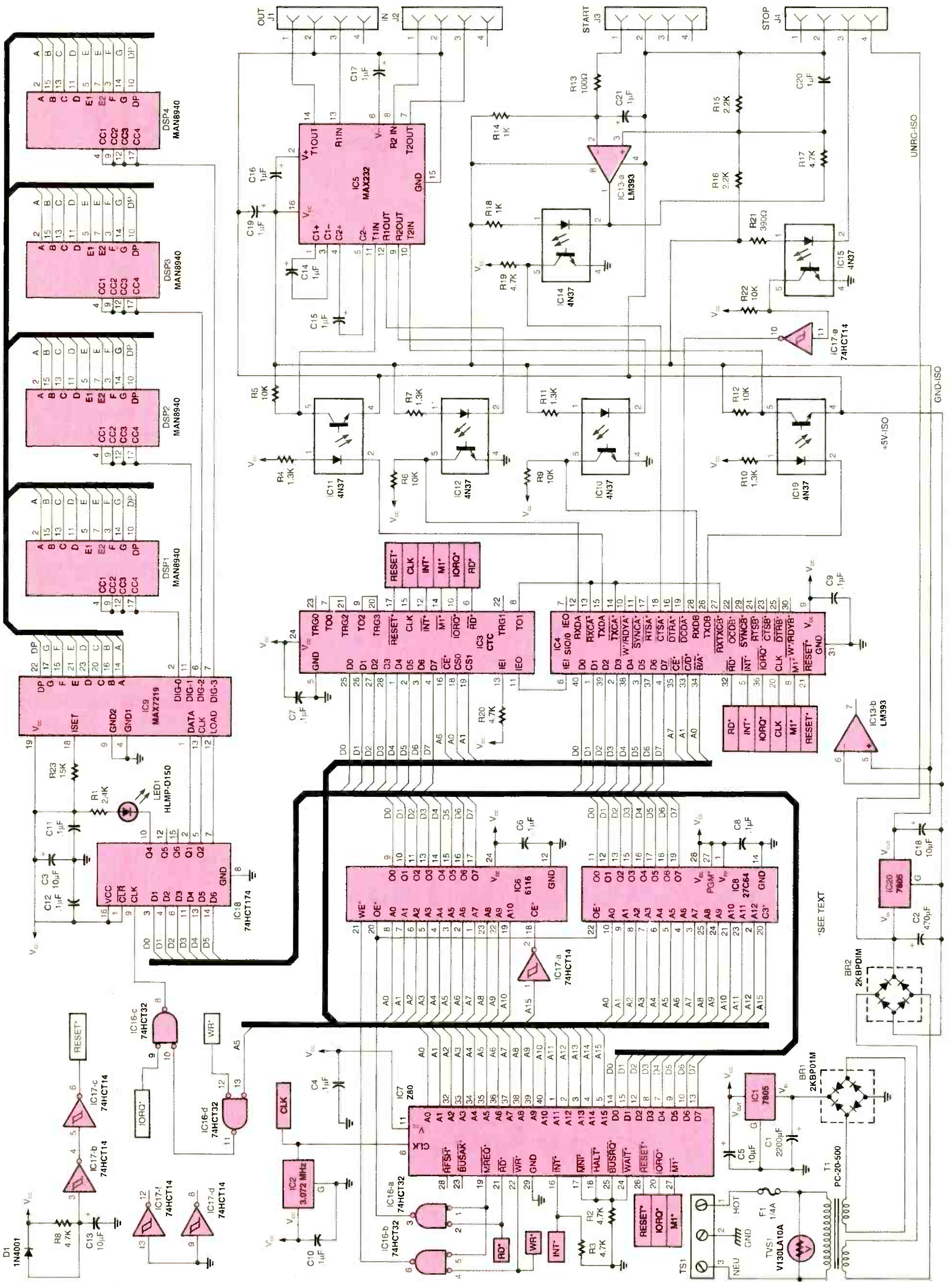


Fig. 1. The Pinewood Derby Timer is built around a Z80 microprocessor. Four seven-segment LED displays show the race-elapsed time and opto-isolated inputs and outputs insure reliable operation.

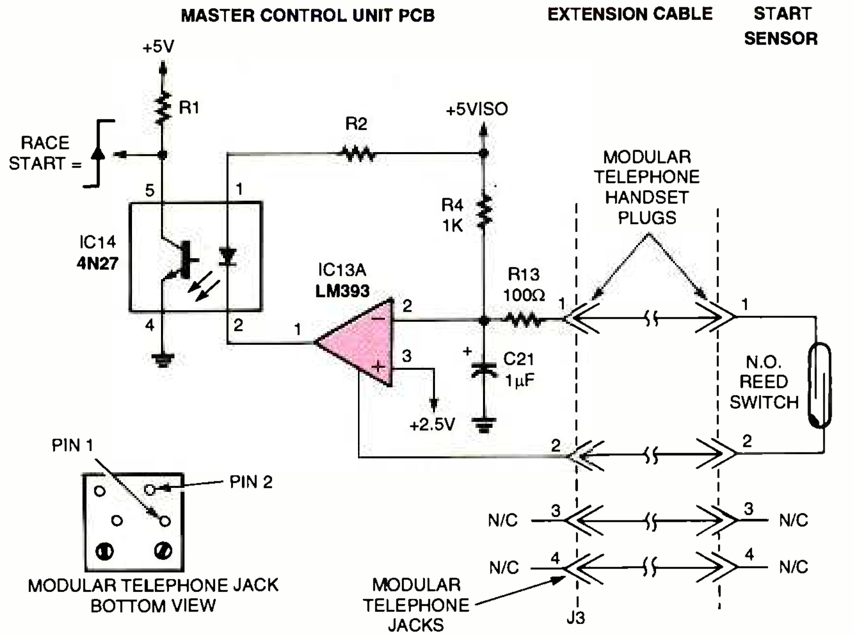


Fig. 2. A telephone handset cable connects the start sensor to the master control unit PCB. When wiring-up the reed switch, carefully follow the telephone jack pin-out diagram.

time is sent from the Z80 data bus to the latch, IC18. Then IC9 receives the latched data and drives the multiplexed seven-segment LED displays, DSP1–DSP4. Two separate 5-volt regulators, IC1 and IC20, provide power for the processor board and serial communications, respectively.

On power-up, the Z80, SIO, and CTC are reset by the combination of R8, C13, D1, and Schmitt triggers IC17B and IC17C. Diode D1 provides a discharge path for C13 allowing the power to be cycled on/off/on fairly rapidly and still generate a reset pulse. This diode also avoids potential reliability problems, resulting from C13 attempting to discharge through the input of IC17B when power is turned off.

Power Supply. Two separate 5-volt power supplies are used in the race timer; one for the processor and related circuitry and the other for the serial interface and start and stop sensors. The power transformer, T1, has two 10-volt secondary windings that feed separate bridge rectifiers, BR1 and BR2. A 5-volt regulator, IC1, provides the supply voltage for all on-board circuitry except for the opto-isolators associated with serial communication and the start-sensor comparator, IC13A. The second 5-volt regulator, IC20, provides power for the serial data opto-isolators IC10, IC11, IC12, IC14, IC15, and IC19; the start-sensor comparator, IC13A; and the start and stop sensors. The reason for two 5-volt supplies is that it provides isolation (separate grounds) between all on-board circuitry and all off-board circuitry and signals. Since the remote display may be connected to the master timing unit by a long cable, there is the real possibility of noise getting induced into the power and ground lines in the cable. With separate supplies, the coupling of power and ground noise into the on-board circuitry is greatly reduced.

Start Sensor Description. Figure 2 is a simplified schematic showing the start sensor and its connection to the comparator, IC13A. The start sensor consists of a moveable, permanent magnet and a stationary, normally open, reed switch. The magnet position is adjusted so that when the starting gate just barely releases the race car, the reed-switch contacts close. The closed contact discharges C21 through R13. When the voltage at the inverting input of IC13A drops below 2.5-volts, the output of the comparator on pin 1 goes high, causing a rising edge on the output of the opto-isolator IC14. This rising edge signifies race start to the processor. The low-pass filter composed of R13 and C21, the 2.5-volt threshold on IC13A, and opto-isolator IC14 are all used to guard against noise that may be present on the long wires going out to the start sensor. Figure 3 shows the placement of the start sensor (reed switch), magnet, and extension-cable connector. Standard four-conductor telephone cables with

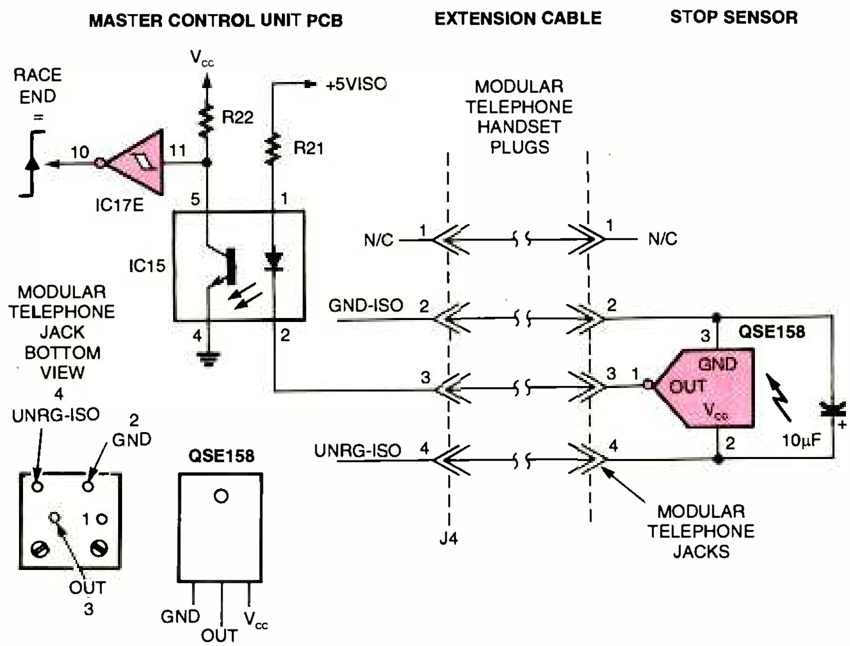


Fig. 3. A second telephone handset cable connects the stop sensor to the Master Control Unit PCB. Keep the leads short on the 10-µF capacitor.

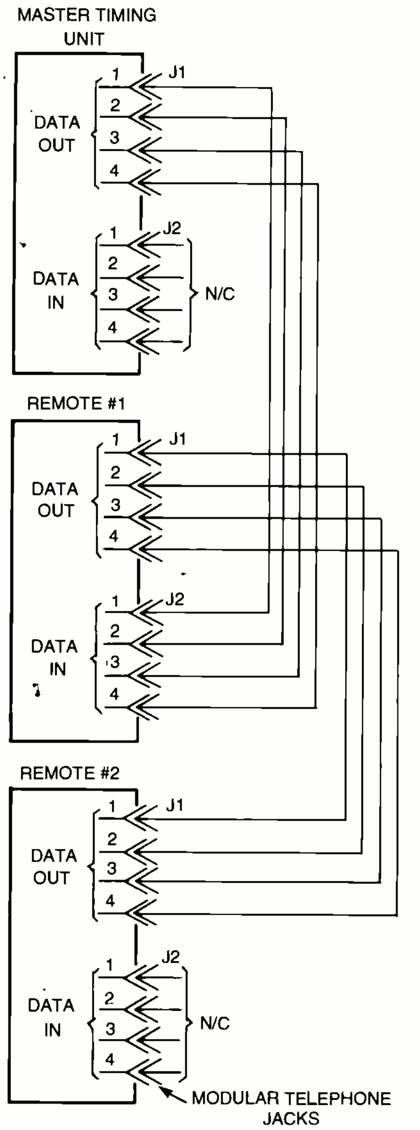


Fig. 4. Telephone handset extension cables are plugged in as shown to interconnect a master and remote display.

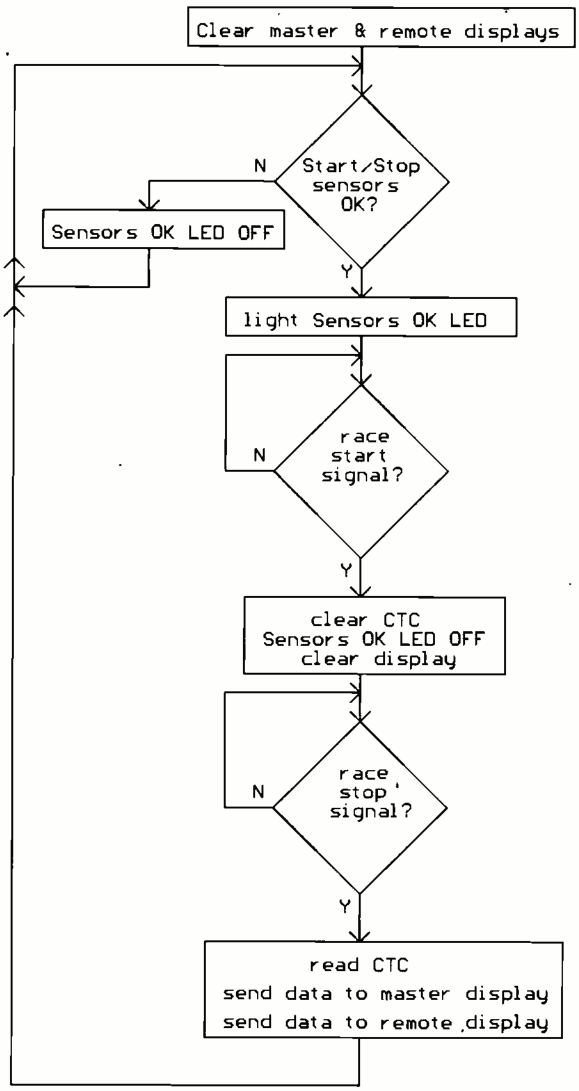


Fig. 5. The main loop is constantly executed by the processor and is responsible for the checking of start and stop sensors and the sending of elapsed-time data to the displays.

handset connectors connect the start and stop sensors to the control unit. This arrangement makes for reliable connections and easy disassembly after the races are finished.

Stop-Sensor Description. Figure 4 shows the connection of the stop sensor to the control unit. The stop sensor is an optically driven switch (QT Optoelectronics QSE158) that is mounted in the race track at the finish line. The sensor is mounted on the bottom side of the track and looks up through a hole in the track to the incandescent light that is shining down from above. A car at the finish line blocks the light path, resulting in a rising edge at IC17-10, which signifies race end to the processor. Several aspects of the design insure high noise immunity—the stop sensor has an on-chip voltage regulator and Schmitt-trigger circuitry, the use of optoisolator IC15, and Schmitt trigger IC17E. The center photo on page 38 shows the over-track light source and the location of the hole for the stop sensor. The top-right photo on page 38 details the placement of the stop sensor, 10 µF decoupling capacitor, and extension cable jack.

A two-channel universal asynchronous receiver/transmitter (UART or SIO) chip, IC4, is used for three functions. First, channel A in the master timing unit serially sends the race-elapsed time to the remote display. Second, channel A handshaking lines (CTS and DCD) receive signals from the start and stop sensors, respectively. Lastly, channel B is used by the remote display as an input to receive the serial race-elapsed time from the master timing unit. Channel B is not used by the master timing unit. The software has been written such that numeric data received by SIO B, via the data-in connector, is also sent out the data-out connector to SIO A on the downstream unit. This means that it is possible to use more than one remote, if desired. The master timing unit has been tested with two daisy-chained remote displays interconnected. The interconnections are made using four-conductor telephone cables with telephone handset plugs. At the conclusion of a race, the race-elapsed

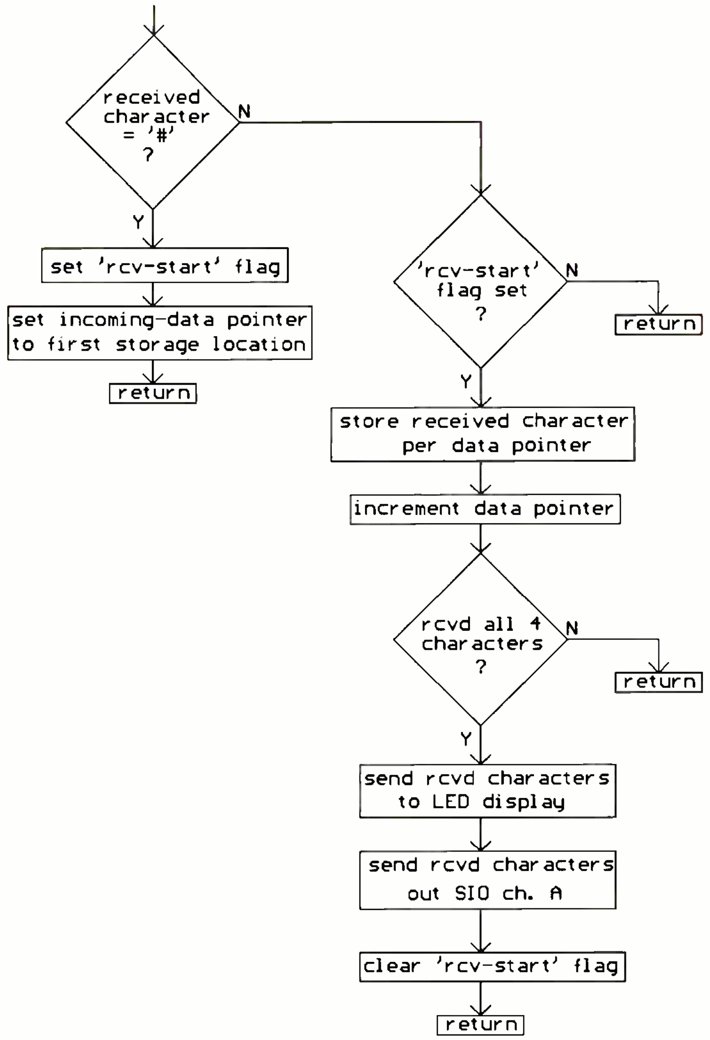


Fig. 6. The interrupt routine is only executed by remote(s) and is responsible for sending received characters to the display and also out the serial port to down-stream remote(s).

time is serially sent at 600 baud by IC4 out connector J1 to the remote display(s). The data transmission consists of six characters—the number character followed by five numbers, most significant digit first and least significant digit last.

Software Description. The software consists of two modules—a main loop and an interrupt routine (interrupt on received character). Figure 5 is a simplified flow chart of the main loop. Keep in mind that the master and remote units both have identical software. The difference in their operation is due to the master timing unit only executing the main loop, while the remote executes the main loop and the interrupt routine. As shown in Fig. 5, the processor first checks to make sure that both start and stop sensors are in their proper state prior to race start. This means that the starting gate must be in the up position (read switch open) and the stop sensor uncovered (light reaching the stop sensor). With both sensors satisfied, the processor lights the sensors' OK LED, signifying that the timer is ready for the race to start. The processor is then placed in a tight loop waiting for receipt of a race-start signal. Upon receipt of race-start, elapsed-time counter, IC3, is reset to zero, the sensors' OK LED is extinguished, and both master and remote displays are blanked. The processor is then placed into another tight loop waiting for the stop signal. After the stop signal is received, the race-elapsed time is acquired by reading the CTC. This binary data is converted to BCD and first sent to the master display and then sent serially to the remote display.

There are two different software versions to chose from. Version 1.2 offers .001 second (1msec) resolution, and version 1.1 offers .00025 (250µsec) resolution.

With the four-digit display available in this design and version 1.2 software, the maximum displayed race-elapsed time is 9.999 seconds. To achieve finer resolution with version 1.1 software, it is necessary to break the displayed elapsed time into two pieces. For example, if the lapsed time is 5.40125 seconds, the master display will show 5.410 for two seconds and then 25 for two seconds and 5.410 for another two seconds and 25 until the start of the next race. You may be asking why offer two different resolutions? The answer lies in the trade-off between avoiding ties and the increased scorekeeper work load of dealing with the more complex display of the race-elapsed time. The author has used this timer successfully in several hundred races. So far, there have been no ties, but in one derby the closest two cars were separated by only .001 second (1msec). So you can see that with version 1.1 software the odds of a tie are reduced even further.

Please note that with version 1.1 software, the remote only displays the time to the nearest .001 second. This has two advantages. The spectators are not confused by a display that would be alternating between two sets of numbers and secondly, if for some reason the scorekeeper got distracted at the end of the race and didn't write down the changing numbers on the master, he would only need to look up at the remote to get the time to the nearest msec and then at the master to get the last ¼ msec. For example, if the race-elapsed time is 5.41025 seconds, then approximately six seconds after the end of the race, the master display will continually show 25 and the remote will show 5.410. This display will remain until the start sensor is activated again—for this reason, it is important that the starter not proceed until told to do so by the scorekeeper. As you can see, it is strongly recommended that version 1.1 only be used in systems that include the remote dis-

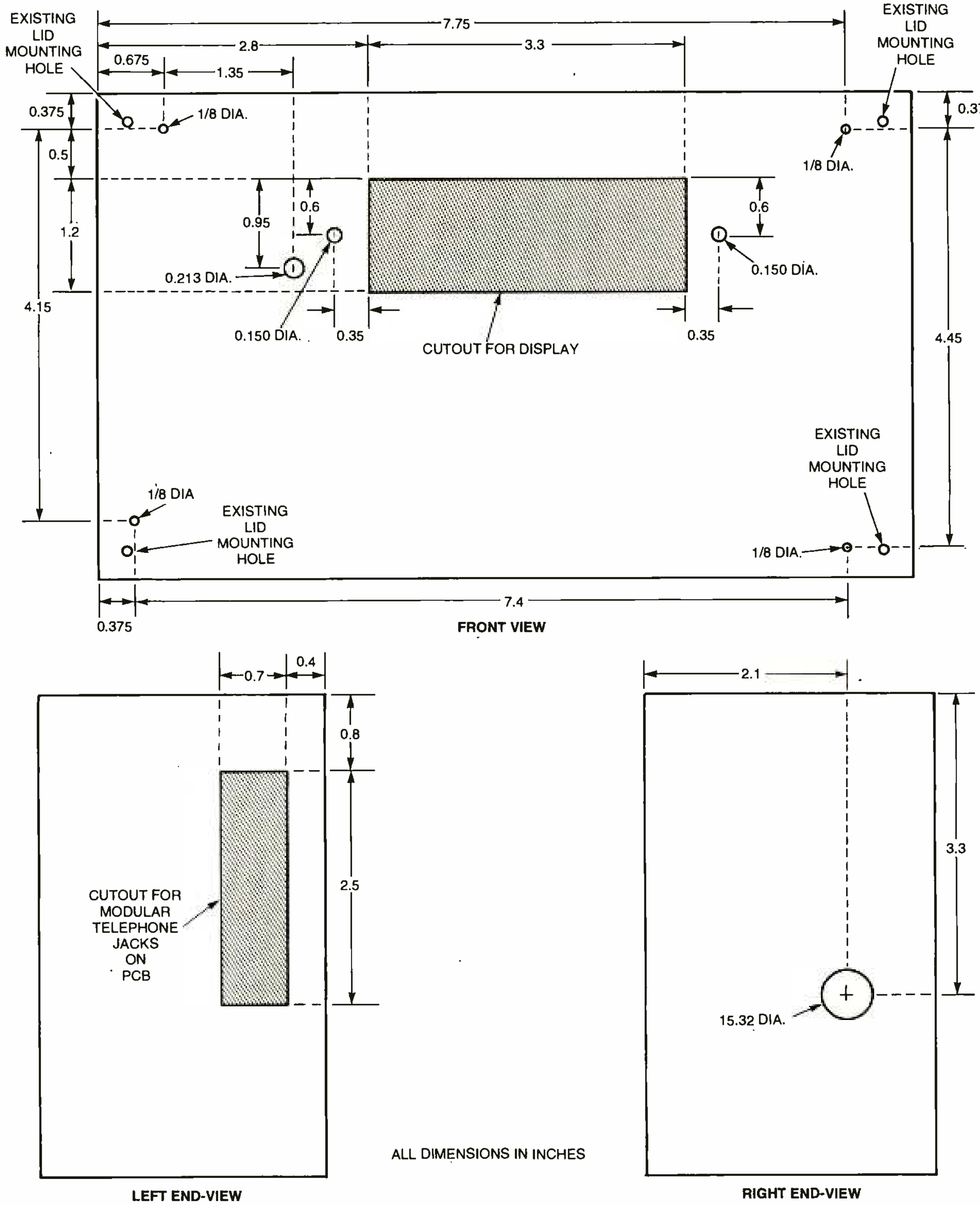


Fig. 7. This drawing will guide you in drilling the enclosure holes and cutouts. Follow the dimensions carefully to insure that everything lines up when the circuit board is fastened to the enclosed lid.

play.

EPROM IC8 contains the software, or more properly firmware, for this project and must be programmed before use. If you would like to program your own EPROM, the software may be downloaded from the Poptronics FTP Web site, *ftp.gernsback.com/pub/pop/timer_1_1.zip*, or *ftp.gernsback.com/pub/pop/timer_1_2.zip*. Alternatively, you may choose to purchase a programmed device from the source shown in the Parts List.

The simplified interrupt on received character flow chart, Fig. 6, shows how the remote processes the race-elapsed time characters that are received from the master. Keep in mind that the processor in the remote is constantly executing the main loop, patiently waiting for a start signal that never arrives. However, channel B in SIO IC4 is

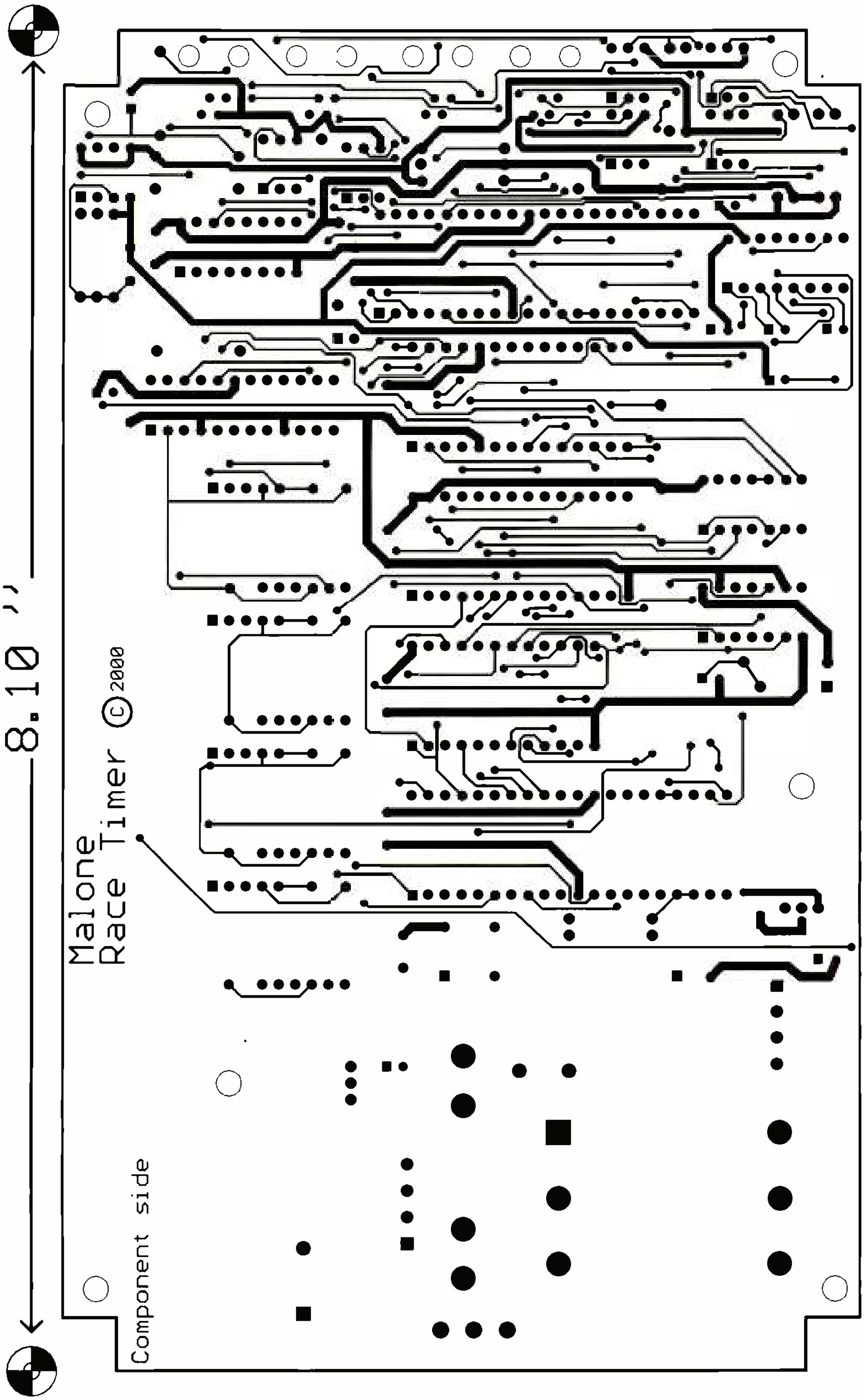


Fig. 8. This is the component-side foil pattern. Note the four notches in the corners of the circuit board that provide clearance between the PCB and mounting-crew bosses on the enclosed lid.

configured to generate a processor interrupt when a serial character is received. This means the master unit does not execute this code as characters are only sent to the remote, not received from it. The remote, however, does receive channel B data from the master. As shown on the flow chart, the first received character is checked to see if it is the number character. The purpose of this check is two-fold. First, in the very unlikely event that noise would induce a character on the remote receive line, it would be rejected by this check. Second, it insures that the race-elapsed time characters are stored in memory in the correct order. After all four digits are received, the DISPBCD routine is called. This routine is used by both the master and remote to send BCD data to their respective four-digit displays.

Enclosure And Extension Cable Construction. Figure 7 shows the location and size of all enclosure holes and cutouts. The printed circuit board, described later, is designed to fit snugly inside the enclosure specified in the Parts List, thus resulting in connectors and displays that line up properly with the enclosure holes. Be sure to center punch all of the hole locations before you start drilling. The rectangular holes for the display and connectors can be roughed-in by drilling a series of closely spaced holes around the perimeter and then filling the enclosure to their proper sizes.

Three extension cables are needed (only two if the remote display is not used). One cable is used for the start sensor to master connection, seen in Fig. 2, one for the stop sensor to master connection, and one for connecting the master to the remote. As

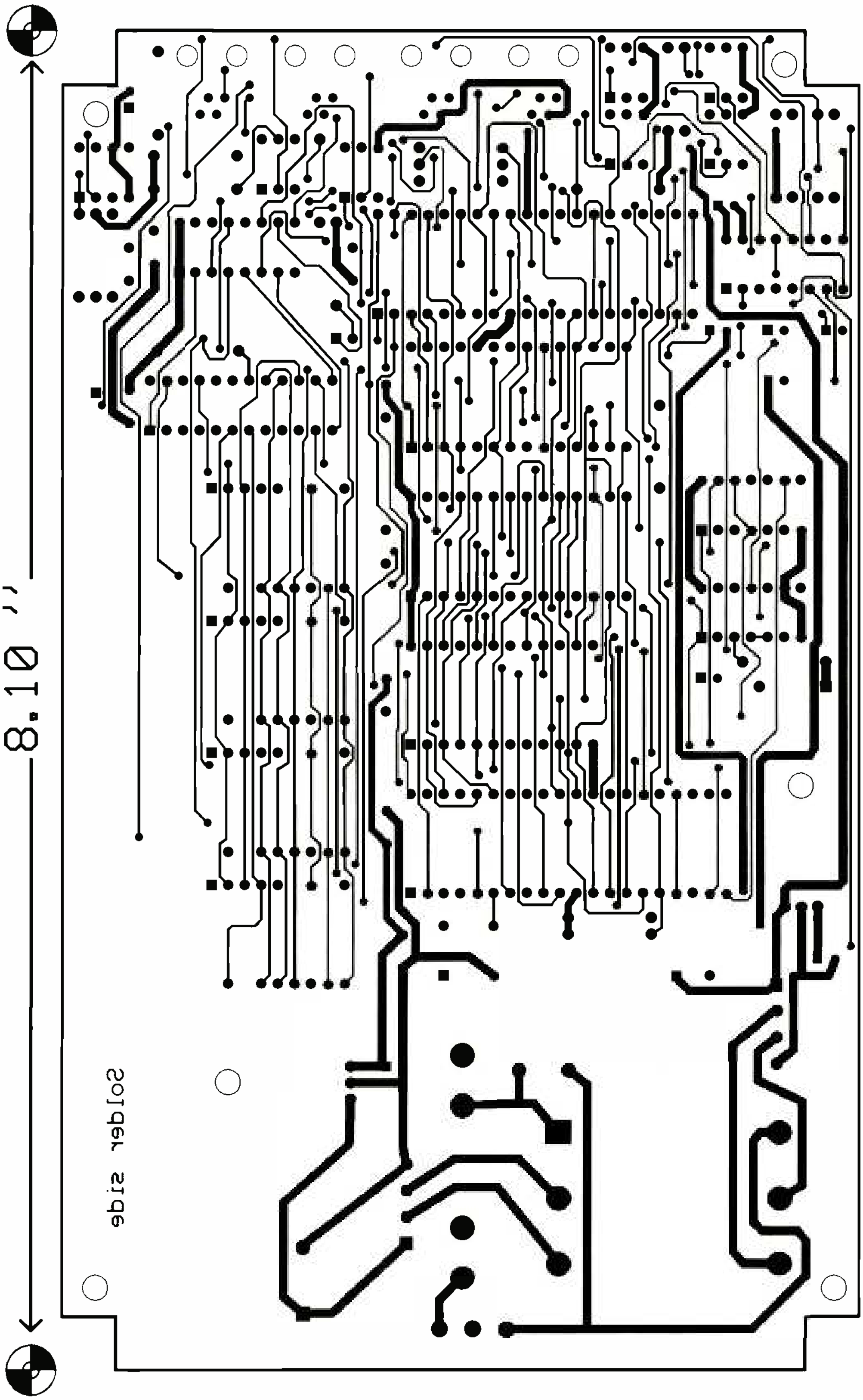


Fig. 9. Above is the solder-side foil pattern for the double-sided circuit board.

you can see from these three drawings, all three cables are electrically the same (i.e., pin 1 connects to pin 1, pin 2 to pin 2, etc.).

Typically, the distance from the finish line (stop sensor) to the scorer's table (master timing unit) is significantly shorter than from the master to the remote or start sensor to the master. Resist the temptation to make this cable the same length; you won't have to label them as to which one goes where. Also, if you make a spare cable (highly recommended), it can then be used to replace any of the three extension cables.

You can purchase extension cables from any telephone accessories store. Just make sure to get cables that are for use on telephone handsets. However, it is recommended that you put your own together. The reason for this comes from Murphy's Law—if it is possible for someone to step on and break a connector, it will happen at the worst possible time. It is much quicker to use your modular-crimping tool to install another pug than it is to run around on a Saturday morning looking for a pre-made cable. Refer to the Parts List for sources of telephone plugs, cable, and crimping tools.

Start-Sensor Construction. As shown in Fig. 2, the start sensor is very simple and consists of a reed switch and permanent magnet. It is strongly recommended that you use an enclosed reed switch like those used in burglar alarms. The glass housing on reed switches is fragile, and there are two big advantages to obtaining an enclosed unit. First, the possibility of mechanical damage is greatly reduced and also, the enclosed units have mounting-hole provisions, which makes their attachment much easier. If you refer to the photo, you will see how small, wood screws are used to

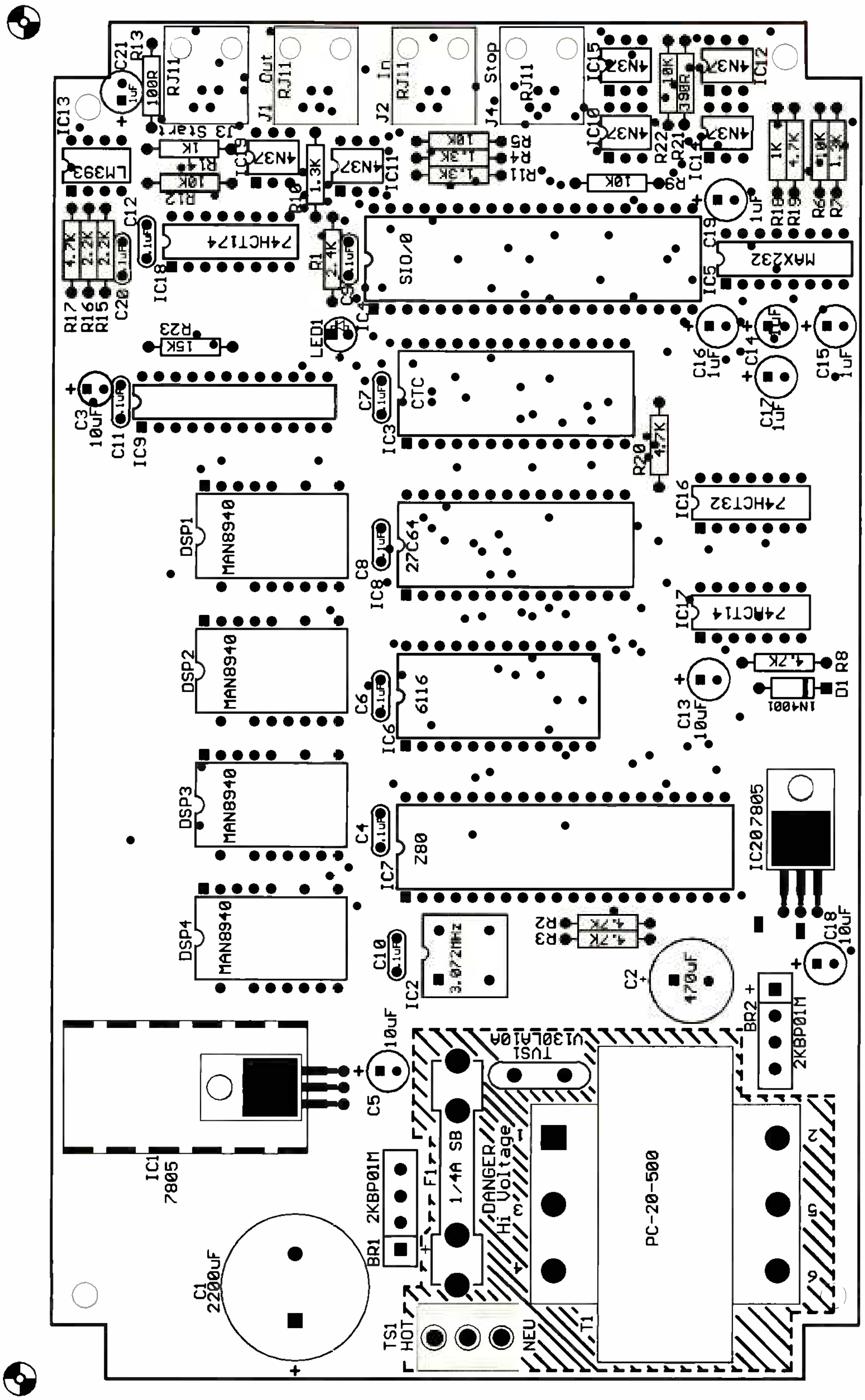
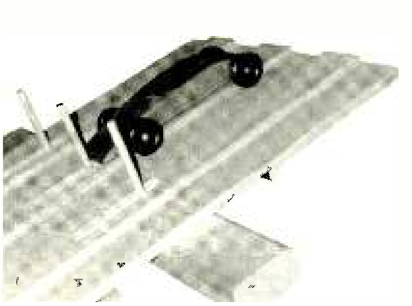


Fig. 10. Here is the component-side silk screen, which also acts as a component-placement diagram.

attach the reed switch housing to the underside of the race track near the start gate. You will need to move and hold the start gate into a position where the race car is just released. Then, determine the appropriate mounting location for the magnet by adjusting its position until you hear the relay click and screw it into place. Solder the two wires from the reed switch to pins 1 and 2 on the modular telephone jack, following the pin-out guide shown in Fig. 2. The modular telephone jack is held against the race track by a clamp composed of two small pieces of wood and a small metal plate with rubber foot attached.

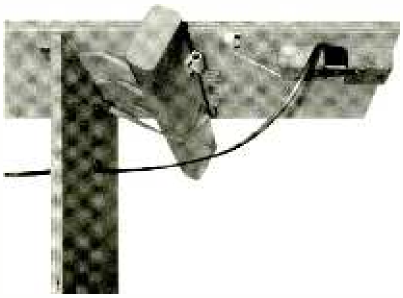
Stop-Sensor Construction. The stop sensor is also very simple, consisting of just an optical switch and capacitor. Observe correct polarity and solder the 10-µF capacitor to the optical switch. Wire the optical switch to the modular telephone jack using the pin-out guide shown in Figs. 2 and 3. Align the light-sensitive face of the optical switch with the hole in the race track located at the finish line. The optical switch/ modular telephone jack is held in place on the underside of the track with the same type of clamp assembly used for the start sensor. The stop-sensor clamp assembly also serves to protect the stop-sensor components from damage since they are located between the race track and the floor. A photo shows the over-track light source shining down on the track at the finish line. Make sure to use an incandescent light source, since the 60-Hz on/off flicker characteristic of fluorescent lights could cause problems. A simple shield confines the light to the track and not spectator's eyes.

Circuit-Board Construc-tion And Test. Due to the number of circuit connections in the race timer, it is recommended that a double-sided PC board be used. However, if you are careful, it would be possi-



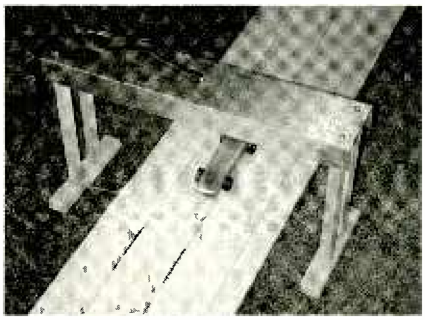
The start gate is shown with the car-holding fingers in the full upright position. The end of the start-sensor reed switch is just visible on the right side of the track.

ble to use other construction techniques, such as perf board or wire wrap. If you choose to make your own PC board, refer to Fig. 8 for the component-side etch and Fig. 9 for the solder-side etch. After you have either etched and drilled your own PCB or purchased one from the supplier shown in the Parts List, it is time to start the actual assembly. Use the parts placement diagram in Fig. 10 and the silk screen on the PC board (if you purchased it) to guide you in placing the parts. It is strongly recommended that IC sockets be used for all ICs as this makes testing and IC replacement MUCH easier. To make it more convenient to handle the board during assembly, install the short, lightweight components first, such as resistors, diodes, and IC sockets. Save the electrolytic capacitors, bridge rectifiers, and power transformer for last. Don't install the ICs in their sockets until instructed to do so. Make sure you install the four seven-segment displays and LED on the SOLDER side of the PC board. The LED should be spaced



This photo is an under-the-track view and shows how the start-gate components are arranged. The car-holding finger has just released the car and the moveable magnet is in the proper position to cause the stationary reed-switch contact to close.

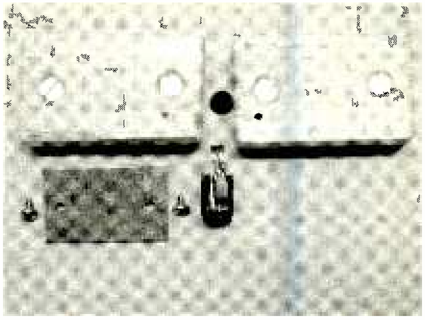
up from the circuit board approximately 4/10-inch so that it can stick up through the hole in the front panel. Install ½-inch long nylon spacers in the corners of the PCB, on the component side. These spacers are used to fasten the PCB assembly to the enclosure lid. Use thermal grease when mounting the heatsink to IC1. Attach the AC line cord wires to the terminal strip at TS1. Double-check component placement and polarity before proceeding to checkout. Figure 15 is a picture of the completed circuit board.



The front of the race car is not quite in position to block the light path between the light above and the under-track stop sensor. The cable for the stop sensor can be seen entering from the left side of the track

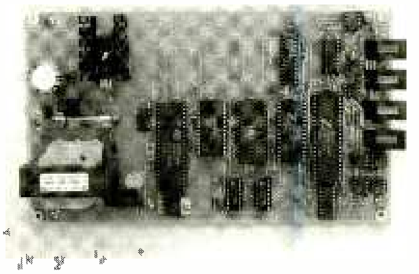
Safety Notice. Before applying power, keep in mind that dangerous voltages are present due to the race timer's connection to the AC power line. Keep your fingers and hands away from the fuse clip, AC hot and neutral connections, and the transformer primary! This area is marked on the printed circuit board silk screen. When probing the PCB, use only DVM test leads and/or oscilloscope probes that are in good condition, with no cracked insulation, etc.

Checkout. After you are finished stuffing the circuit board (don't put the ICs in their sockets yet), you are ready to start the checkout process. Plug in the line cord into an AC outlet and use a DVM or oscilloscope to check the main +5-volt supply (VCC) by confirming +5-volt ±.2-volt across C5. Next, check for +5-volt at all ICs—refer to the schematic to determine which pins are connected to VCC and GND. Next, check the +5-volt isolated supply (+5-volt ISO) by mea-



This is an under-the-track view of the stop sensor removed from the track thru-hole, protective wood blocks, and clamping plate. The metal plate firmly holds the phone jack in place so the optical sensor can face the over-track light source.

suring across C18 and confirming the presence of +5-volt ±.2-volt. With power off, insert the oscillator, IC2, into its socket. If an oscilloscope is available, apply power and confirm the presence of the 3.072-MHz signal at IC7-6. Otherwise, with the power off, insert all of the ICs into their respective sockets, apply power, and observe 0.000 on the LED display. Plug the start sensor into J3 and the stop sensor into J4. Illuminate the stop sensor with an incandescent light. The sensors' OK LED should be lit. If the LED is not lit it is because one, or both, sensors is in the active state. That is, if the start sensor is active (reed switch closed) and/or the stop sensor is not illuminated, the sensors' OK LED will not be lit. Keep in mind that this LED is not intended to be the ultimate in troubleshooting aids. For instance, if the start and stop sensors are unplugged from the master timing unit, the sensors' OK LED will



Photograph of the completed circuit board. The AC line connects to the terminal strip on the left side of the board just above the power transformer. This prototype board does not have a silk screen; however, the boards available from the author do have a silk screen with component reference designators, which makes assembly much easier.

PARTS LIST FOR THE DIGITAL RACE TIMER

MASTER REMOTE AND PC SEMICONDUCTORS

BR1, BR2—100-volt, 2A bridge rectifier (Digi-Key 2KBP01M)
DSP1-4—QT Optoelectronics MAN8940 seven-segment LED display (Mouser)
LED1—2mA LED, Hewlett Packard HLMP-D150 (Allied Electronics)
IC1, IC20—LM7805, +5-volt, 1.5-amp voltage regulator, integrated circuit (Digi-Key)
IC2—Epson SE1219, 3.072-MHz, half-size crystal oscillator, integrated circuit (Digi-Key)
IC3—Z84C3008, CMOS Z80 family counter/timer controller, integrated circuit (Digi-Key)
IC4—Z84C4008, CMOS Z80 family SIO/0 serial controller, integrated circuit (JDR)
IC5—MAX232CPE, RS232 dual receiver-transmitter, integrated circuit (Mouser)
IC6—HM6116-1, 2K × 8 static CMOS RAM, integrated circuit (Jameco)
IC7—Z84C0008, CMOS Z80 microprocessor, integrated circuit (JDR)
IC8—27C64, 8K × 8 CMOS EPROM, 250nS (or faster), integrated circuit (Digi-Key)
IC9—MAX7219, LED display driver, integrated circuit (Digi-Key)
IC10–12, IC14, IC15, IC19—4N37, optoisolator, integrated circuit (Digi-Key)
IC13—LM393, dual comparator, integrated circuit (Digi-Key)
IC16—74HCT32N, quad 2-input, OR, integrated circuit (Digi-Key)
IC17—74HCT14, hex inverter, integrated circuit (Digi-Key)
IC18—74HCT174, hex D-type flip-flop, integrated circuit (Digi-Key)
D1—1N4001, general purpose diode

RESISTORS

(All resistors are ¼-watt, 5% carbon units.)
R1—2400-ohm
R2, R3, R8, R17, R19, R20—4700-ohm
R4, R7, R10, R11—1300-ohm
R5, R6, R9, R12, R22—10,000-ohm
R13—100-ohm
R14, R18—1000-ohm
R15, R16—2200-ohm
R21—390-ohm, ¼-watt, 5% carbon unit
R23—15,000-ohm

CAPACITORS

C1—2200-µF, 25-watt V_{DC}, electrolytic
C2—470-µF, 25-watt V_{DC}, electrolytic
C4, C6–12, C20—.1-µF, 50-watt V_{DC}, ceramic
C3, C5, C13, C18—10-µF, 16-watt V_{DC}, tantalum
C14–C17, C19, C21—1µF, 16-watt V_{DC}, tantalum

ADDITIONAL PARTS AND MATERIALS

F1—3AG, ?-amp, slow-blow fuse (Mouser 5760-13250)
Fuse clip, PCB mount, two each (Mouser 504-1A1119-10)
J1-4—Modular telephone handset jack, PCB mount, four conductor (Mouser 571-5559801)
T1—Dual 10-V_{AC} 1-amp, secondary PCB-mount transformer (Signal Transformer PC-20-500)
TS1—3-pin screw terminal (Mouser 506-5ULV03)
TVS1—V130LA10A varistor (Mouser 570-V130LA10A)
Enclosure—8.46- × 5.12- × 3.27-inch Altec 94.012 (Allied Electronics)
AC-line chord—18 AWG, 3 conductor (Mouser 173-53102)
Line-chord strain relief—(Mouser 561-MP5P4)
Heatsink for IC1—(Mouser 532-551002B00)
Printed circuit board
Display bezel with red filter—(JMJ Technical Products 1-358-R60)
Standoffs—½- × ¼-inch, nylon, four each (Mouser 561-TSP3)
Miscellaneous hardware, solder, thermal grease
IC sockets—(Mouser)

EXTENSION CABLE PARTS

Optional modular crimping tool—one each (Jameco 116097)
4-conductor modular telephone cable—(Mouser 172-UL4010FT)
4-conductor modular telephone handset plug—two each (Mouser 154-UL6164)

START-SENSOR PARTS

Reed switch and magnet pair—one each (Mouser 507-AMS-10WS)
Wood screws—eight each
Modular telephone handset jack, PCB mount, 4-conductor—one each (Mouser 571-5559801)
1- × 2-inch wood blocks—two each
1- × 2-inch sheet metal—one each
Rubber foot—one each (Mouser 517-SJ-5023BK)

STOP-SENSOR PARTS

Optional sensor—QT Optoelectronics QSE158 (Mouser 512-QSE158)
10-µF, 16-volt V_{DC}, tantalum capacitor
Rubber foot—one each (Mouser 517-SJ-5023BK)
Incandescent light with stand and light shield

SOURCE INFORMATION

Allied Electronics; 800-433-5700
Digi-Key; 800-344-4539
Jameco; 800-831-4242
JDR; 800-538-5000
JMJ Technical Products; 908-233-7038
Mouser; 800-346-6873
Signal Transformer; 516-239-5777

The following parts are available from D. Malone, P.O. Box 1542, Battle Ground, WA 98604 (e-mail, dmalone@pacifier.com): Complete kit of all parts including silk-screened, solder-masked circuit board, programmed 26C64, machined enclosure, and parts for start and stop sensors ($165). Kit does not include incandescent light source or stand, or sensor clamps. Pro-grammed 27C64 EPROM ($7). Com-mented source code on IBM 3.5-inch disk ($19.95). Silk-screened, solder-masked circuit board ($25). On complete kit or programmed 27C64 orders, specify 1-mS resolution (firmware version 1.2), or ?-mS resolution (firmware version 1.1). Please add $5 to all orders for shipping and handling. Washington state residents add sales tax.

be lit, since neither sensor is in their active state. The intention of this diagnostic aid is to alert the scorekeeper that the start gate is not fully retracted to the car-holding position or a race car has inadvertently been left at the finish line, thus obscuring the start sensor.

Bring a magnet into close proximity to the reed switch, and when the reed switch closes the display should read ——. Next, cover the stop photosensor with an opaque object and the display should then display the elapsed time between reed switch closure and light blockage. Keep in mind that the maximum time that can be displayed is

WHY USE A 3.072-MHz OSCILLATOR?

The oscillator frequency for this project was driven by two requirements. First, it was decided that the race elapsed time needed 250-µS resolution. This means that there must be a source of 4-KHz pulses (? kHz = 250µS). Therefore, the CTC needed to receive an oscillator frequency that could be divided by an integer and result in a 4-KHz pulse train. 3.072 MHz divided by 768 yields 4 kHz. CTC channel 0 is used for this purpose.

Second, the SIO needed to be fed by an oscillator frequency that would yield a standard baud rate for serial communication to the remote display. CTC channel 1 is used to divide 3.072 MHz by 320 to yield 9600 Hx. With the SIO, IC4, programmed for a 16X clock, a SIO clock frequency of 9600 Hz results in a serial data rate of 600 baud.

9.999 seconds.

If you experience difficulty in getting the unit to work, check for these common assembly-related issues.

- Check for proper orientation on polarity-sensitive components, such as electrolytic capacitors, diodes, and ICs.
- Look for bent IC pins that don't make contact with their socket pins.
- Look for cold solder joints, or where excessive solder has inadvertently connected two adjacent pads
- Use your finger to locate hot components. Use good judgement. Lightly and quickly place your finger tip near ICs and polarized capacitors. For example, an electrolytic capacitor that is accidentally installed backwards can get VERY hot and power needs to be turned off immediately!

Using The Timer. Mount the remote display, if used, six or seven feet off the ground on a suitable stand or shelf. This will provide maximum visibility for the spectators. Place the master timing unit on a table near the finish line, in line with the race track. At this location the scorekeeper can see and communicate with the person placing the race cars on the start gate. Plug the start-and-stop extension cables into the appropriate sensor and jacks on the master timing unit. Refer to Fig. 8 for master timing unit to remote display connections. Position the incandescent light source over the finish line and turn on the light. Plug the master timing unit and remote display into AC outlets and place a race car at the start gate. With the start-gate in the car-holding position and the stop sensor illuminated, the sensors' OK LED should be lit. Give the go-ahead signal to the starter, release the race car, and the race is on! During the race both the master and remote display ——. When the car blocks the light beam at the finish line, both displays immediately display the race-elapsed time. Refer to the software description for display differences between version 1.1 and 1.2 software.

It is recommended that the scorekeeper and starter run a few cars though before the start of the actual derby. These practice runs will help establish the necessary information exchange between the two race officials. For example, the starter will tell the scorekeeper the number of the car that is about to race, and the scorekeeper will signal to the starter when he is ready and the sensor's OK LED is lit.

When the remote display is used, after just a few races the spectators will quickly develop a feel for what is a good elapsed time. Soon you will hear cheers from people that can only see the remote display due to the crowd that inevitably swarms around the finish line.

Parting Thoughts. Since Pinewood Racing occurs during only a small portion of the year, you may want to use the master timing unit for other purposes during the remaining time. For instance, by taking advantage of the serial communications capability, you could use the unit as a remote display. As an example, a remotely-located thermometer probe is under development that will send serial data to the Master Timing Unit, thus providing an easy-to-read temperature display. ■

Q & A

mailto: q&a@gernsback.com

Resistor Voltage Ratings

Q *I have noticed a mistake in many of your circuits that is quite dangerous, particularly in circuits using high voltages. Everyone knows that capacitors have voltage ratings and resistors have power ratings. But did you know that a resistor also has a voltage rating?*

You may be wondering how a resistor can have a voltage rating. As it turns out, this value does not refer to the resistive element but rather the resistor's insulation. If this value is exceeded, the insulation will break down or cease to be insulating. In fact, the insulation would now have a low resistance and the resistor would now consist of two resistances in parallel, the original element resistance and the altered insulation resistance, which will greatly change the resistor's value. Many resistors have ratings of only around 100 to 500 volts.—Donald Taylor, Jr.

A It may seem to be hopeless finding resistors that can be used at voltages above 500 volts, but special high-voltage resistors do exist, used in such things as Geiger counters and electrometers. They are really neat looking, the resistive element enclosed inside a cylindrical glass envelope. They may be found with extremely high resistance values and very high voltage ratings. Such resistors must be handled with care as fingerprints can alter their value.

For high-voltage circuits, the use of special resistors and wire is essential, and high-voltage construction practices must be followed.

Donald, in this day and age of solid-state devices, we've forgotten that we need to be careful of the components and wiring practices used when working with higher-voltage circuits. It is good that you brought up this subject. Ham radio operators who "rolled their own" transmitters and linear amplifiers were usually aware of those circuit-design considerations since they were routinely working with anywhere from 300 to 5000 volts. These days, we still need to take caution when working with any circuits using voltages in excess of around 200 volts, especially those using laser tubes, magnetrons, klystrons, traveling wave tubes, cathode ray tubes, x-ray tubes, and transmitting tubes. If it's filled with a rarefied gas or a vacuum, it'll likely involve a high voltage somewhere.

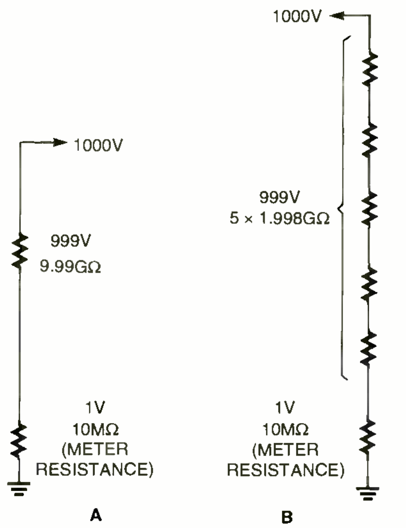


Fig. 1. A single, high-value, high-voltage resistor (a) is needed when the meter forms a part of the voltage divider. Multiple resistors that have a lower voltage rating (b) can be placed in series as a substitute, spreading the applied voltage out over several resistors.

Like hams of yesteryear, we hobbyists don't often have the financial resources to spring for special resistors and usually make do with substitutes. Sometimes, there is no substitute. A good example of this is the 1090-megohm resistor in a 20,000-volt divider probe used with old vacuum-tube voltmeters and the high-value resistor in the high-voltage accessory probes of newer digital multimeters. These probes are designed for poking around TV picture tubes. It's nearly impossible to spread 1090 megohms over a five-inch length using off-the-shelf resistors. Past issues of the *ARRL Handbook* have had high voltage probes made that way, but for the slightly lower voltages found in transmitters and linears.

To explain the voltage rating of resistors a bit more, one needs to realize that a standard ¼-watt carbon resistor has maybe 0.2 to 0.3 inches between the leads, depending upon resistor style. Film resistors have metal end caps, so there's no more than 0.1 to 0.2 inches that separates the end terminals of the resistor; and composition resistors are much the same since their leads extend internally into the body of the resistor quite a bit. Of course, a high voltage across the leads of a lower-value resistor will simply burn the resistor up. But across a high-value resistor where the power rating is not exceeded, the voltage could easily arc over between the end caps or internal leads if it's high enough. Circuits like this should be designed with a single resistor that can withstand this voltage or made with series-connected, equal-value resistors where the voltage is divided out equally among all the resistors, such that each will be within its voltage rating.

One of the first places that amateur designers will err is in the area of voltage dividers, especially multipliers for measurement circuits such as meters. Instrument manufacturers use longer, high-voltage resistors, but hobbyists often use standard-sized resistors in circuits designed to knock 1000 volts down to 1 volt or so. That input resistor ends up with 999 volts across it and needs to be made up of several series-connected resistors or a more-expensive high voltage resistor. Five series-connected resistors will

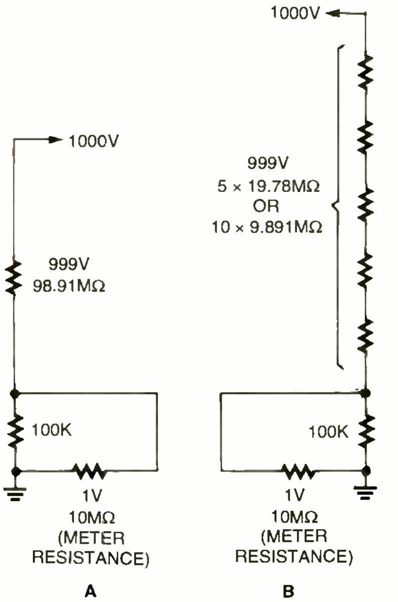


Fig. 2. Two resistors along with the meter's internal resistance can make up a lower-resistance voltage divider so that components are easier to find. Still, a single resistor (a) must have a high voltage rating while multiple resistors in series (b) can have lower voltage ratings since they equally share the applied voltage.

probably do the job, but the precision of the circuit will suffer as you have five uncertainties to deal with rather than just one. A 1-% resistor split into five individual 1-% resistors will end up with an uncertainty of around 2.2%.

If a divider is designed to use the 10M-ohm input resistance of a digital voltmeter as part of the voltage divider, a special 9.99G-ohm resistor will be needed in series, as shown in Fig. 1a. Even when broken into five individual resistors, as shown in Fig. 1b, special resistors will still be needed for the high-value individual 1.998G-ohm resistors required. In cases like this, it's less expensive to use a divider with smaller resistors, adding one in parallel with the meter as shown in Fig. 2a. The values of the five-resistor string are still a little high, but more easily obtainable and might be easier yet if ten resistors were used. One has to be careful with a design like this so that the values don't get so low that the metering circuit imposes a heavy load on the circuit to be measured or that the resistors in the meter divider don't dissipate too much power.

Although it was mentioned that some of our published circuits might have been violating these design rules, I haven't looked for any specific cases. If there were any, I would suspect that it would be in articles or columns where they've been discussing lasers, neon lamp supplies, plasma globes, and other such topics.

Errors of the Ancients

Q *"Build the Monodigichron" was published in the September 1973 issue of* **Popular Electronics.** *I recently built this but cannot get it to function. I understand there was an "Out of Tune" addressing a problem with this project. It was published quite a bit later than is usual for these corrections. I've checked the Detroit Public Library, but their copies are pretty torn up! Can you help or direct me to a source for this item? Perhaps one of your other readers can help. Thanks in advance for your kind attention to this request.—O.C., via e-mail*

A I'm one of those odd individuals who has saved every electronics magazine he could get his hands on—and then some. I've gone through my stash, looking at both the "Out of Tune" and the "Letters" departments for anything that involved your project and found nothing in the 27 issues after the original project publication. That's a thorough search through every issue through December 1975. See how much time I devote to my loyal readers? I also checked my copies of the annual indices and found nothing. I don't think I've missed anything. If you've built this project and it doesn't work, either it has an original publication error that was never noted or the original circuit is correct and something is wrong with your layout or one or more of the components.

As I went through those magazines, I was reminded that the January and February 1975 issues that featured the introduction of the MITS Altair 8800 computer were at one time selling on e-bay for over $100.

Circuit malfunctions and missing documentation are some of the problems that you can get into if you build something from the "ancient" past. Other problems surface when a project uses a very specific part that is now obsolete or a programmed chip for which the firmware was available only by mail or as a download on a now-defunct bulletin board. I always caution prospective authors to include listings in the magazine if possible and to avoid specialized parts. Their availability through mail order or Internet is short-

HOW TO GET INFORMATION ABOUT ELECTRONICS

On the Internet: See our Web site at *www.poptronics.com* for information and files relating to **Poptronics** and our former magazines (**Electronics Now** and **Popular Electronics**) and links to other useful sites.

To discuss electronics with your fellow enthusiasts, visit the newsgroups *sci.electronics.repair*, *sci.electronics.components*, *sci.electronics.design*, and *rec.radio.amateur.homebrew*. "For sale" messages are permitted only in *rec.radio.swap* and *misc.industry.electronics.marketplace*.

Many electronic component manufacturers have Web pages; see the directory at *www.hitex.com/chipdir/*, or try addresses such as *www.ti.com* and *www.motorola.com* (substituting any company's name or abbreviation as appropriate). Many IC data sheets can be viewed online: *www.questlink.com* features IC data sheets and gives you the ability to buy many of the ICs in small quantities using a credit card. You can also get detailed IC information from *www.icmaster.com*, which is now free of charge although it formerly required a subscription. Extensive information about how to repair consumer electronic devices and computers can be found at *www.repair faq.org*

Books: Several good introductory electronics books are available at RadioShack, including one on building power supplies.

An excellent general electronics textbook is *The Art of Electronics*, by Paul Horowitz and Winfield Hill, available from the publisher (Cambridge University Press, 800-872-7423) or on special order through any bookstore. Its 1125 pages are full of information on how to build working circuits, with a minimum of mathematics.

Also indispensable is *The ARRL Handbook for Radio Amateurs*, comprising over 1000 pages of theory, radio circuits, and ready-to-build projects, available from the American Radio Relay League, Newington, CT 06111, and from ham-radio equipment dealers.

Back issues: Copies of back issues of and past articles in **Electronics Now, Popular Electronics**, and **Poptronics** can be ordered on an "as available basis" from Claggk, Inc., Reprint Department, P.O. Box 12162, Hauppauge, NY 11788; Tel: 631-592-6721. To ensure receipt of the correct material, readers must supply complete information on the article or issue that they wish to buy.

Poptronics and many other magazines are indexed in the *Reader's Guide to Periodical Literature*, available at your public library. Copies of articles in other magazines can be obtained through your public library's interlibrary loan service; expect to pay about 30 cents a page.

Service manuals: Manuals for radios, TVs, VCRs, audio equipment, and some computers are available from Howard W. Sams & Co., Indianapolis, IN 46214; (800-428-7267). The free Sams catalog also lists addresses of manufacturers and parts dealers. Even if an item isn't listed in the catalog, it pays to call Sams; they may have a schematic on file which they can copy for you.

Manuals for older test equipment and ham radio gear are available from Hi Manuals, PO Box 802, Council Bluffs, IA 51502, and Manuals Plus, 130 N. Cutler Dr., N. Salt Lake, UT 84054.

Replacement semiconductors: Replacement transistors, ICs, and other semiconductors, marketed by Philips ECG, NTE, and Thomson (SK), are available through most parts dealers (including RadioShack on special order). The ECG, NTE, and SK lines contain a few hundred parts that substitute for many thousands of others; a directory (supplied as a large book and on diskette) tells you which one to use. NTE numbers usually match ECG; SK numbers are different.

Remember that the "2S" in a Japanese type number is usually omitted; a transistor marked D945 is actually a 2SD945.

Hamfests (swap meets) and local organizations: These can be located by writing to the American Radio Relay League, Newington, CT 06111; (*www.arrl.org*). A hamfest is an excellent place to pick up used test equipment, older parts, and other items at bargain prices, as well as to meet your fellow electronics enthusiasts—both amateur and professional.

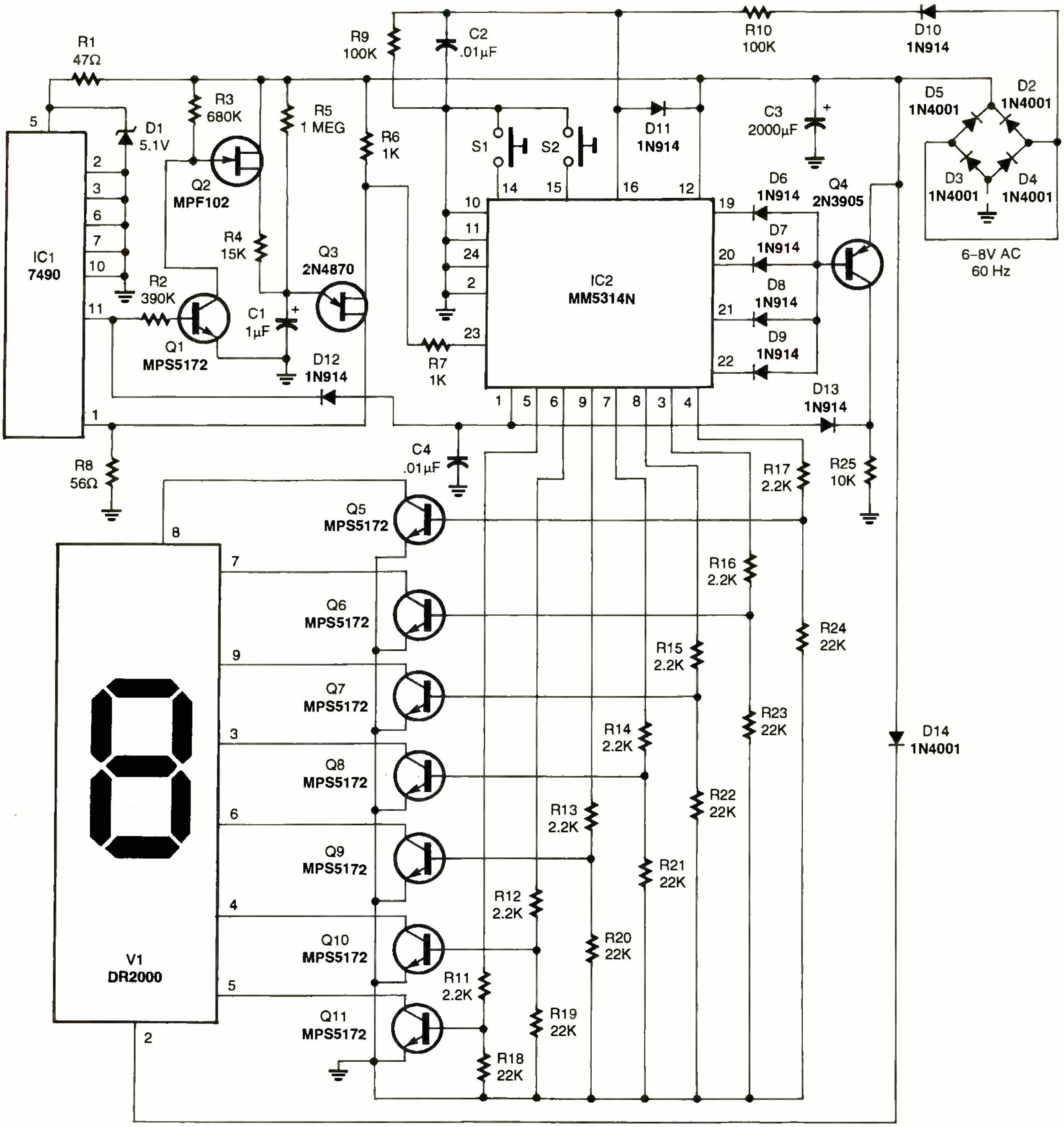


Fig. 3. The "Monodigichron" as originally presented in the September 1973 issue of **Popular Electronics** *is a novelty clock that displays the time using a single 7-segment LED.*

lived in comparison to the eternal archival possibilities of the original magazine article. I'm always in contact with folks who come across old articles or need a copy of an old article they remember from their childhood. Sometimes they're headed down the road to disappointment.

The Monodigichron is a novelty digital clock that displays the time using a single 7-segment digit, scanning through slowly one digit at a time. I'm going to publish a reprint of the schematic in case any readers remember any quirks about the circuit or see anything odd that was missed but not reported. Check out Fig. 3.

Discontinued/Obsolete Parts

Back in 1975, I had a great mail order source for both new and obsolete parts from a company in San Diego. I could buy TTL ICs for a fraction of what they sold for through the usual hobbyist channels. A couple of years later, I ran across an article where the U.S. Marshal Service and/or the FBI had raided and closed down this company because they had been dealing in stolen inventories. Hmm. THAT'S why they were so cheap! And I thought ICs got hot only from reversed power connections.

Several columns ago, the question came up as to where one could purchase parts, especially semiconductors, which were discontinued or obsolete. There are companies out there that, when they hear that a part is being discontinued, will buy up large inventories of that part and offer it for sale long after it's unavailable through the normal distributor channels. I only knew of one or two sources and asked readers for some input on the subject.

Gary Fortnum responded with a couple of sources. One is Rochester Electronics (*www.rocelec.com*), and the other is American Micro Semiconductor (*www.americanmicrosemi.com*). Gary also mentioned that the Internet site *www.repairfaq.org/REPAIR/F_Obsol_IC.html* is a helpful resource that is maintained by "Service Clinic" author, Sam Goldwasser.

John Power also reported on Rochester Electronics, saying that they call themselves "The World's Most Comprehensive Source of Discontinued Semiconductors."

Alan Wolke tossed out the name of Tom Clemens, who owns Clem-Neff Enterprises (570-595-0647)—a business that has hard-to-find and obsolete components, targeting the amateur radio community.

Gary, John, and Alan, thanks for your informative input. If any more of you readers have additional sources, let us know. Out of several sources, only one may have a particular chip.

Heathkit Clock Chips

In the April 2002 column, a reader asked for a source for the clock chip used in his GC-1107 clock. Three readers have answered the call.

Dick Little mentions that Heath part number 443-848 has the NTE2061 as a substitute, available from most mail-order parts houses.

Bruce Bubello told me that the chip is a National Semiconductor MM5316N and was surprised that this one had failed. In his experience, the MM5316 was a very robust chip. He happens to have one on hand and is offering it to our friend.

Marv Mitich, who has assembled approximately 40 Heathkits over the years, has found that Heath part number 442-848 crosses to a EA7316C with a substitute of NTE2060, ECG2060 or SK3966. I haven't looked up the difference between the 7316 and 5316, but I would guess that they're the same except for the 5316 being a beefier part.

Finally, Theodore Turk mentioned that he has the GC-1005 Heathkit clock that uses the MK5017AA, Heathkit part number 443-601, making it available if it would help out.

I won't even attempt to sort out any of the part number anomalies here, letting those who need the information take care of that task. Thanks to all of you for responding.

Car Flashers

Q *I just read the article in the May issue where several people want to add flashers to their cars. I strongly recommend buying a flasher unit designed for the specific car. Most of the newer cars use a switched negative for the light circuits. If you start adding things using a switched positive circuit, they aren't going to work at best, and you could cause serious damage. The rear lights (brakes) are tied to the antilock brake circuit and flashing the lights can feed back into that circuit causing it to malfunction. This can also feed back into the transmission causing damage. Another plus with commercially available units is that most of them are potted in plastic to protect them from the weather. Please pass this warning on to your readers. As a technician, I know it's fun to build your own circuits and use them. It also saves money if everything is correct and hooked up right.—Jack Price*

A Jack, I'm not sure which "flashers" you were referring to in the May issue. In the "Q & A" column, we were adding controllers for trailer lights, using the auto's brake lights only as input sources, so that wouldn't apply. The "Wig-Wag" circuit was playing with the headlights. I'll agree that we all need to be careful with things when we start playing with the CONTROL of the auto's lights. The anti-lock brakes may take a "we're-hitting-the-brake-pedal" signal from the brake light line, but they'll be doing that ahead of the left-right turn signal diverter circuit if the turn signals are integral with the brake lights. If they didn't, that signal would pulse upon application of the turn signal.

As a side note, electric trailer brake controllers are no longer tied into the hydraulic brake lines as they were in the 1960s. There are two or three systems in use, and one system used by Tekonsha ties into the brake line to let the controller know that the brakes are being deliberately applied while an accelerometer input applies the brake current according to how fast the driver is attempting to slow down. If the brake signal was not used as an initiating signal, the controller would try to apply trailer brakes anytime the driver let off the accelerator or the vehicle pitched forward slightly. Speed bumps would be a killer!

I find it odd that a car manufacturer would try to switch the negative lead since they've been deeply in love with the massive amount of wiring they save by using the chassis for the negative return on everything. I'll have to research that out a bit more to see what's going on there. I'm certainly no auto mechanic.

Your warning didn't go unmentioned as I spent the first two paragraphs of the "Wig-Wag" answer warning of the woes that could befall anyone messing around with the headlights. And in both the January and May columns, I expressed my opinion that a commercial trailer light controller was a better choice than rigging something up, for both reliability and cost. I hate reinventing the wheel, especially when both of those reasons kick into gear.

As I was working on many of these projects, I remembered that a large number of them each year in the **Popular Electronics** issues of the 1960s and 1970s revolved around automotive projects, including a lot of automotive test instruments, ignition systems, wiper controls, voltage regulators, and a circuit to mimic the sequential turn signals of the Cougar and Thunderbird. The more-recent "Add Daytime Running Lights To Your Car" of 1996 was almost a rare article. I think that the complexity of automotive electronics has killed off a lot of these projects. For that matter, that very complexity has satisfied most of those older projects. Today's cars have electronic ignition, electronic voltage regulators, intermittent wipers and such things. And the old tachometers and dwell meters of the past aren't of much use today, as most of us can't mess around with today's complex engine controls anyway.

Playing around with the headlights will be impossible as more and more vehicles begin using the newer versions of mercury-vapor lamps that require exotic electronic controls for fast ignition. And it's only a matter of time before the familiar 12-volt systems give way to 42-volt systems. Starting, braking, suspension, and power steering will be revolutionized. Auto repair shops will close down and the electronics repair shops will have to hire mechanical specialists to work on the mechanical aspects of the cars that will be brought in for repair.

More on Kelvin Clips

Q *This is in reference to the Kelvin clips that were discussed at some length in the April 2002 issue. For whatever it may be worth, Allied Electronics carries Kelvin clips in their catalog for $7.85 each. They are Mueller part number BU-75K, Allied catalog number 830-4205 found on page 994 of their 2001 catalog or on their Web page at* www.alliedelec.com. *I agree that eight bucks seems like a lot for a clip, but I personally would be willing to pay it to avoid the rather involved process of making my own as described. There's just a couple of 'gotchas.' The $7.85 does not include shipping, and I believe Allied has a $50 minimum order.—Bill Robinson*

A Thanks for that information, Bill. I hadn't really done any checking around for them until you wrote. Since Mueller is a big name in clips and test leads, I took a look at the Newark catalog. There they have the BU-75K clips with gold/silver tip contacts for $12.99 each, catalog number 90F1604. Under catalog number 84F764 they also have BU-78K clips with gold contacts for only $55 each (ouch!). Looking further, they also carry the Pomona 5940 Kelvin clips, which is a set of two clips with four 24-inch leads and a fifth lead for guarding or grounding, all for only $166.27, Newark catalog number 95F1364. These, of course, are intended more for replacement leads on high-end 4-terminal ohmmeters such as those sold by Agilent (formerly Hewlett-Packard) and Keithley. Newark does not have a minimum order amount, but does tack on a $5 service charge for any order under $25, so even though the BU-78K costs more through them, overall they can be cheaper if the clips are all you order or if you find another $12.01 in merchandise to order. Hosfelt is still the winner here at $7.50 each for the clips, although I don't have a catalog handy at the moment to check on their minimums.

In this turn-key world of off-the-shelf ham transceivers, audio equipment and test gear, I don't feel too badly if I spend a couple of hours making my own little Kelvin clips, tedious though the project may be. If I want Kelvin clips as soon as possible, I'll have them in a couple of hours for less than a dollar if I make them or I can wait one to five weeks if I order a commercial pair for twenty bucks. Hobby electronics and home construction is what this magazine and its forebears have always been about. I guess I'm getting fed up with today's instant gratification and feel proud when I can say, "I made those!"

Another Quad Timer

Q *There is, in addition to the NE558, an NE559, both quad timers, but the 559 is a lower power version and has a shorter propagation delay. I really enjoy your column. I grew up with many of the hobby magazines for the novices. It now must be very hard for them to learn about electronics. We have so many parts now only available in surface-mount technology (SMT). Kind of killing the old breadboarding thing.—Jerry Scheltgen*

A I'm glad you enjoy the column, Jerry. I hope it isn't my mistakes that are the most entertaining part! I ran into that problem of an op-amp that was only available in SMT, which was rather irritating. SMT does present a bit of a breadboarding problem. They make expensive little SMT-to-DIP (dual in-line package) converter boards, but those are a bit of a pain to use because you have to solder the SMT IC to the board, which limits the life span of both the IC and the converter board. I'm always making little jigs for such things. I'll have to work on something that will temporarily hold an SO-8 SMT IC in place so that the converter board is more like a tiny breadboard on the big breadboard. I like to breadboard circuits before I build them so that I can get some of the "duh" errors out before committing to a permanent circuit. It seems silly under that same philosophy to breadboard a DIP version of an SMT circuit that you want to construct. I can't conceive of an SMT solderless breadboard that would even work, let alone be as easy to use as our current DIP-compatible solderless breadboards. (Sigh.)

Whine, Whine, Whine!

Q *I use a 12-volt LCD portable screen in my van for the kids to watch movies on the road. I use a home VCR running on a converter that puts out a 110 modified sine wave. I have been sending the sound input into the LCD screen, and at low volumes I have extreme static/engine noise. I put the volume all the way up and use a volume control on the headphones, but the engine whine is still present.*

I am looking for a circuit I can build that would be 12-volt, would amplify the sound so I can send it through headphones, and would have a selectable filter or filters to customize the sound. A volume control would also be nice. The sound input would be from a standard DVD or VCR with RCA phono jacks. Can you help recommend a source or circuit?—D.B., Pittsburgh, PA

A Trouble is, if you're getting that much engine noise into your present system, adding more components probably won't help. You'll really be masking symptoms rather than fixing the problem. I think you need to back up a bit and work on getting rid of the whine. It's obviously getting in through the vehicle's power system since your VCR and LCD are connected together with shielded cable. They ARE connected together with shielded cable, aren't they?

Ham radio operators with mobile installations have been battling automotive electrical noise ever since the Stanley Steamer went out of vogue. The electrical noise has several sources. Contributors are the alternator, ignition system, blower motor, windshield wiper motor, and power windows. The windows are a temporary annoyance, so they're no worry. The biggest sources are usually the alternator and blower motor, and you can tell by the noise you hear what the main culprit is. If it's a high-pitched whine that increases in frequency when you hit the accelerator, it's coming from the alternator. If it's a lower-pitched whine that increases with frequency and intensity when you increase the blower motor speed, then that's the source. The other items can cause havoc for an entire 500-mile trip, so might need attention also. Since there are so many potential noise sources, it can get expensive trying to squelch each one individually. It's easier to get rid of the noises at a bottleneck where they all come together to irritate you: the input to your VCR/LCD combo. Go to your local retail electronics store and see if they have a noise filter for the 12-volt line that feeds your kiddie-tainment system. It may solve your problem. If it doesn't, you may have to get more serious. A stroll to your public library to check out an edition of the *ARRL Radio Amateur's Handbook* (or whatever they're

(Continued on page 50)

PIC-tronics

TJ BYERS

Traffic-Light Logic

A new monthly column for the adventurous who want to take the PIC walk. (If you have to ask, you must read!)

I'm hooked on electronics, and I'm hooked on toys. I'm also hooked on microcontrollers, especially the PIC kind. I love it when the three come together. There's nothing more satisfying than seeing a PIC-based bot miss the kitchen wall for the first time or watching a light bar rock to the beat of a 16F628 program. In fact, anything that brings life to objects through microcontrollers, software, and whim beckons me like a flame to a moth.

In the coming months I will show you some of my pet projects and how they came to be. All are based on the new 16F628 PIC chip, a more robust—and less expensive—version of the popular 16C84/16F84. Each article will provide all the details needed to duplicate the project, including a full parts list and software code.

My ideas for projects come from the darndest places. Things I see every day. Things I'd like to see every day. And things that appear differently to me than to other people. The marriage can take many forms and spans a range from useful to interesting to simply frivolous.

It's the last that gave me the idea for this project: an LED traffic signal. Lights are a lure for me—especially moving lights. That, and the thought of putting the traffic light pattern to the pulse of a PIC, made this project irresistible.

Ground Rules

Everyone has seen a traffic light and takes its operation for granted. If you watch the light pattern carefully, you may be surprised. While you may assume that when the cross-traffic signal goes red, you get an immediate green light, that's not the case. In real life, there is a short period when the lights are red for both directions. This period,

LISTING 1

```
include     <P16F628.inc>
__config    _INTRC_OSC_CLKOUT & _WDT_OFF & _PWRTE_OFF & _LVP_OFF

;====Traffic Light=====
;Author: Tim Hamel
;Date: 3/4/02
;Basic Operation:
;Traffic light loops through a timed sequence.
;Red lights are on at the same time to deal with red light runners.
;======================


;===Declare Some RAM Locations===
d1      equu    0x20
d2      equ     0x21
d3      equ     0x22
dlval   equ     0x23

;===LED Pin Definitions===
#DEFINE     NSRED PORTB,0           ;N/S red light
#DEFINE     NSYEL PORTB,1           ;N/S yellow light
#DEFINE     NSGRE PORTB,2           ;N/S green light

#DEFINE     EWRED PORTB,7           ;E/W red light
#DEFINE     EWYEL PORTB,6           ;E/W yellow light
#DEFINE     EWGRE PORTB,5           ;E/W green light
;========================


        org     0       ;Reset vector is at 0x0000
        goto    main


;====1 Second Delay========
;Basically, this routine runs loops within loops to "kill" clock cycles.
sec
        movlw   0x3A ;58
        movwf   d1
Delay_00
        movlw   0x4A
        movwf   d2
Delay_01
        movlw   0x4C
        movwf   d3
Delay_02
        decfsz  d3, f
        goto    Delay_02 ;228
        decfsz  d2, f
        goto    Delay_01 ;222
        decfsz  d1, f
        goto    Delay_00

                        ;3977 cycles
        movlw   0x1c
        movwf   d1

Delay_10
        movlw   0x2e
        movwf   d2
Delay_11
        decfsz  d2, f
```

(Listing continued on next page)

```
        goto    Delay_11
        decfsz  d1, f
        goto    Delay_10

                        ;46 cycles
        movlw   0x0f
        movwf   d1
Delay_20
        decfsz  d1, f
        goto    Delay_20

        return
;=========================

dlyn:   movwf   dlval    ;Move delay value to a variable

dly1    call    sec      ;Call 1 second delay dlval times
        decfsz  dlval,f  ;Does dlval = 0?
        goto    dly1     ;No
        return           ;Yes, return to main program


main    movlw   0
        tris    PORTB    ;Make PORTB/PORTA outputs.
        tris    PORTA
        clrf    PORTB
;=========================


;===Everything below this line will repeat indefinitely.====
loop

;1===N(orth)/S(outh) Green, E(ast)/W(est) Red ====
        bsf     NSGRE    ;Turn on N/S Green light
        bsf     EWRED    ;Make sure E/W light is Red
        movlw   .15      ;Load value for 15 second delay
        call    dlyn     ;Start delay

;2===N/S Yellow, E/W Red ===

        bcf     NSGRE    ;Turn off N/S Green
        bsf     NSYEL    ;Turn on N/S Yellow
        movlw   .2       ;Load value for 2 second delay
        call    dlyn

;3===N/S Red, E/W Red ===

        bcf     NSYEL    ;Turn off N/S Yellow
        bsf     NSRED    ;Turn on N/S Red
        movlw   .1       ;Load value for 1 second delay
        call    dlyn

;4===N/S Red, E/W Green ===

        bcf     EWRED    ;Turn off E/W Red
        bsf     EWGRE    ;Turn on E/W Green
        movlw   .20      ;Load value for 20 second delay
        call    dlyn

;5===N/S Red, E/W Yellow ===

        bcf     EWGRE    ;Turn off E/W Green
        bsf     EWYEL    ;Turn on E/W Yellow
        movlw   .3       ;Load value for 3 second delay
        call    dlyn

;6===N/S Red, E/W Red ===

        bcf     EWYEL    ;Turn off E/W Yellow
        bsf     EWRED    ;Turn on E/W Red
        movlw   .2       ;Load value for 2 second delay
        call    dlyn
        bcf     PORTB,0  ;Turn off N/S Red
        goto    loop     ;Do it again

        end
```

The program opens with the typical configuration parameters, followed by the output pin assignments; for instance, the North/South red light is assigned to PortB, pin 0 (physically pin 6 on the 16F628).

which is usually 1 to 3 seconds long, gives time for cars in the intersection to clear out before the cross traffic is given the green light. Makes sense.

Most traffic light models, particularly those made using logic chips, don't have a simultaneous red light condition. It's blink red, blink green. I not only found that annoying, but a challenge. It didn't take me long to figure out that this was a job for a PIC.

First, I made a chart showing the sequence of events and the timing values (Table 1). Notice that the timing for the two sides is asymmetrical. That is, the East/West traffic has a 20-second green light and the North/South flow has only a 15-second green light. This pattern assumes that there are more cars going sideways (east to west), than there are going up and down. The yellow and red overlap times are similarly adjusted.

On The Road To Code

Now that I had a game plan, the next step was translating concept to code. I had two choices: a serial program or a look-up table. Here are the trade-offs. Serial code typically requires more memory space, but is easy to follow and easier to modify. A look-up table can deal with more values in a smaller memory size, but is rigidly fixed in its operation. It doesn't take a rocket scientist to figure out which method is best for this project: serial code.

I program in assembly language for a couple of reasons. First and foremost, it results in a smaller code (some call it a tighter code) compared to a compiled program like BASIC. I know it takes more strokes to do the same thing, but routines that you do often, like displaying data on an LCD, can be placed in a "module"—a packet that has all the code you need for that routine so that you don't have to reinvent the wheel. Simply plug it in where needed. As we go along, I will build up a library of commonly-used modules.

Second, assembly language has a touch on the pulse of the PIC family. It gives you insight into the inner workings that are invisible to you at higher-level languages. Wait before you jump up and say, "I don't wanna know how the dumb thing works! I just want it to work, and I know PICBasic." My retort is: The more you know about the capabilities of the PIC, the more it can do for you. Furthermore, the PIC instruction set is just 35 commands. My kids have memo-

TABLE 1

Sequence	North/South	Signal	East/West	Signal	Comment
#1 -- 15 sec					
Red	OFF	○	ON	●	
Yellow	OFF	○	OFF	○	North/South flow
Green	ON	●	OFF	○	
#2 -- 2 sec					
Red	OFF	○	ON	●	
Yellow	ON	○	OFF	○	North/South caution
Green	OFF	○	OFF	○	
#3 -- 1 sec					
Red	ON	●	ON	●	
Yellow	OFF	○	OFF	○	Clear intersection
Green	OFF	○	OFF	○	
#4 -- 20 sec					
Red	ON	●	OFF	○	
Yellow	OFF	○	OFF	○	East/West flow
Green	OFF	○	ON	●	
#5 -- 3 sec					
Red	ON	●	OFF	○	
Yellow	OFF	○	ON	○	East/West caution
Green	OFF	○	OFF	○	
#6 -- 2 sec					
Red	ON	●	ON	●	
Yellow	OFF	○	OFF	○	Clear intersection
Green	OFF	○	OFF	○	

The East/West traffic has a 20-second green light and the North/South flow has only a 15-second green light. This pattern assumes that there are more cars going sideways (east to west), than there are going up and down.

The PIC Program

Ready? (Drum roll, please.) Here's what I came up with—Listing 1. The program opens with the typical configuration parameters, followed by the output pin assignments; for instance, the North/South red light is assigned to PortB, pin 0 (physically pin 6 on the 16F628). Next, a 1-second delay timer is established using a series of looping routines.

The rest of the program is self-explanatory and is a mirror image of Table 1; follow the bouncing annotation. Notice how easy it is to change the on and off times for any sequence of green/yellow/red. Simply enter the number of seconds you wish into the "Load value..." line using a text editor like WordPad.

I know some of you have programmed in PIC assembly language before and may question why there's a period before the Load value (e.g., movlw .2 ;Load value for 2 second delay) number. Without the period, the PIC assumes you are speaking in hex (16) numbers. Adding the period tells the program you mean decimal seconds.

All the above was done using just a few lines of assembly language. Simple, huh? If you insist on using PICBasic, you have all the information you need in Table 1.

'Nuf textbook stuff for this month. Ready to get your hands dirty?

rized more TV show time slots than that.

Finally, don't panic. All my programs are well annotated so that you are never at a loss as to what's happening when. You'll be able to download a copy of the program from *www.gernsback.com* or buy a programmed PIC from the source listed in the Parts List. So for those of you who want only to build an LED traffic light and could care less about the software details, skip to "Let There Be Light."

PARTS LIST FOR THE BASIC TRAFFIC LIGHT (FIG. 1)

1—16F628 PIC
6—330-ohm resistors
2—Red LEDs
2—Yellow LEDs
2—Green LEDs

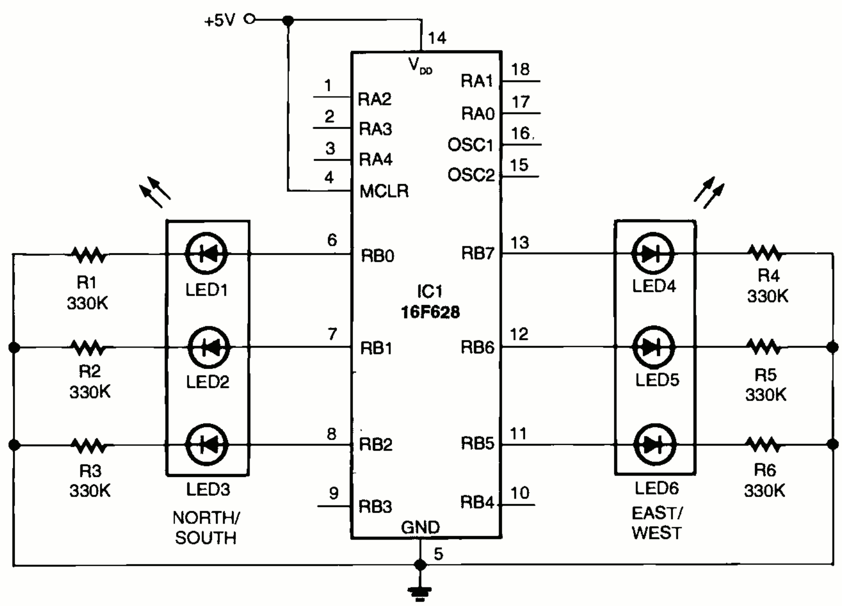


Fig. 1. A simple traffic light for experimenting can be made using nothing more than a 16F628 PIC, six LEDs, and six resistors.

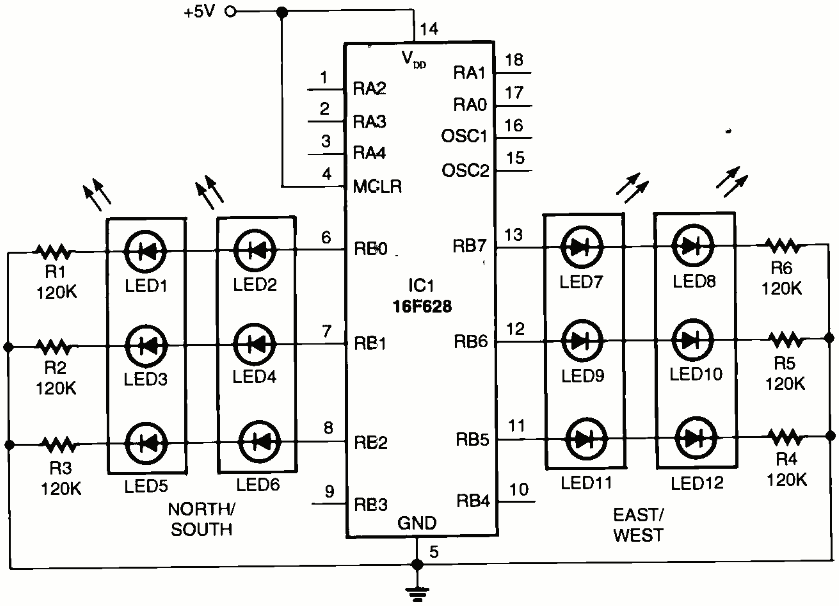


Fig. 2. A more realistic effect is created by placing the North/South and East/West LEDs in series to generate a four-sided sign.

PARTS LIST FOR THE FOUR-SIDED LIGHT (FIG. 2)

1—16F628 PIC
6—120-ohm resistors
4—Red LEDs
4—Yellow LEDs
4—Green LEDs

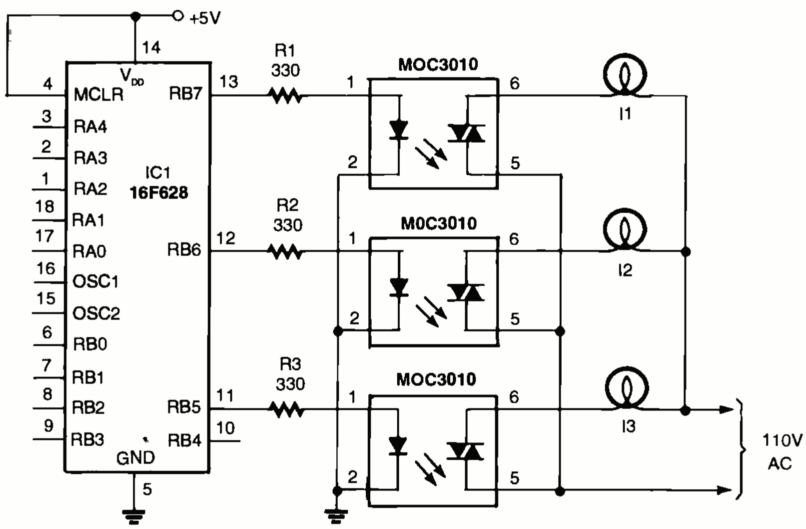


Fig. 3. This circuit lets you increase the light output using incandescent lamps. For a two- or four-sided signal, you need to add three more MOC3010 optoisolators to the RB0, RB1, and RB2 outputs. Use Fig. 1 as a guide.

PARTS LIST FOR THE 110-VOLT LIGHT (FIG. 3)

1—16F628 PIC
3—330-ohm resistors
3—MOV3010 optoisolators
3—110V lamps (see text)

Let There Be Light

Before I begin a discussion on the project's hardware construction, let me warn you that I'm forever a dreamer and a tinkerer. Some of my ideas turn out to be a "marketable item" (right, sure) and actually make it to the printed circuit board (PCB) stage, which I'm more than willing to share here. Other projects, though, never leave the breadboard and

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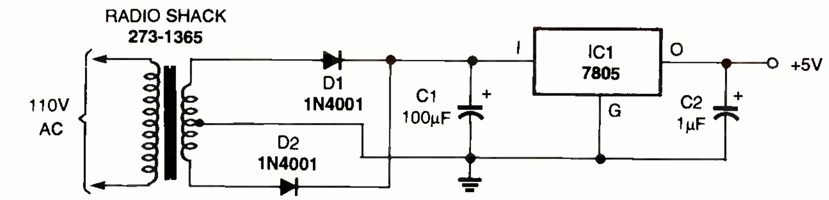

Fig. 4. The traffic signal will operate from any 5.5-volt source, including batteries. Here's a simple power supply for those who believe in DIY.

PARTS LIST FOR THE POWER SUPPLY (FIG. 4)

1—7805 IC
2—1N4001 diode
1—100µF, 16V capacitor
1—1µF, 16V tantalum capacitor
1—12.6VCT transformer (RadioShack 273-1365)
1—Heat sink (RadioShack 276-1363)

A programmed 16F628 traffic light PIC is available from Tim Hamel, 1283 Fir Acres Dr., Eugene, OR 97401-1811 (tekphobia@attbi.com). The price is $12, including shipping and handling.

are done just to satisfy my curiosity.

That said, this project falls into the "breadboard only" category, which leaves the fabrication details up to you and your imagination. However, I can visualize it as a realistic addition to any serious model railroad layout, a unique hanging party decoration, or as a fascinating light show for a den.

Let's begin with the schematic, or more properly the schematics. Figure 1 shows the basic traffic light design with only two sides; a four-sided model is shown in Fig. 2. This view shows the 16F628 PIC from the top, with a slight relocation of pins 5 (GND) and 14 (V_{CC}) to make the drawing easier to understand.

The series resistors limit the LED current to just under 10 mA per output pin, and I purposely didn't place the LEDs in parallel in Fig. 2 simply because that would put more strain on the PIC than I prefer—and it saves six resistors. I've built both circuits using a wide variety of LEDs and found that each had its place. The smaller 3-mm LEDs are a perfect choice for a model railroad layout, and the larger 5mm work well for a desktop display.

I've also included a 110-volt version that can control incandescent lamps up to 100 watts (Fig. 3), but it only shows one side of the traffic light. I first saw this version of a traffic signal in a friend's den, using 7-watt Christmas bulbs. I realized that one side was just right for his small bar. For outdoor scenes you will want a two-sided display with 60- or 100-watt bulbs.

And The Rest

You may notice that the clock crystal is glaringly absent. No, I didn't forget it. Unlike the 16F84, the 16F628 has a built-in, software programmable oscillator (the INTRC command) that runs at 4 MHz. Of course, you can use an external clock or crystal, but let's save that for another month.

Finally, you'll need a 5-volt power supply. Fortunately, the 16F628 is very forgiving and will operate from 3.0 to 5.5 volts, so a good 5-volt, DC wall-wart rated at 200 mA will work just fine. In case you want to roll your own, check out Fig. 4. While it's very straightforward, make sure you place the capacitors as close to the 7805 as possible.

That's all the space I have room for this month. Next month I'll show you how to interface an external ADC (*a*nalog-to-*d*igital *c*onverter) to monitor temperature. 'Til then **P**

Q & A

(continued from page 45)

calling it this year) to look at the mobile installation section should point you to a serious noise filter you can build. You should only have to worry about the 12-volt line feeding your system. Avoid messing with some of the techniques described in the Handbook that are needed to keep noise out of sensitive short-wave receivers such as grounded cans over the distributor and shielded ignition wires. A low-pass power filter on the 12-volt line should do the trick without having to invest in some kind of amplifier/filter system. You may need a filter at the output of the inverter as well, but more than likely the LCD power is the culprit.

Writing to Q&A

As always, we welcome your questions. Please be sure to include:

(1) plenty of background material,

(2) your full name and address on the letter (not just the envelope),

(3) and a complete diagram, if asking about a circuit; and

(4) type your letter or write neatly.

Send questions to Q&A, **Poptronics**, 275-G Marcus Blvd., Hauppauge, NY 11788 or to *q&a@gernsback.com*, but do not expect an immediate reply in these pages (because of our backlog). We regret that we cannot give personal replies. Please no graphics files larger than 100K. **P**

mailto: serviceclinic@gernsback.com

SAM GOLDWASSER

AC ADAPTERS

It seems that the world now revolves around AC Adapters or 'Wall Warts' as they tend to be called. While AC adapters aren't usually highly sophisticated devices, they are essential to the functioning of much modern electronic equipment. Countless millions of perfectly good products are discarded due to the failure of the AC adapter cord or just the loss of the AC adapter to that bottomless utility drawer. Thus, being able to match up an AC adapter with its associated equipment or safely substituting another one can come in very handy. Despite the fact that the plugs to the equipment may be identical THESE CAN GENERALLY NOT BE INTERCHANGED. The type (AC or DC), voltage, current capacity, and polarity are all critical to proper operation of the equipment. Use of an improper adapter or even just reverse polarity can permanently damage or destroy the device. Most equipment is protected against stupidity to a greater or lesser degree—but don't count on it.

There are several types:

AC Transformer—All wall warts are often called transformers. However, only if the output is stated to be 'AC' does the device simply contain a (step-down) transformer. These typically put out anywhere from 3 to 20 V_{AC} or more at 50 mA to 3 A or more. The most common units range from 6 to 15 V_{AC} at less than 1 A. Typically, the regulation is very poor so that an adapter rated at 12 V_{AC} will typically put out 14 V_{AC} with no load and drop to less than 12 V_{AC} at a rated load. However, some may output 2X or more of the rated voltage with no load! To gain agency approval, these adapters need to be protected internally so that there is no fire hazard even if the output is shorted. There may be a fuse or thermal fuse internally located (and inaccessible without partially destructive disassembly).

DC Power Pack—In addition to a step-down transformer, these include at the very least a rectifier and filter capacitor. There may be additional regulation, but most often there is none. Thus, while the output is DC, the powered equipment will almost always include an electronic regulation. As above, you may find bad connections or a blown fuse or thermal fuse inside the adapter, but the most common problems are with the cable.

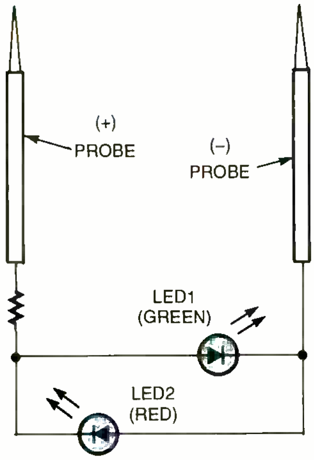

Fig. 1. A handy low-cost device can be built into an old ballpoint pen case or something similar to provide a convenient indication of wall adapter type, operation, and polarity:

Switching Power Supply—These are complete low-power AC-DC converters using a high-frequency inverter. Most common applications are laptop computers and camcorders. The output(s) will be fairly well regulated, and these will often accept universal power—90–250 V_{AC} or V_{DC}. The remainder of this article deals primarily with the simple AC and DC transformer-based wall adapters. For in-depth treatment of the switchmode variety, see the "Service Clinics" on this topic or the information at my Web site, *www.repairfaq.org*.

Safety

For the common transformer-based AC adapter, there is no danger anywhere inside the device once unplugged. For the switchmode variety, there can be lethal voltages stored on capacitors even after being unplugged, especially where the unit is defective (since there may be no load to discharge the cap). Any internal over-current fuses or thermal fuses represent essential safety features of an AC adapter. These must NOT be removed except during testing. Where a fuse is found to be blown, use only an exact replacement. I really don't recommend running a repaired cobbled-together AC adapter unattended in any case, since even the sealed case provides some additional amount of fire protection.

About AC Adapter Ratings

The following mainly applies to AC adapters using transformers. Those based on switchmode power supplies adapters have tended to be well designed with decent regulation and realistic ratings. Of course, they are generally also much more expensive!

There is no standard for rating AC adapters. When a particular adapter is listed as, say, 12 V, 1 A max, there's a good chance the output will average 12 V when outputting 1 A; but what it does at lower currents is not known. In fact, lightly loaded, the output voltage may be more than double its nameplate rating! This could be disastrous where a piece of equipment is plugged into it that doesn't expect such a high voltage. The rating also doesn't say anything about the ripple (for DC models)—it could be almost anything. The lifetime of an AC adapter (particularly those outputting DC) when run at or near its nameplate rating may be very short. Why? Because they often use low temperature (cheap!) components that can't take the heat.

For AC output models, the transformer itself may fail (or at least the thermal fuse). For DC models, the electrolytic capacitor(s) may go bad very quickly. The likely result will be that the output voltage will disappear entirely

(AC models) or drop in value with greatly increased ripple (DC models). Where the adapter is used with its intended equipment, one can presume the manufacturer did the proper testing to assure compatibility and adequate life (though this isn't always the case!). However, where it is used in some other application, the life of the adapter and the equipment may be much shorter than expected, possibly failing almost immediately.

Protect Yourself From "Unknown AC Adapter Syndrome"

Apparently, manufacturers of equipment powered by AC adapters have discovered that they can improve their bottom line by NOT printing the AC adapter ratings on the device itself, and possibly not even in the user manual. I don't know whether this is actually done for liability reasons (so you aren't tempted to actually use an AC adapter other than their own exorbitantly priced replacement) or just to save 3 microcents on printing ink, but the net result is that the owner has no idea what adapter in that drawer that collects adapters is the correct one. They could at least specify a particular model adapter if they don't think the average consumer has an intelligence greater than a carrot.

For example, I own 2 U.S. Robotics modems. One uses a 9 V_{AC} adapter; the other uses a 20 V_{AC} adapter. The power jacks are identical and totally unmarked. Guess what happens if I guess wrong? With too little voltage, the modem may appear to work but be unreliable. With too much voltage, the smoke will very likely be released instantly.

To save yourself a lot of hassle and possible damaged equipment, put a label on each AC-adapter powered device you own with the voltage, current, AC or DC (with polarity), and model number of the adapter (make one up if nothing is obvious and put it on the device and adapter). Then, if you misplace the adapter, you'll know what to look for and if it is nowhere to be found, will have enough information to purchase a replacement.

Why Do AC Adapters Usually Use Heavy Transformers?

The main reasons are safety and cost. Line isolation is essential for safety with respect to electrical shock—no part accessible to the user must be connected to either side of the power line. A regular transformer provides this automatically. While combinations of passive components can reduce the risk of shock, nothing quite matches the virtually fail-safe nature of a simple transformer between the power line and the low-voltage circuitry. To achieve similar isolation without a line transformer generally requires a switchmode power supply that actually contains a small high-frequency transformer to provide the isolation. Until recently, such systems were much more expensive than a simple iron transformer, but that is changing and many modern devices now use a wall adapter based on this approach. These can be recognized by their lightweight, DC (probably regulated) output, and the required warnings NOT to cut them off and replace them with an ordinary plug! I wonder how many people have ignored the warnings when their equipment stopped working and replaced that fat "plug"? What a scenario for disaster!

AC Adapter Testing

AC adapters that are not the switching type can easily be tested with a VOM or DMM. The voltage you measure (AC or DC) will probably be 10–25% higher than the label specification. If you get no reading, wiggle, squeeze, squish, and otherwise abuse the cord both at the wall wart end and at the device end. You may be able to get it to make momentary contact and confirm that the adapter itself is functioning. The most common problem is one or both conductors breaking internally at one of the ends due to continuous bending and stretching. Make sure the outlet is live—check with a lamp.

Make sure any voltage selector switch is set to the correct position. Move it back and forth a couple of times to make sure the contacts are clean. If the voltage readings check out for now, then wiggle the cord as above in any case to make sure the internal wiring is intact—it may be intermittent. Although it is possible for the adapter to fail in peculiar ways, a satisfactory voltage test should indicate that the adapter is functioning correctly.

Pocket Wall Adapter Tester/Polarity Checker

A handy low-cost device can be built into an old ball point pen case or something similar to provide a convenient indication of wall adapter type, operation, and polarity:

- The green LED will light up if the polarity of an adapter with a DC output agrees with the probe markings.
- The red LED will light up if the polarity of an adapter with a DC output is the opposite of the probe markings.
- Both LEDs will light up if your adapter puts out AC rather than DC.
- The LED brightness can provide a rough indication of the output voltage.

Getting Inside an AC Adapter

Manufacturers come up with all sorts of creative ways of making access a challenge:

- Some adapters are secured with screws—possibly with strange heads. If this is the case, disassembly is possible without damage, at least in principle. However, you may need to find or improvise for the special tool.
- Some of them are fully potted and impossible to open without dynamite. Forget it—move on with your life. These will feel solid and there will be no "give" when pressing the sides.

For those that are glued:

- A hacksaw or thin file can be used to carefully cut along the glue line just deep enough so that the two halves can be popped apart. Make sure you don't rip into internal components! Gently whacking a large knife with a soft mallet may be a bit more persuasive. :)
- A vise can be used to squeeze on diagonally opposing corners, which will hopefully pop the case open along the glue line (or somewhere!). After the repair, the two halves (or pieces!) can be glued back together.

AC Adapter Repair

Although the cost of a new adapter is usually modest, repair is often so easy that it makes sense in any case. The most common problem (and the only one we will deal with here) is the case of a broken wire internal to the cable at either the wall wart or device end due to excessive flexing of the cable. Usually, the point of the break is just at the end of the rubber cable guard. If you flex the cable, you will probably see that it bends more easily here than elsewhere due to the broken inner conductor. If you are reasonably dexterous, you can cut the cable at this point, strip the wires back far enough to get to the good copper, and solder the ends together. Insulate completely with several layers of electrical tape. Make sure you do not interchange the two wires for DC output adapters! (They are usually marked somehow either with a stripe on the insulator, a thread inside with one of the conductors, or copper and silver colored conductors). Before you cut, make a note of the proper hookup just to be sure. Verify polarity after the repair with a voltmeter.

The same procedure can be followed if the break is at the device plug end, but you may be able to buy a replacement plug that has solder or screw terminals rather than attempting to salvage the old one. Once the repair is complete, test for correct voltage and polarity before connecting the powered equipment. This repair may not be pretty, but it will work fine, is safe, and will last a long time if done carefully. If the adapter can be opened—it is assembled with screws rather than being glued together—then you can run the good part of the cable inside and solder directly to the internal terminals. Again, verify the polarity before you plug in your expensive equipment.

WARNING: If this is a switching power supply type of adapter, there are dangerous voltages present inside in addition to the actual line connections. Do not touch any parts of the internal circuitry when plugged in and make sure the large filter capacitor is discharged (test with a voltmeter) before touching or doing any work on the circuit board.

If it is a normal adapter, then the only danger when it's open is direct connections to the AC plug. Stay clear when it is plugged in.

AC Adapter Substitution and Equipment Damage

Those voltage and current ratings are there for a reason. You may get away with a lower voltage or current adapter without permanent damage but using a higher voltage adapter is playing Russian Roulette. Even using an adapter from a different device—even with similar ratings, may be risky because there is no real standard. A 12-volt adapter from one manufacturer may put out 12 V at all times, whereas one from another manufacturer may put out 20 V or more when unloaded.

A variety of types of protection are often incorporated into adapter-powered equipment. Sometimes these actually will save the day. Unfortunately, designers cannot anticipate all the creative techniques people use to prove they really do not have a clue of what they are doing. The worst seems to be where an attempt is made to operate portable devices off of an automotive electrical system. Fireworks are often the result.

If you tried an incorrect adapter and the device now does not work, there are several possibilities (assuming the adapter survived and this is not the problem):

- An internal fuse or IC protector blew. This would be the easiest to repair.
- A protection diode sacrificed itself. This is usually reverse biased across the input and is supposed to short out the adapter if the polarity is reversed. However, it may have failed shorted, particularly if you used a high current adapter (or automotive power).
- Some really expensive hard-to-obtain parts blew up. Unfortunately, this outcome is all too common.

Some devices are designed in such a way that they will survive almost anything. A series diode would protect against reverse polarity. Alternatively, a large parallel diode with upstream current limiting resistor or PTC thermistor, and fuses, fusable resistors, or IC protectors would cut off current before the parallel diode or circuit board traces have time to vaporize. A crowbar circuit (zener to trigger an SCR) could be used to protect against reasonable overvoltage.

Voltage and Polarity of AC Adapter-Powered Devices

Knowing the voltage and polarity is often required when the original adapter is lost or misplaced or isn't labeled so you are not sure if it is the correct one for your device. Or, to be able to set the voltage and polarity on a universal adapter. It's amazing how many things like modems and answering machines don't list the voltage and polarity on the case—it's not like the extra printing would cost anything! If you are simply replacing a broken adapter with a universal type, check the label on the old one—they almost always provide this information. There are three issues: AC versus DC, the voltage, and polarity. Unfortunately, fully determining these requirements experimentally can be non-trivial. While many devices have built-in protection for reverse polarity (which would probably also include putting AC into a device requiring DC), others do not and may be damaged or may at least blow an internal fuse. Few devices protect against extreme overvoltage. If you have a multimeter, there are also some tests you can perform without opening the device, but they are not foolproof. Here are some general guidelines. The more of these you can confirm, the greater the confidence of avoiding disaster.

The best way would be to find the information without serious testing. It may be readily available:

- Examine the device for labels, either embossed near the power jack or on the rear or underneath such as DC 5V —— AC 12 V ~.
- If there is a voltage listed, but no indication of AC/DC, 6 V or less is likely to be DC (and may require decent regulation); higher voltages could be either AC or DC (probably filtered but unregulated though not always).
- A symmetric (non-polarized) jack means it is supposed to operate on AC.
- If the device has a metal case or you can get to the metal shields on connectors, check for continuity to the power jack. This probably is the negative input (though no guarantee—some manufacturers do really strange things!).
- Check your user manual!
- Contact the manufacturer or their Web site.

The next best way would be to open it up and trace enough of the power circuitry to identify components that have obvious voltage ratings and polarities like electrolytic capacitors. There may even be labeling on the circuit board.

- There will almost always be at least one electrolytic cap very near the power input.

(Continued on page 58)

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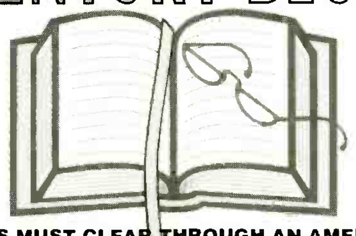

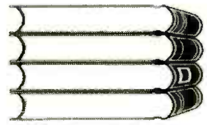

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CHARLES D. RAKES

More On Timer Circuits

Last month we were into a number of timer circuits; and as I remember, we ran out of time before we ran out of timer circuits. Also, this visit we're going to look at some fun electronic sound-generator circuits, which to some might be a source of irritation, frustration, and real aggravation. One of the circuits will include a timer circuit and an irritating sound-generator circuit. So get ready for some electronic circuitry fun.

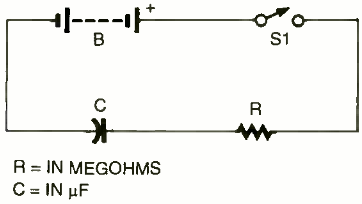

Fig. 1. The schematic above is a basic RC timing circuit. With the component values as follows: B1=10-volts, C=10-µF, and R=1-megohm, and with S1 closed, the voltage across the capacitor after one time constant will reach 6.32 volts.

Big Time RC Timer

Before hopping into the tar pit, here's a brief look at the basic RC timing configuration and how the R works with the C in determining a timer's time period. The time required in seconds to charge a capacitor to 63.2% of the applied voltage is one time constant. The timing formula is Time= Resistance in ohms × Capacitance in farads. Locating resistors in ohms is no problem, but capacitors in farads are not nearly as easy. Not to worry, because we can shift a few decimals around and end up with a more friendly timing formula.

Time in seconds = Resistance in megohms × capacitors in microfarads. Both of these components are off-the-shelf and out-of-the-junk-box items.

The combination of a 1-megohm resistor and a 1-µF capacitor is 1 × 1= 1 second in charge time for one time constant. A 1-meg resistor and a 10-µF capacitor combination produce a 10-second time constant. A basic RC timing circuit is shown in Fig. 1. With the component values as follows: B1=10-volts, C=10-µF, and R=1-megohm, and with S1 closed, the voltage across the capacitor after one time constant will reach 6.32 volts.

Several years ago someone discovered a way to stuff behemoth amounts of microfarads in a tiny package no bigger than a robust blueberry. If you can imagine a ONE-FARAD capacitor of this size, you're ready for our basic timer circuit shown in Fig. 2. Now we can go back to the original formula of Time = R × C in farads for our next timer circuits.

This is a delay-on type timer that remains off until the capacitor charges up to a predetermined voltage. In this circuit a single gate of a 4093 CMOS quad 2-input NAND Schmitt trigger IC is the voltage-sensing device. When the charging voltage reaches about 3 volts, the gate changes state lighting LED1, which will remain on as long as power is applied. To reset the timer the capacitor must be discharged, and the modified circuit in Fig. 3 does just that.

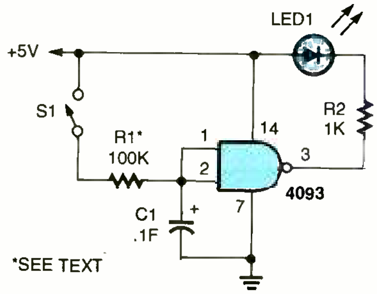

Fig. 2. This is a delay-on type timer that remains off until the capacitor charges up to a predetermined voltage. In this circuit a single gate of a 4093 CMOS quad 2-input NAND Schmitt trigger IC is the voltage-sensing device.

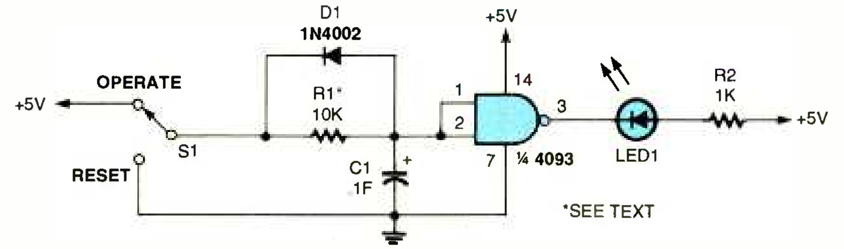

Fig. 3. S1 can be used to reset the circuit by discharging the capacitor through D1 to ground. The voltage remaining across the capacitor will be about .6 volts, and that will be the starting voltage for the next delay-on time period, which will be shorter than starting with a completely discharged capacitor.

PARTS FOR THE MODIFIED TIMER CIRCUIT (FIG. 3)

LED1—Light-emitting diode, any color
D1—1N4002 silicon diode
IC1—4093 CMOS quad 2-input Schmitt trigger NAND gate
C1—.1-Farad/5.5-V_{DC} capacitor
R1—10,000- to 100,000- ohm, ¼-watt, 5% resistor (see text)
R2—1000-ohm, ¼-watt, 5% resistor (see text)
S1—Single-pole two-position switch

PARTS LIST FOR THE BASIC TIMER (FIG. 2)

LED1—Light-emitting diode, any color
IC—4093 CMOS Quad 2-input Schmitt trigger NAND gate
C1—.1-Farad/5.5-V_{DC} capacitor, RadioShack #900-5220
R1—10,000- to 100,000- ohm, ¼-watt, 5% resistor (see text)
R2—1000-ohm, ¼-watt, 5% resistor (see text)

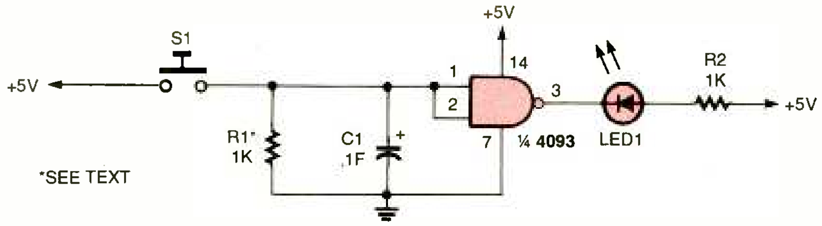

Fig. 4. A delay-off timer circuit is shown above, which is very similar to our delay-on circuit. Closing S1 for a few seconds to charge the .1-Farad capacitor activates the timer.

PARTS LIST FOR DELAY-OFF TIMER (FIG. 4)

LED1—Light-emitting diode, any color
IC1—4093 CMOS quad 2-input Schmitt trigger NAND gate
C1—.1-Farad/5.5-V_{DC} capacitor
R1, R2—1000-ohm, ¼-watt, 5% resistor
S1—Normally open, pushbutton switch

After the timer has timed out, S1 can be used to reset the circuit by discharging the capacitor through D1 to ground. The voltage remaining across the capacitor will be about .6 volts, and that will be the starting voltage for the next delay-on time period, which will be shorter than starting with a completely discharged capacitor. Using the .1-F capacitor I had on hand and with a timing resistor (R1) of 1k, the on-delay time was about 40 seconds, and with a 10-k

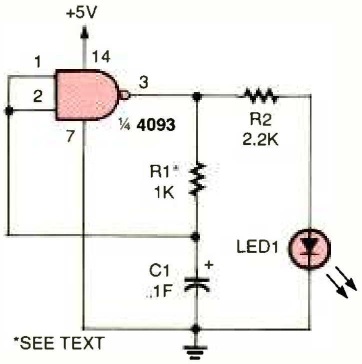

Fig. 5. When the power is first applied to this circuit, the voltage across the capacitor is zero and so is the 4093's input gate. The gate's output is high supplying a positive charging current to the timing capacitor.

PARTS LIST FOR "AT A SNAIL'S PACE" (FIG. 5)

LED1— Light-emitting diode, any color
IC1—4093 CMOS quad 2-input Schmitt trigger gate
C1—.1-Farad/5.5-V_{DC} capacitor
R1—1000-ohm, ¼-watt, 5% resistor (see text)
R2—2200-ohm, ¼-watt, 5% resistor (see text)

resistor the delay lengthened to over 7 minutes. Resistor values up to 100K will give much longer on-delay times. It just takes a lot of time to select the value of R1 for a desired long turn-on delay time period.

Even though using the time formula with the RC values used, the time should figure out to about 100 seconds. However, there are several factors that come into play that reduces the formula's time figure. Starting at a voltage of .6 and with the capacitors with a tolerance of =80/-20%, the 40-second delay is a realistic value. Some experimenting in selecting the desired timing resistor will be necessary to obtain just the right delay.

A delay-off timer circuit is shown in Fig. 4, which is very similar to our delay-on circuit. Closing S1 for a few seconds to charge the .1-Farad capacitor activates the timer. The input voltage to the 4093's gate goes high pulling the output low, lighting the LED which remains on until the timing capacitor discharges to about 2.2 volts. The delay-off time with a 1-k resistor is about 50 seconds, and about 8 minutes with a 10-k discharge resistor.

At A Snail's Pace

The 4093 is a versatile gate, indeed. The gate's Schmitt-trigger input allows it to be connected in the simplest of astable oscillator circuits. Just how low can the frequency of an oscillator go using the .1-Farad capacitor as the C in the simple RC circuit? Never fear 'cause we're about to find out.

The oscillator circuit is shown in Fig. 5. Let's review how this simple circuit oscillates before getting into the low frequency operation. When the power is first applied to the circuit, the voltage across the capacitor is zero and so is the 4093's input gate. The gate's output is high supplying a positive charging current to the timing capacitor. As the voltage across the capacitor rises to the gate's input trigger level, the output switches low. This starts the discharge of the capacitor. When the capacitor's voltage drops to the gate's turn-off level, the cycle starts over and will repeat as long as power is applied.

This is all possible because of the unique hysteresis characteristics of the Schmitt-trigger gate. The gate's input turn-on voltage is greater than the turn-off voltage. This difference in input voltage is what allows the single gate to oscillate in the RC circuit configuration.

The RC values shown in Fig. 5 will produce a frequency of one complete cycle every two minutes. This is not the low end, but the highest frequency obtainable with this circuit while using the .1-farad capacitor. For lower frequencies just increase the value of R1 and stretch out the cycle.

Before leaving this simple oscillator circuit behind, there's one modification I want to share with you, shown in Fig. 6.

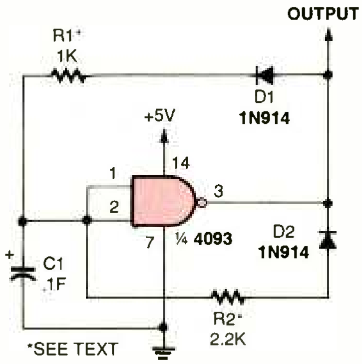

Fig. 6. The addition of two diodes and one resistor allows this circuit's on/off time to be adjusted independently. The capacitor's charging time is set with R1 and the discharge time by R2.

PARTS LIST FOR THE MODIFIED OSCILLATOR (FIG. 6)

IC1—4093 CMOS quad 2-input Schmitt trigger NAND gate
D1, D2—1N914 silicon diode
C1—.1-Farad/5.5-V_{DC} capacitor.
R1—1000-ohm, ¼-watt, 5% resistor (see text)
R2—2200-ohm, ¼-watt, 5% resistor (see text)

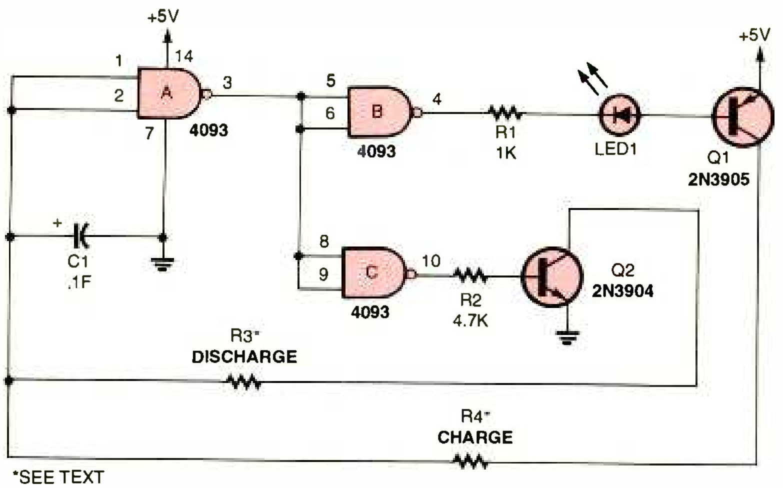

Fig. 7. This circuit increases the charging current by using a NPN transistor as the current supplier. A PNP transistor does similar work in discharging the timing capacitor.

PARTS LIST FOR "SPEEDING THINGS UP" (FIG. 7)

SEMICONDUCTORS

LED1— Light-emitting diode, any color
IC1—4093 CMOS quad 2-input Schmitt trigger gate
Q1—2N3905 PNP transistor
Q2—2N3904 NPN transistor

RESISTORS

(All resistors are ¼-watt, 5% units.)
R1—1000-ohm
R2—4700-ohm
R3, R4—See text

CAPACITORS

C1—.1-Farad/5.5-V_{DC}

The addition of two diodes and one resistor allows the circuit's on/off time to be adjusted independently. The capacitor's charging time is set with R1 and the discharge time by R2. To increase either time just increase that resistor value. By the way, this is an excellent circuit to use with much smaller capacitor values—but that's another story.

Speeding Things Up

An expanded and more versatile timing circuit using three of the 4093's four gates is shown in Fig. 7.

Gate A is still the boss sensing the voltage across the timing capacitor, while gates B and C are used as transistor drivers. The major problem with our previous circuit is the gate's ability to supply sufficient charging current fast enough to speed the timing cycle up.

This circuit increases the charging current by using a NPN transistor as the current supplier. A PNP transistor does similar work in discharging the timing capacitor. The transistors can safely handle many times the maximum output current of the CMOS gates.

The cycle time with a charging resistor of 100 ohms (R4) and a discharging resistor of 2200 ohms is one cycle every 30 seconds. The cycle breaks down into about two seconds for charging and about 28 seconds for discharging. Increasing the discharge resistor to 10k

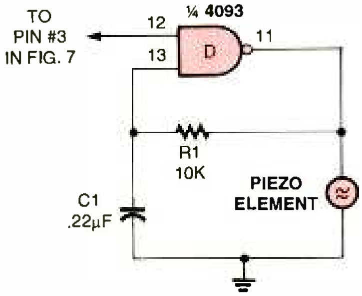

Fig. 8. The timer circuit in Fig. 7 activates the "Bawling Calf" circuit. Activation begins when pin #3 of gate A goes high to signal the timer circuit to charge C1. During this short time, the calf will call its mama.

PARTS LIST FOR PHANTOM ONE (FIG. 8)

IC1—Gate D of 4093 in Fig. 7
C1—.22-µF, ceramic-disc capacitor
R1—10,000-ohm, ¼-watt, 5% resistor (see text)
Piezo element, any type without built-in oscillator circuits

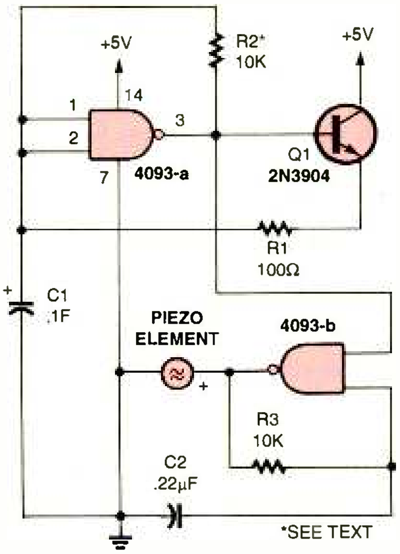

Fig. 9. Gate A is connected in our long-term timing circuit, with Q1 supplying the heavy charging current for C1, while gate B produces the nasty noise. T1 sets the charging time and R2 the discharging time.

PARTS LIST FOR VERSION TWO (FIG. 9)

SEMICONDUCTORS

IC1—4093 CMOS quad 2-input Schmitt trigger NAND gate
Q1—2N3904 NPN transistor.

ADDITIONAL PARTS AND MATERIALS

R1—100-ohm, ¼-watt, 5% resistor
R2, R3—10,000-ohm, ¼-watt, 5% resistor
C1—.1-Farad/5.5-V_{DC} capacitor
C2—.22-µF, ceramic-disc capacitor
Piezo element, any type without built-in oscillator circuit

extends the overall cycle time to one cycle every two minutes and fifteen seconds. That figures out to about 4.5 times that of a 2200-ohm discharge resistor. And 2200-ohms times 4.5 is very close to 10k, which make the discharge timing fairly linear.

Therefore a 100k-discharge resistor should produce a cycle time of about 22.5 minutes. Actual cycle time proved out to be 23 minutes.

Beware Of The Phantom

Now we're going to add a bit of devious fun to our circuit and turn it into an electronic phantom that mysteriously appears for a second or two and then disappears for hours. Friends will ask, what was that noise and where did it come from? What noise? I don't hear anything. Now you got 'em going for sure. Plant two phantom-circuits in a room with different time periods and really jack up the frustration factor.

Version one of the phantom circuit is a simple addition to our last long-term timer circuit. We have one of the 4093 gates left over that's just waiting to become the noise-generating circuit. The circuit appears in Fig. 8. The circuit should look very familiar, because it's our basic timer circuit operating at a fast rate producing a nice irritating sound like a forlorn baby calf bawling for it mother. The bug factor is climbing higher.

The timer circuit in Fig. 7 activates the "bawling calf" circuit. Activation begins when pin #3 of gate A goes high to signal the timer circuit to charge C1. During this short time, the calf will call its mama. The sound-delivering device is a piezo element without a built-in sound generator circuit; these are available in many shapes and sizes, and most any will work here.

If a different sound-effect is desired, fiddle with the values of C1 and R1. Making either larger in value will lower the output frequency and smaller values will increase the frequency.

Version Number Two

A two-gate, one-transistor version of our irritating circuit is shown in Fig. 9. Gate A is connected in our long-term timing circuit, with Q1 supplying the heavy charging current for C1, while gate B produces the nasty noise. T1 sets the charging time and R2 the discharging time. The irritating output sound remains on during the charging time and off during the discharging time.

The behemoth memory backup capacitors we've been playing with are more commonly found operating behind the scenes in tons of electronic devices we all use today. Maybe that's why it's so much fun to find other uses for these types of devices. Here's a circuit challenge—come up with some different uses for these micro-jumbo capacitors and maybe we'll share some of them with all of our circuit-building friends.

Until next time, good circuitry to all! P

SERVICE CLINIC

(continued from page 53)

- If there is nothing between it and the power jack, then polarity will be that of the cap and you will have an upper bound on voltage (but the actual safe operating voltage will probably be considerably less).

- If there is a diode in series with the cap, then the voltage and polarity will be as above (except for the 0.7 or so V diode drop), and the device is probably designed to operate on DC (and possibly AC but there may not be enough filtering).

- If there is a bridge rectifier or multiple rectifier diodes between the input and any DC loads, it is probably designed to operate on AC.

- If the device also has a battery compartment and the battery powers the device the same way as the adapter (possibly with one connection going through a diode or an interlock on the power jack), then the AC adapter polarity and voltage will be the same (± 0.7 V or so) as the battery. However, some devices use totally different means of powering themselves with battery and AC operation!

If you have a multimeter for which you know the polarity of its output on the ohms ranges (VOMs may be reversed from the probes; DMMs are often the same—this can be determined by testing a diode or with another meter), then test on the low ohms range first in one direction, then the other. This is like applying a very low safe voltage to the device:

- Open in one direction and a charging cap (resistance starts low and increases relatively slowly) indicates a series diode (protection or a rectifier). The probe polarity where the cap is charging is the correct one. (Note: once the internal caps charge up, reversing the leads again may result in an apparent open reading.)

- A diode drop in one direction and charging cap in the other indicates a parallel-protection diode. Again, the slowly charging direction is correct.

- Symmetric behavior may indicate it is supposed to use AC. However, this could just mean that a filter cap is directly across the input and DC is required.

Anything else will probably require you do one of the first few checks. Except for manufacturer supplied information, even these are no guarantee of anything! Once AC versus DC and polarity (if relevant) are determined, start low on voltage to see at what point the device behaves normally. Depending on design, this may be quite low compared to the recommended input voltage or very near it—no way to really know. Devices with motors and solenoids may appear to operate at relatively low voltage but fail to do the proper mechanical things reliably if at all. RF devices capable of transmitting may behave similarly when asked to transmit. Devices with more constant power requirements may operate happily at these reduced voltages. However, depending on the type of power supplies they use, running at a low voltage may also be stressful (e.g., where DC-DC converters are involved).

NOTE: Some devices with microcontrollers and/or logic will require a fast power turn-on so it may be necessary to switch off and then on for each input voltage you try for proper reset. Again, determining the requirements from the manufacturer is best!

Wrap-up

It would have been nice if AC adapters could have been standardized like computer power cords. Unfortunately, this hasn't happened and we are stuck with a zillion different types. With the help of this article, it should at least be possible to avoid damage from use of an improper adapter and to be able to select one that will keep your equipment happy.

I welcome feedback of almost any kind (via e-mail only please to sam@repairfaq.org). And there is much more repair, general electronics, and laser and optics information on my Web site, *www.repairfaq.org*. P

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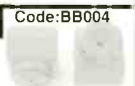

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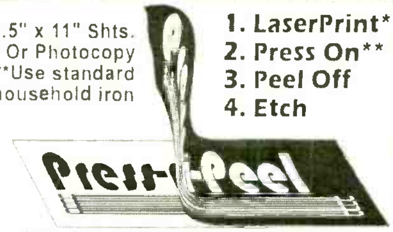

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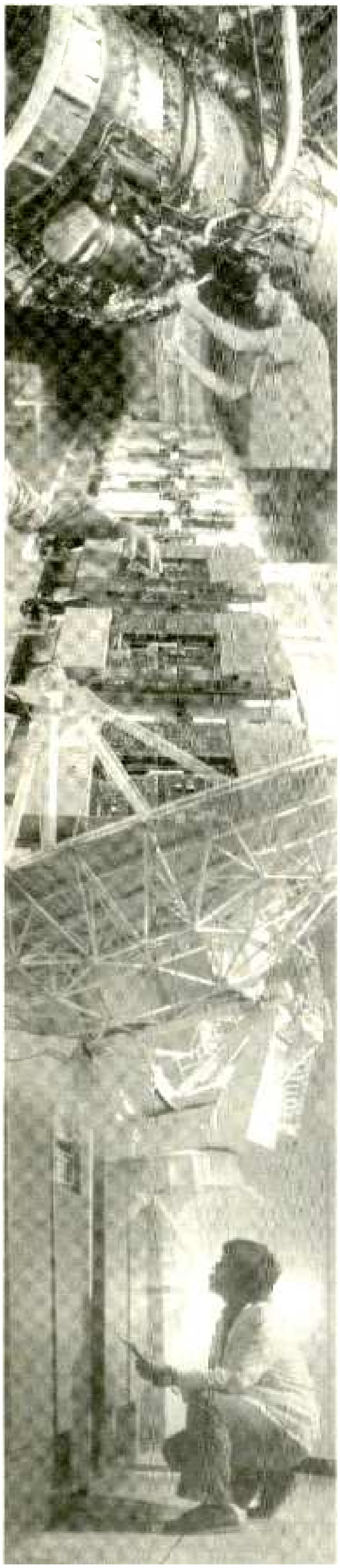

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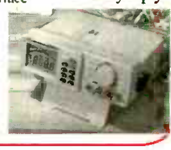

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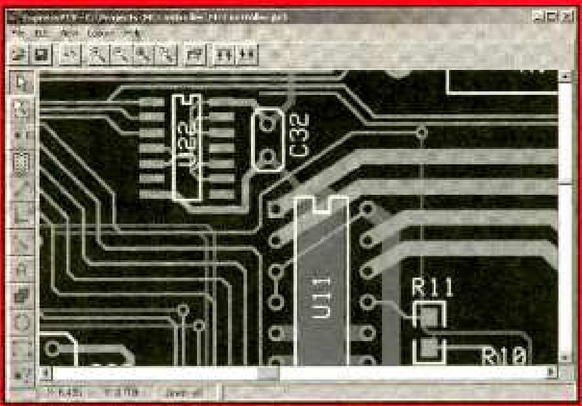

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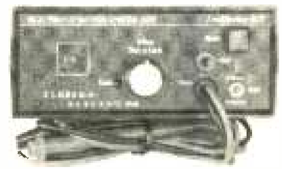

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