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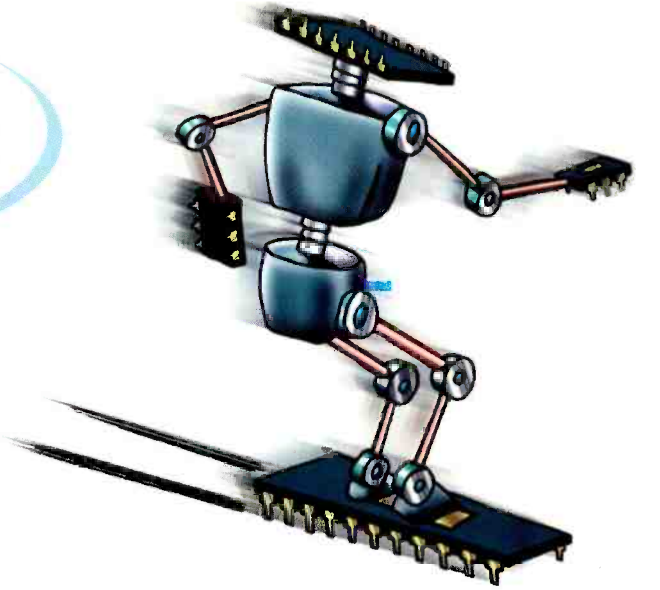

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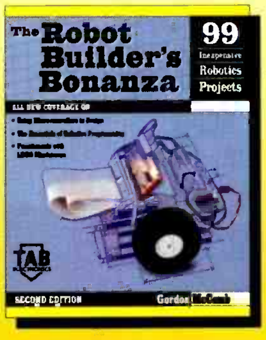

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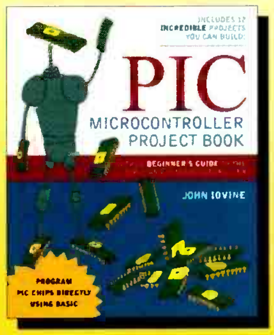

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November 2001, Vol. 2, No. 11

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THE MAGAZINE FOR THE HANDS-ON ELECTRONICS ACTIVIST!

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Editorial

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Maybe It Was A Mistake To Think…

Maybe it was mistake to think that the readership wouldn't mind something a little off the scale, such as "Radio Signals and The Great Pyramid." They would not grow into an anger-fueled fervor and erupt into cries of outrage. It was to be a catalyst plopped into the soup of mundane electronics.

Stuff like:
"Hey it runs on a 9-volt battery. It only costs three dollars. When you press this switch it beeps and this knob controls how fast it beeps. What's that? What does it do? Oh; it beeps."

Get the point?

So, I threw it into the mix. Oh, and mix it did. The calls came in steady—the letters, too. Did you know most retired engineers have the same vernacular as eighteenth century pirates? They called me names; they called the author names; they asked leading questions. Luckily my military training taught me how to maintain my bearing in times of interrogation. The situation grew grim, but there was a lesson learned—a vocal demographic of the readership likes their electronics straight up. That is, they don't want any tie between Physics and "New Age pseudo-science." All they want are components and electricity. According to *them*, the projects better follow all known laws of physics. If the authors plan on breaking standards, then they better have hard data backing up their claims and be willing to share all their findings with the masses. Unless these readers can build it "for real," they don't want to read about it.

And here is the verdict: *Unless I hear otherwise, that "stuff" won't be seen in these parts no more, ya hear!* It would be such a pleasure if everyone could open a copy of **Poptronics**, browse through the table of contents, and exclaim, "Awesome! Just what I wanted!" Well, we can't make all the people happy, all the time.. Needless to say, I won't ignore my core readership and dismiss them as big, mean skeptics (you big, blue "Meanies!"). In closing, let me say thanks. Thanks for the feedback in this grand PLL we call **Poptronics**.

In other news…"Robotics Workshop" has opened its doors once again. This time Scott M. Savage has the helm, and he plans to show our readers a thing or two about robotics. Mr. Savage joins the rest of our columnists who have brought you a wonderful November issue. Kick back, and crack us open. It's time for some electronics—the kind I hope you like.

Salutations,

Chris La Morte

Christopher La Morte
Managing Editor

LETTERS

mailto: letters@gernsback.com

Corrections for "Radio Signals and The Great Pyramid"

*"Limestone is a sedimentary rock." "**Poptronics** shouldn't print speculative manuscripts without prima-facie evidence." Next time, I will get corporate to spring for an airline ticket so I can verify prototypes that are in operation. Well, seriously folks; here are just a sprinkling of letters that seemed to materialize from the aether onto my desk. For the record, I believe this is the highest volume of feedback ever received in such a short period of time.—Editor*

Pseudo-Science Disappoints

I have been a loyal reader for five years. Every month I'm always glad to receive your periodical and enjoy sharing it with the VT students where I work. Unfortunately, your article "Radio Signals and the Great Pyramid" by B.K. Bayles wasn't up to standard. To suggest, even with reservations, that "the passages in the Great Pyramid were purposely constructed in order to provide a current path for massive amounts of energy" shocked me. The evidence doesn't support this silly theory. Please don't let the need for new subscribers entice you into printing pseudo-science. How Sandia National Labs and NASA can be in the same issue with B. K. Bayles, I don't know. **Poptronics**, please come back, I miss you.

I really enjoy your current selection of departments; Iovine, Goldwasser, Rakes, and others are doing a fine job. Please consider adding one more department—biography. Hugo Gernsback often looked into the lives of uniformed technicians in both the civilian and military arenas. Why not bring back this tradition, and once a month interview a scientist, engineer, or technician to see what their job is like and where they think the future will bring us. Just a thought.

Keep up the good work.

D. E. CHADBOURNE, CET
Ray Brook, NY

That is an excellent idea, sir. I think the readers would enjoy brief biographies of scientists, inventors, and even some interesting hobbyists. Thanks for the feedback. I understand your dismay on the "Pyramid" article. We meant no harm.—Editor

Non-Fiction Goes Fiction

I am writing about the preposterous story about the Great Pyramid in the September issue of **Poptronics**. I assume you will get a lot of letters about this one. You say the author writes non-fiction books. Since this article is not factual, isn't it fiction? It is so outrageous that it wouldn't do even for an April issue.

The article abounds with outstanding errors, besides a lot of weird imagination. Some examples follow. Paramagnetism of stones has nothing to do with only existing at or above 76°F—specific heat is not measured in degrees anyway. Limestone is not an igneous rock! The imprinted magnetism of a rock does not tell its age. Sandstone is not formed as described. "Sandstone rock will contain dirt and minerals"—well it had better, since that is what it is made of! Etc., etc.

"Radio frequency is 20Hz–20kHz," is true, but it is rarely thought of in such a low-frequency range, and it really has no obvious upper limit. Skin effect at such low frequencies is at best only a concept. What is meant by using alternating current instead of direct current to "carve" stone?

The fantastic story says to follow along with Fig. 2, but from there onward references are to lettered things while Fig. 2 has only numbered things. It seems you only printed part of a longer story as there are large gaps in its attempt at logic. Plus, I never did find out how the thing becomes an alternate source of energy.

My question is, why did you waste so many pages of **Poptronics** on such garbage??

KENNETH E. STONE
Cherryvale, KS

Perhaps I felt that the readers would be whipped into a frenzy of discussion on the topic of energy production using photovoltaic means. Actually, this did happen in some instances. However, other people seemed to be insulted and lashed out. That reminds me...I have to go smack my weather man! Thanks for the feedback, sir.—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:

Letters
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Scientific Exceptions

I am a regular subscriber to **Poptronics** and count on it providing me with scientific knowledge. I enjoy it very much.

However, I take exception to the September 2001 issue, which devoted eight pages of rambling-on about "Radio Signals and the Great Pyramid." I began to question the author's scientific acumen when, in the second sentence, she talked about "energizing the passages of the Great Pyramid with radio signals to build a triode amplifier and generate electricity."

I tried to read carefully a number of paragraphs thinking that I might be missing something. I could not find any logic anywhere. Even the diagram

looked phony. Is this some sort of April Fool's joke? If so, I give you credit. It is a good one.
JAMES L. BUCKWALTER, PE
Visalia, CA

I see, sir. No, this was no joking matter. It was a theory for scrutinizing readers. I believe the verdict is quite clear.—Editor

The Future Of Energy Production

I agree that photovoltaic solar energy has made great strides with many research avenues showing promise. There are lots of really interesting research approaches such as dye/TiO2 and solar-heated vacuum thermionic emitters (nanoscale diamond pyramids!), as well as less far-out developments such as tailored multi-band material combinations of semiconductors and new production tweaks for amorphous Si cells. New Age fairy tales disguised as science disrespect the many people spending their careers advancing these solar technologies. Photovoltaics have crept within a factor of three or so (on a 1–10 scale) of being cost-competitive for electric power production. As energy demands increase, it seems inevitable that off-grid, localized power production will become a large factor in coming years.

In any case, I do agree that energy consciousness is important; and I would be happy to see articles connected with the electronics aspects of real-world solar electric/heating/cooling systems, or wind generator systems that people have installed in their homes and businesses. There are probably a number of interesting control and power-conversion issues that come into play.
ROB JARECKI
via e-mail

This is a response from Mr. Jarecki, after I replied to his initial letter. Let's take a look at some choice excerpts from his original correspondence.—Editor

"Will future essays discuss the antenna pattern considerations of Quija boards, or explain ghostbusting technology? I am not sure whether it bothers me more to think that your editorial staff is utterly scientifically naïve, or just cynically uncaring about the potential damage done by exposing the uninitiated to such misinformation. Please focus on the electronics circuit designs that make your magazine interesting, and don't risk alienating your core readership to pander to the lowest common denominator."

Hmmm...if I wasn't so naïve, I'd say I was insulted. Luckily I'm cynical and uncaring, so insults just bounce off my dunce cap. Here would be my opportunity to retaliate, but to paraphrase Don Corleone: "Never let them know you're angry, Santino!" Instead, I replied as follows.—Editor

I am sorry if the "Pyramid" article insulted you in any way. We learn from our mistakes, and I have learned never to mix "New Age" logic with hard science. I have angered the gods of Physics. Yet, this article has generated the most feedback of any article in ***Poptronics****.*

In the future, I will keep with more conventional electronics. Here's a thought though: The initial theory of taking the Sun's rays and converting them to electrical energy is not a ludicrous idea. Renewable energies, whether wind, solar, tidal, biomass, etc., are going to have to become status quo within the next decade.

Maybe Bayles' "Pyramid" article will at least make us think about energy other than fossil fuels and archaic steam converters. On a 100 degree day in New York, when the ozone alerts are posted and one can barely see across the bay through the blue/grey haze, I often wonder, "Is there a better/cleaner mode of energy production/distrubution?"
LA MORTE
At His Desk

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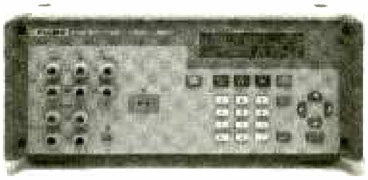

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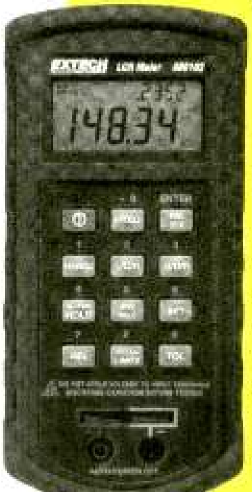

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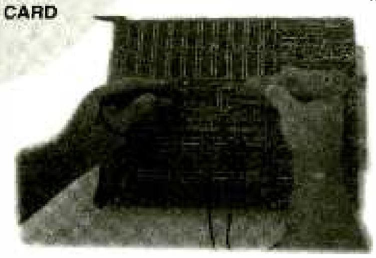
A high-speed continuity tester, the *SF10 Short Finder Brush* ($39.95) has an ergonomic design that makes it easy to use for anyone in electronics. It comes with a pointed tip probe, as well as a stainless steel brush probe. The probes allow users to quickly locate shorts in complex electrical circuits, such as printed circuit card assemblies, IC sockets, and more.



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Recoton Mobile Electronics, 2950 Lake Emma Road, Lake Mary, FL 32746; *www.jensenaudio.com.*

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Nintendo, 4820 150th Avenue NE, Redmond, WA 98052; *www.nintendo.com*.

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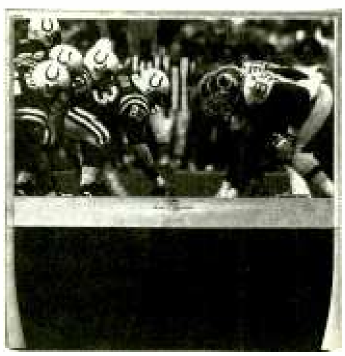
Big-Screen HDTV + DBS

The *RCA Scenium HD65W20* ($4499) is a 65-inch widescreen rear-projection HDTV set based on new LcoS (liquid-crystal on silicon) technology. It has a built-in all-format ATSC decoder and a built-in all-format DirecTV satellite receiver. It offers more than 1.5-million pixels of digital video resolution, a high-definition optical system, a high-gain dark-tint screen for 25% improved picture brightness, and Intellifocus auto convergence. Other features include NTSC twin-tuner PIP, V-Chip, and component video inputs to automatically adjust the scan rate for the connection of progressive-scan DVD players.



Thomson Multimedia, 10330 North Meridian St., Indianapolis, IN 46290; *www.rcascenium.com*.

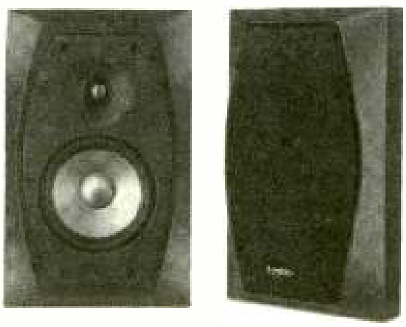
CIRCLE 59 ON FREE INFORMATION CARD

Wall "Towers"

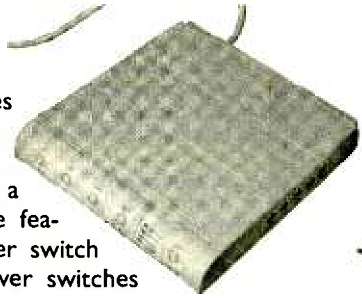
When performance is paramount, but tower speakers just won't fit, consider the *OWS-1* wall-mount speakers ($319/pair). They feature Infinity's Ceramic Metal Matrix Diaphragm (CMMD) driver technology, said to deliver exceptional sonic accuracy. The slim-profile enclosures, available in either black or white finish and measuring just 4½ inches deep, work with any décor and are much easier to install than in-wall speakers.

Infinity Systems, Inc., 250 Crossways Park Drive, Woodbury, NY 11797; 800-553-3332; *www.infinitysystems.com*.

CIRCLE 58 ON FREE INFORMATION CARD



USB Surge Protection



The *GE Under Monitor surge protector with USB Hub Model SU93973* ($64.99) makes it easy to swap peripherals without rebooting. Designed to fit under a PC monitor, the device features one master power switch and four individual power switches on its front panel. Four corresponding USB ports are on the side, and on the back are five surge-protected outlets (one is unswitched, with continuous power).

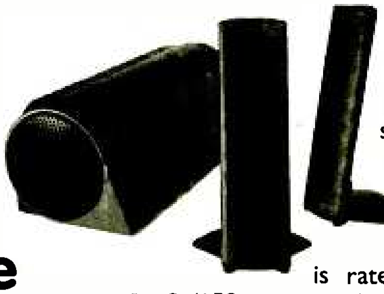
Jasco; 800-654-8483; *www.jascoproducts.com*.

Wireless Communicator

Aimed at teens, the *Inter-tainment* computer ($129) is a handheld device that provides wireless interactive gaming, instant messaging, e-mail, and Internet access via a link to a PC or Wireless Internet Gateway. Available in five translucent colors, it also includes personal organizer, address book, graphics editor, and music composer functions. Its 1 MB of memory can be upgraded to 16 MB.

Cybiko, Inc.; 630-529-1029; *www.cybiko.com*.

Shake, Rattle & Roll



Using NXT's SurfaceSound technology, the *Tremor S-150* desktop multimedia speaker system ($149.99) provides big sound from a small package. The two satellite speakers feature a wide dispersion pattern for room-filling sound, while the powered subwoofer provides deep, rumbling bass for music or gaming. The system is rated at 75 watts total RMS (150 watts peak). Both desktop stands and swivel bracket mounts are included.

TDK Electronics Corp.; 800-835-8273 or 516-535-2600; *www.tdk.com*.

Affordable Laser Printer

The *ML-1210* ($199) speeds through printing jobs at 12 pages per minute with a resolution of 600 dpi. It uses micro toner for sharper text and graphics and features a toner-save button said to reduce toner consumption by up to 40%. Equipped with both parallel port and USB interfaces, the printer is compatible with the iMac as well as Windows-based PCs.

Samsung Electronics America, Inc.; 888-887-8536; *www.samsungusa.com*.

Internet Radio Shelf System

The *FW-i1000* ($499), when used with an always-on broadband connection, brings uninterrupted streaming digital audio from the Internet to a CD mini shelf system, with no need to "boot up" every time you want to listen to music. Stations can be sorted by genre, region, or language, and, when available, station name, artist, and title will be displayed. The system can play back MP3 files stored on a PC and can be upgraded via the broadband connection when new Internet audio functions become available. The 220-watt system features a three-CD changer and Philips' power wOOx speaker technology for deeper bass.

Philips Electronics; 770-821-2715; *www.philips.com*.

Gizmo is published by Gernsback Publications, Inc., 275-G Marcus Blvd., Hauppauge, NY 11788. Senior Writers: Christopher Scott and Teri Scaduto.

CD ROM based resources for learning and designing

The internationally renowned series of CD ROMs from Matrix Multimedia has been designed to both improve your circuit design skills and to also provide you with sets of tools to actually help you design the circuits themselves.

matrix multimedia

Electronic Circuits and Components provides an introduction to the principles and application of the most common types of electronic components and how they are used to form complete circuits. Sections on the disc include: fundamental electronic theory, active components, passive components, analogue circuits and digital circuits.

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

Digital Electronics details the principles and practice of digital electronics, including logic gates, combinational and sequential logic circuits, clocks, counters, shift registers, and displays. The CD ROM also provides an introduction to microprocessor based systems.

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

Electronic Projects is just that: a series of ten projects for students to build with all support information. The CD is designed to provide a set of projects which will complement students' work on the other 3 CDs in the Electronics Education Series. Each project on the CD is supplied with schematic diagrams, circuit and PCB layout files, component lists and comprehensive circuit explanations.

PICtutor and C for PICmicro® microcontrollers both contain complete sets of tutorials for programming the PICmicro series of microcontrollers in assembly language and C respectively. Both CD ROMs contain programs that allow you to convert your code into hex and then download it (via printer port) into a PIC16F84. The accompanying development board provides an unrivaled platform for learning about PIC microcontrollers and for further development work.

Digital Works is a highly interactive scalable digital logic simulator designed to allow electronics and computer science students to build complex digital logic circuits incorporating circuit macros, 4000 and 74 series logic.

CADPACK includes software for schematic capture, circuit simulation, and PCB design and is capable of producing industrial quality schematics and circuit board layouts. CADPACK includes unique circuit design and animation/simulation that will help your students understand the basic operation of many circuits.

Analog Filters is a complete course in filter design and synthesis and contains expert systems to assist in designing active and passive filters.

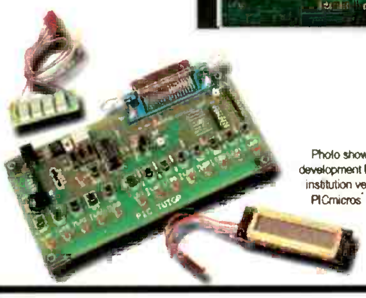


Photo shows PICmicro® development kit supplied with institution versions of C for PICmicros® and PICtutor

Shareware/demo CD ROM with more than 20 programs $4.99 refundable with any purchase.

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Please circle the products you would like to buy on the table below, calculate the total cost, fill in the rest of the order form and send it to us. NY residents add sales tax. Please allow 6 weeks for delivery.

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Analog Electronics	$50	$99
Electronic Projects	$75	$159
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C for PICmicros	$179	$350
Digital Works	$50	$99
CADPACK	$75	$159
Analog Filters	$75	$159
Postage - USA	$5	$5
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FROM NASA TO YOUR DESKTOP

Experience real depth 3-D without glasses.

Dimension Technologies, Inc. (DTI) has been researching and developing flat-panel, 3-D displays for over fifteen years. In 1993, DTI designed and constructed a fully functional, fully-animated holographic display for NASA. Now, after years of tweaking, DTI is offering its desktop flat-panel 2-D/3-D display to the public, starting at a cost of $1699 for their 15-inch unit. Units can be ordered directly from DTI's Web site at *www.dti3d.com*. We had the chance to evaluate the pre-production unit, and here's what we found.

Amazing...Simply Amazing. The majority of us have seen three-dimensional images, either on a television with those red and blue glasses, or if you're a little grayer you may remember the blackish specs handed out at the cinema. Recent years have brought us many variations of virtual reality shutter-glasses for use on a home computer, but the *DTI 15-inch 2-D/3-D Display* is in a class all its own. The engineers at DTI have developed a new patented technology, called Parallax Illumination, which allows users to view real depth three-dimensional images without any headgear or glasses. Furthermore, this same device can be switched to a high-resolution 2-D display simply by pressing a button. This function is just one of the thirteen patented technologies that has been incorporated into the DTI LCD.

It only took ten minutes to hook up the LCD to my home system. A cable runs from the monitor to your computer's video card, another cable runs from the LCD to an available serial port, and finally, there is a power cable that plugs into the wall. A tutorial gently guided me through the simple viewing

Here is the 15-inch DTI LCD 2-D/3-D display. The screen offers incredible 3-D imaging, as well as high-resolution 2-D imaging. All for well under $2000.

technique. For reasons explained later, the person viewing the screen must sit in a precise zone that is easily confirmed when a blinking LED mounted on the screen extinguishes. That's right, you guessed it! This unit has an optical sensor that detects if its user is seated properly in front of the device in order to experience the intended effect.

What's This About Parallax? The people of DTI have packed their Web site with tons of technical data that can be seen at *www.dti3d.com*, but what follows is a brief description of the process known as *Parallax Illumination*.

Humans have stereoscopic vision. Our two eyes are spaced approximately 2.5 inches apart (on the average), and each eye receives its own image of the environment. The left eye's image differs slightly from the right eye's image due to angular difference of the observation point.

A quick experiment to demonstrate the difference between the images is to sit in a chair and stare at an object on the wall, like a light switch, with both eyes open. Now, alternately close the right eye and then the left eye. Repeat this at about a frequency of twice per second. You should notice an apparent movement of the object.

(Continued on page 15)

Business Buzz

CAMERA COLLABORATION
Matsushita and Leica Camera are collaborating in the development of digital still cameras that will be marketed under both Panasonic and Leica brand names starting in the third quarter of 2001. They will combine Panasonic's digital A/V technologies with Leica's expertise in optics. Panasonic has already used Leica lenses in some of its digital camcorders. The new digital still cameras will feature SD Memory Cards, making them easy to link with similarly equipped A/V devices.

TALKING TEXT
According to AT&T Labs, its Natural Voices Text-to-Speech is the most human-sounding computer-speech system in the world. David Offen, director of engineering for BeneTech, a nonprofit organization that develops technologies to meet social needs, such as online books for people with disabilities, agrees. "We rated 15 different synthesized speech systems. AT&T Labs' Text-to-Speech got the highest grade of them all," Offen said.

The two-part system consists of a text-to-speech engine that turns written words into natural-sounding speech, and the actual voices. Users can choose from a library of existing voice types, or develop a custom voice, to duplicate the sound of a company's celebrity spokesperson, for instance.

Potential customers include customer service companies that operate call centers, telemarketers, and travel or reservations systems. Other Natural Voices products are expected to follow, including speech products that will run on cell phones.

RADIO TO THE POWER OF X
With two geostationary satellites dubbed "Rock" and "Roll" positioned 22,000 miles above the earth, ready to beam digital radio signals to listeners coast to coast, XM Satellite Radio is ready to rock-n-roll. Its The first receivers were scheduled to debut in September in San Diego and Dallas/Fort Worth, with 100 channels of music and talk radio available. National rollout is expected in November, just in time for the Christmas buying season. The subscription-based service will cost $9.99 a month, with receivers starting at about $250. Car, home, and portable devices will be available.

Poseidon Drowning-Detection System

The "Third-Eye" camera is an off-the-shelf Sony black-and-white CCD camera, optimized for underwater use.

You let your kids swim at the community pool, believing they are safe because the pool is staffed by well-trained lifeguards. Unfortunately, despite their best efforts, lifeguards cannot constantly monitor everyone in a crowded, noisy pool. Surface reflection and glare compound the problem. According to the Centers for Disease Control and Prevention, an average of six people drown in U.S. pools every day, and drowning is the second leading cause of injury-related deaths for American children. Many of these incidents occur at public facilities staffed with certified professional lifeguards. Furthermore, many nonfatal drowning accidents result in permanent injuries. For every person who drowns, four times as many people nearly drown. Finally, a drowning event can leave a lifelong mark on lifeguards who attempted an unsuccessful rescue.

Early Detection

The answer is not necessarily to hire more and better trained lifeguards. What is needed is the ability to detect and reach a drowning victim quickly. To prevent death or lifelong injury, resuscitation must be initiated as quickly as possible, ideally within 30 seconds.

Poseidon Technologies SA in Boulogne, France has developed a drowning-detection system, which features machine vision to identify swimmers in trouble. Machine vision, already used extensively in industrial automation applications, combines video cameras with computers into systems that can "see" and then make decisions based on what they see. In France, an estimated 1–2 people drown each week in public pools. The system was not designed to replace lifeguards, but to help them save lives and prevent injuries.

Machine Vision and Alarms

One of the challenges to applying the computer vision to outdoor pools was to develop machine-vision algorithms to image swimmers underwater. The big problem was the shadows from the natural lighting. This was solved by using computer stereo vision to discriminate volume and textures such as a swimmer versus a shadow or a light.

The Poseidon system uses a network of cameras located above and below the surface of the pool. The cameras are off-the-shelf Sony black-and-white CCD

Shown here is the display on the Supervision Workstation, which features a flashing light, a buzzer, and an easy-to-use touchscreen.

cameras. The "Third-Eye" underwater camera units, optimized for underwater use, are sealed within the pool walls under the surface. Each unit's cameras have a combined field of vision of over 180 degrees to provide overlapping surveillance at the deep end of the pool. The cameras are networked to a central onsite processor that analyzes all the camera images in real time. Using machine-vision algorithms developed by Poseidon, the computer monitors the trajectories of swimmers and identifies suspicious situations, such as a slowly sinking or immobile victim, and triggers an alarm.

The alarm includes a flashing light and buzzer on the supervision workstation installed next to the pool. This command center for the system is naturally waterproof and has a touch-sensitive screen for easy use. Real-time video images are displayed and recorded immediately on a workstation monitor. The lifeguards also wear lightweight, water-resistant Poseidon pagers that provide both audible and vibration alarms. Poseidon gives the staff the coordinates of the swimmer within 10 to 15 seconds of a possible drowning event. With a range that extends more than 200 meters, the unit also displays the elapsed time since detection. There is an optional "After Hours Intrusion" mode that can detect swimmers when the pool is closed and send an alarm to the police or another security-monitoring station.

A Life Saved

The system at the Centre Aquatic Jean Blanchet in Ancenis, France has already been credited with saving a swimmer's life. A young man escaped serious permanent injury, or death, thanks to the rapid intervention by the lifeguards made possible by the Poseidon System. The Poseidon system has been in operation at the Ancenis pool since 1993.

Installation and Information

To date, 15 pools in France, the Netherlands, England, and Canada have been equipped with the Poseidon system. This includes the 82- × 65-foot pool at the North Toronto Community Centre. Other installations in Sarasota, FL and Dedham, MA are in the works. The company plans to offer Poseidon to smaller pools, such as those at hotels and resorts.

For more information, contact Poseidon Technologies Inc., 100 Cummins Center, Suite 217C, Beverly, MA 01915; 866-342-0980; *www.poseidon-tech.com*. —**by Bill Siuru** PT

Virtual Therapy

More than 30 million Americans aged 15 to 54 suffer from some type of anxiety disorder—roughly half from fear of flying. In traditional treatments, the therapist spends several sessions familiarizing the patient with a real airplane. Only when the patient feels comfortable being on a stationary aircraft is an actual flight attempted. This course of treatment presents logistical problems and can be embarrassing for the fearful flyer.

Enter *V*irtual *R*eality (VR) therapy, the brainchild of Larry Hodges, a Georgia Institute of Technology professor of computing. He and his partner, Emory University professor of psychology Barbara Rothbaum, are co-founders of Virtually Better Inc., an Atlanta-based company that provides VR treatment and markets the licensed therapy programs to clinical psychology practices and hospitals. It costs $15,000 to install a complete VR therapy system, which represents a tremendous drop in price from even a few years ago. Hodges credits the booming video game industry with part of that drop—3D graphics have become much cheaper. Many insurance companies have begun covering the cost of VR therapy, which usually requires between 7 and 15 office visits ranging from $100 to $200 a session.

In VR therapy for overcoming the fear of flying, the patient is seated in a darkened room in a chair that vibrates to simulate the motions of a plane. He wears a helmet-like, head-mounted display with earphones and separate

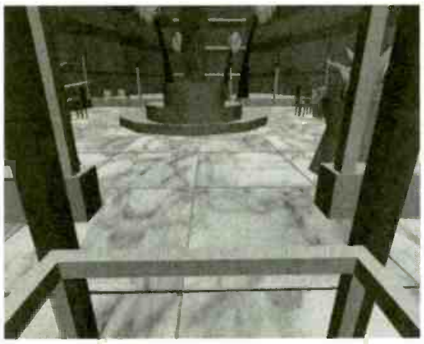
Research Notes

BEAT THE (ATOMIC) CLOCK

What keeps time more accurately than an atomic clock? The mercury-ion clock developed by a team of physicists at the National Institute of Standards and Technology is 1000 times more stable than today's best clocks. For instance, the NIST-F1 atomic clock, based on the natural atomic resonance of the cesium atom, is accurate to within one second in 20 million years. The new clock, based on energy transition in a single trapped (missing one electron) mercury ion, resonates much faster. While the NIST-F1 measures an atomic resonance of about 9 billion cycles per second, the mercury-ion device monitors an optical frequency of about 1 quadrillion cycles per second—so fast that it can be read only by an ultra-precise laser. You'd have to outlive the universe—hang around for some 15 billion years—to see it drift by even a second.

THE SCIENCE OF SPLAT

Researchers at Sandia National Laboratories, along with a consortium of eight U.S. companies including auto makers and aircraft engine manufacturers, are working to improve the fundamental scientific understanding of a new manufacturing technique called Cold Spray. Microscopic powdered particles of metal or other solids are injected into a supersonic jet of rapidly expanding gas and shot at a target surface. When the particles hit the substrate, they splat so hard they stick, just like bugs on a windshield. Consortium members plan to use the process to create tough new coatings on car- or aircraft-engine components made from lighter-weight composites, or to deposit layers of conductive metals onto substrates for use as heat-tolerant underhood auto electronics. The Cold Spray process might also be used as a low-temperature alternative to welding and to join chemically dissimilar materials with bonds that gradually transition from one material composition to another.



A virtual hotel lobby as viewed from a simulated glass elevator. This scene is one of several virtual-reality environments used successfully in treating subjects for fear of heights.

screens for each eye. A built-in head-tracking device feeds location and orientation data to the therapist's computer. Armed with that data, the computer knows which way the patient is looking and displays the appropriate visuals—the Atlanta skyline fading into the distance during takeoff, for instance. Although the 3D graphics are simple, when they are combined with the chair's vibrations, the roar of the engine during takeoff, and the therapist, playing pilot, announcing the flight's departure, the result is realistic enough that the patient feels immersed in the virtual scenario. A controlled study found that the VR method was as effective as traditional therapy in treating the fear of flying, and was more enjoyable for the patients.

Other VR therapy programs have been designed to treat fear of heights, storms, and public speaking. Veterans Administration hospitals in Boston and Atlanta are successfully using a Georgia Tech/Emory-created VR therapy program called *Virtual Vietnam* to treat veterans suffering from post-traumatic stress disorder. A program for people who are afraid of driving is under development, as is a "virtual house fire" that will be used by the Atlanta Fire Department to train and evaluate officers. PT

➤ Longer-Life Batteries

Scientists at Brookhaven National Laboratory have developed a new metal alloy that could significantly increase the life of rechargeable batteries. When used as an electrode in nickel/metal hydride (Ni/MHx) batteries, the alloy has a high capacity for storing charges, a long-lasting ability to be charged and recharged, and a high resistance to corrosion. Because it contains no expensive cobalt or toxic cadmium, it "is inexpensive and relatively environmentally benign," said John Reilly, head of the BNL research team.

The team was trying to understand the role played by cobalt and to find a way to replace cobalt with something less costly. While investigating several cobalt-free alloys, they accidentally discovered a combination of lanthanum, nickel, and tin with a very high storage capacity that didn't decay over many charge/discharge cycles. A slight, inadvertent change to the usual 1:5 lanthanum to nickel/tin combination, and the resultant changes in the alloy's structure, led to increased corrosion resistance and long-term energy-storage capacity. Batteries using the new alloy could eventually result in longer between-charge times for cell phones, laptops, and other portable gear. PT

Attention, Drivers!

Everyone knows that it isn't safe to drive while tuning the radio, eating a Big Mac, talking on a cell phone, or reading the paper. In fact, the National Highway Traffic Safety Administration estimates that such distractions are involved in 20% to 30% of all accidents.

Now Ford Motor Company has unveiled the VIRTTEX, or *Vir*tual *T*est *T*rack *Ex*periment. The simulator allows researchers to study, in a controlled environment, how everyday driving tasks, such as swapping CDs, affect driver performance. The VIRTTEX "vehicle" rests atop six angled hydraulic pistons that allow it to move up to 11 feet to any side and tilt up to 20 degrees, duplicating actual forces experienced while driving.

A VIRTTEX occupant wears a laser headset to track eye movement during a simulated drive on the virtual roadway.

The tests' main focus is on the use of mobile electronic devices while driving. Test drivers are asked to retrieve e-mail, use an electronic address book, or make a phone call, while coping with virtual traffic. The lab can simulate sudden, unexpected actions by the surrounding virtual cars. Driver responses, both mental and physical, are examined. Because the tasks can be repeated indefinitely, VIRTTEX data can be used as the basis for scientific conclusions. The results of the study, which are expected to be published early in 2002, will be used to determine how Ford can incorporate electronic devices into vehicles without creating a safety risk. PT

HANDS-ON-REPORT

(continued from page 11)

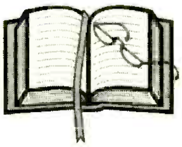
As your right eye closes, the object jumps to the left and vice versa. This apparent movement is parallax. Using stereoscopic vision's natural parallax trait as a key, DTI developed a technique to obtain a stereo pair image of virtually any object. This image is comprised of two images—one from a left-eye perspective and one from a right-eye perspective—that are sent to the LCD screen.

The Secret Substrate. The real trick to depth-perception is the way the image is released by the LCD. Picture an LCD set at 1024 columns by 768 rows. The DTI display projects two images onto the pixel array. The left-eye image is assigned to all odd-numbered columns and the right-eye image is assigned to all even-numbered columns. Optical circuitry projects the image through the substrate, which causes the light to be projected as 1024 uniformly spaced vertical lines. Of the 1024 lines, 512 are for the right eye to receive and 512 are for the left eye to receive.

Imagine a lattice of light projecting from the screen and at a set point, the lines cross and enter their respective target. This precise point occurs at regular intervals, resulting in viewing zones where the blinking LED sensor extinguishes. So, when a person is at the right calculated angle and distance (just about over a foot away and centered), the screen suddenly comes to life with full 3-D depth. The truly amazing occurrence is that some programs not normally three-dimensional seem to be. The technicians at DTI explained that their driver tries its best to fill-in the missing effect, but companies like nVIDIA are collaborating with DTI for full 3-D support.

In A Nutshell. Overall, the performance of the DTI display was phenomenal. The screen can be integrated with a computer, dual video cameras, or even sonar and radar. Most home users will no doubt use the display for applications such as 3-D video games and computer-aided design. The product worked as promised—three-dimensional viewing with no aids to the eyes. The price is right, at well under $2000. I remember when the 19-inch SVGA were priced higher for standard support. Here, you get 2-D/3-D display capability together with the small footprint of a flat-panel LCD display.

For more information, contact DTI, 315 Mt. Read Blvd., Rochester, NY, 14611; 716-436-3530; e-mail: info@dti3d.com or circle 80 on the Free Information Card. P



YESTERDAY'S NEWS

A PEEK INTO THE GERNSBACK ARCHIVES

1900 1910 1930 1941 1950 1960 1971 1980 1991 2000

Dateline: November 1941 (60 years ago)

Radio-Craft focuses on radio as a defense mechanism. The cover story retells an incident of a military information interception by an enemy radio station. It brings to light the importance of radio signals in modern warfare. A complementary article elaborates on how the NYA—an acronym for the National Youth Administration—trains men to work with radios on a national security level. Other features are about a 70-watt flexible amplifier, experimental photo-cell relay, and a compact kilowatt Xmitter. *(Radio would soon become a major aspect of wartime command and control. Today's armies rely heavily on electronic technology in order to achieve voice and data transmissions to and from the battlefield.)*

Dateline: November 1971 (30 years ago)

Radio-Electronics begins to highlight security systems with a cover title, "Stop Burglars With Electronics." One article helps readers choose the best alarm system to suit their own personal needs; a build-it-yourself $5 vehicle alarm is included, along with one all-purpose multi-sensor system. While in today's world everything is digital, thirty years ago they were exploring photoelectric devices, infrared systems, Doppler frequency shifts, and ultrasonic detectors. Other articles talk about the use of inductors and how to build a scope-mountable camera. *(Thirty years has provided a major boost in security technology. Now simple proximity switches can be updated with video cameras and IR sensors, which have shrunk in size and cost.)*

Dateline: November 1991 (10 years ago)

Popular Electronics is a hobbyist's treasure trove of do-it-yourself information. With detailed step-by-step instructions, this issue shows you how to build a band-sweeper with the NE602 frequency converter, two different remote-controlled outlets for AC-power devices, a counter-surveillance monitor for catching unwanted bugs, and a music-synthesizing circuit. It includes experiments in galvanism—demonstrating basic electronics—and explores easier ways to get images from the computer screen to paper by examining the screen "dumping" process. *(Today, Gernsback still supports learning, experimentation, and discussion in the field of electronics.)*

Seasons Greetings

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Poptronics® combines the best attributes of ***Electronics Now*** and ***Popular Electronics***. It is *the* magazine for the hands-on electronics activist. We will be presenting articles on just about everything electronic—from satellite TV equipment to DVDs, gadgets and gizmos to energize your life, audio amplifiers, professional service features, PC-related projects, and much, much more.

PLUS: A selection of computer-oriented columns that explore the digital realm from the inner workings of a PC to the latest the Web has to offer. On the electronics side, there is something for everyone—from the beginner (Basic Circuitry and Q&A) to the expert. Whether your interest is fixing equipment (Service Clinic), tinkering with robots (Robotics Workshop), or adventuring to the farthest reaches of electronics and science (Amazing Science)—***Poptronics®*** takes you there.

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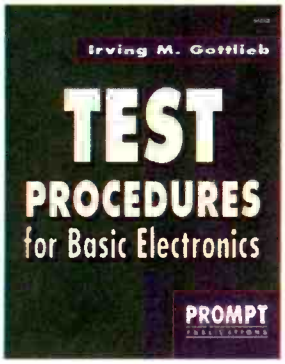

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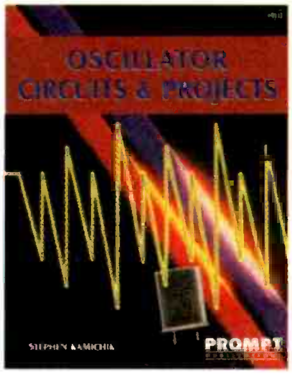

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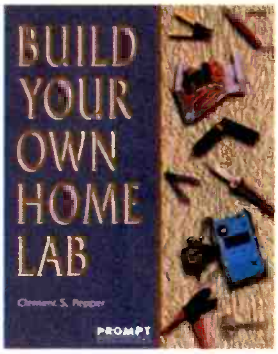

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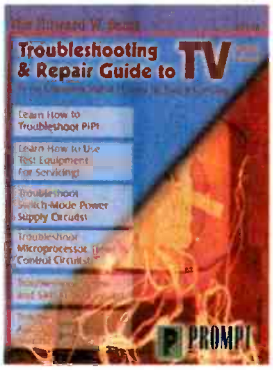

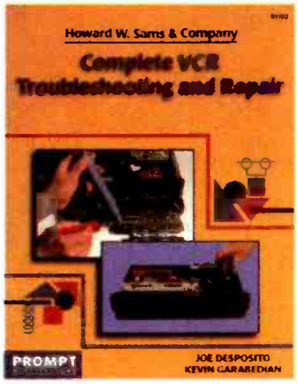

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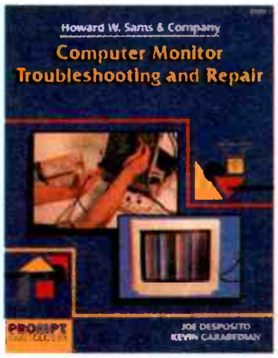

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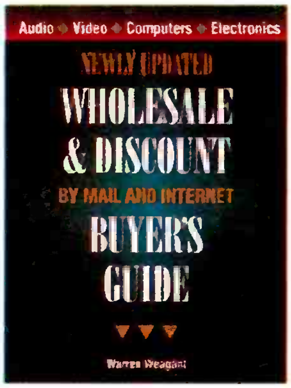

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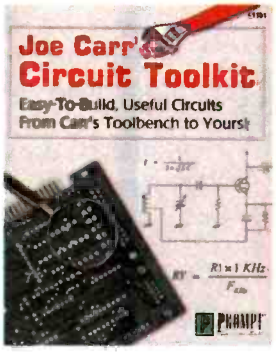

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Finding Out About Fiber

In the 1990s, "fiber-optic cable" became a well-known catch phrase. Little did we know that what appeared to be a simple wire buried in the ground was in fact a subterranean super highway capable of transporting more information than we could imagine. Today, schools are connecting to one another with fiber, corporations are switching from copper wire to strands of glass, and video communication is surpassing previously impenetrable technological boundaries with the tremendous bandwidth that fiber-optic technology has to offer. The entire world is moving toward a fiber-friendly age—but what is a fiber-optic cable and how does it work?

For such a seemingly simple piece of equipment, the sheer amount of data that one strand of fiber-optic glass is capable of transporting is almost impossible to grasp. When one imagines a nearly invisible, hair-sized strand of stretched glass, it may appear that the data-transmission capacity is limited by its small size and delicate construction. This couldn't be further from the truth.

When asked for a simple, yet effective way to describe the capabilities of one strand of fiber-optic cable, Bob Grosh, Engineer for Realtime Learning Group, Inc., a national communications company, offered an insightful analogy. "Imagine a single drinking straw and that one telephone line has the bandwidth equal to the size of that straw. Now, take twenty-four more straws and put them in a bundle. Imagine that the drinking straw has grown to the size of a fire hose. We can now compare the fire hose to a T-1 line, which consists of 25 separate telephone lines. As we move up in bandwidth, we arrive at the DS-3 (703 telephone lines), and our fire hose becomes much larger—to about the size of a standard culvert beneath a city street. Next in line is a 100-Mb circuit, which would be equivalent in size to that of a storm sewer. The actual bandwidth of fiber-optic cable, with the current technology available, would equal a pipe through which a Greyhound bus could pass. With possible future developments in the electronics that support this medium, the theoretical bandwidth of one strand of fiber is as large as a pipe wide enough to accommodate the moon."

Fiber-optic cable comes in many varieties as seen above. Drastic measures are taken to protect fragile glass fiber. An outer layer of PVC combines with a mesh tube of Kevlar surrounding the fiber to form a shield. The tips of the cable are then spliced to special connectors that allow the cables to be plugged into various transceivers and multiplexing equipment.

That's a lot of bandwidth.

So what exactly is this incredible technology that can boast virtually unlimited bandwidth? Simply put, fiber optics is the "...Science of transmitting data, voice, and images by the passage of light through thin, transparent fibers."—*Encyclopedia Britannica.*

UNDERSTANDING FIBER OPTICS

Fiber-optic technology consists of three basic elements. According to Michael Vastag, Sr. Applications Engineer with Corning Fiber, "All standard fiber is the same size and is comprised of the core, cladding, and coating. The core carries the light signals, the cladding keeps the light in the core, and the coating protects the actual glass. The core is composed of silica and germania, the cladding is pure silica, and the coating is a type of plastic called acrylate. From one piece of glass eight inches wide and a meter long, 300–500 km of fibers is produced."

There are two types of fiber—single-mode and multi-mode. In single-mode fiber, the core, which the light travels through, is very narrow. This keeps the dispersion rate to a minimum, and there is little data loss. Imagine a heavy-set person walking through a narrow hallway. There is a single path for that person to follow. Since there is room for just one person at a time, he has no choice but to move forward. Single-mode fiber is capable of generating 40 Gb/sec (Gigabytes per second) or more and can transmit data over very long distances.

Single-mode fiber uses laser light, which has higher speeds and a narrower spectral width. With its higher power concentration and quality, laser light can be significantly higher in price and because of this, single-mode fiber tends to be more expensive than multi-mode. With high data rates, few splices/terminations, and easy upgradability, single-mode fiber is usually the best choice for long distances.

Multi-mode fiber (MMF) is different in structure than single-mode and cannot boast as high performance. Multi-mode fiber has a much larger core than single mode. This large inner canal allows easier connection and improved coupling efficiency. With the more spacious core, there is a higher

MULTIMODE	SINGLE-MODE
Large core size	Small core size
Easier to terminate and splice	More difficult to terminate and splice
LED light source, less expensive electronics	Laser light source, more expensive electronics
"Limited" bandwidth	"Unlimited" bandwidth
Low attenuation	Lowest attenuation
Distances up to a few km (300-500 km typical)	Very long distances
Lowest cost system for shorter links with many terminations	Best solution for high bandwidth longer links

rate of information loss due to light dispersion. Picture the heavy-set man. This time, he is walking through a wide tunnel, and there is enough room for other people to travel at the same time. They go in many different directions, bumping into each other as they zig and zag towards the end of the tunnel. Due to the collisions with one another, each person has dropped some of his belongings and has taken much longer to get through the tunnel.

"The larger the core, the more modes of light that can propagate; and the more modes, the greater the effects of pulse spreading due to modal dispersion. But, with multi-mode fiber, the larger core makes splicing much easier," explains Vastag.

Multi-mode fiber is ideal for shorter distances and is much less expensive than single-mode fiber because of ease of the connectivity and use of lower cost light sources. Applications include premise wiring, inter-building scenarios like computer networks and campus networks, telephony distribution, local area networks, and data transportation.

DEFINITIONS

According to a fiber-optics manual developed by Vastag, there are a few important definitions necessary to understand optical fiber—micron, types of communications systems, wavelength, index of refraction, mode, and optical characteristics.

Micron—A micrometer is a metric measure of distance. One micron = 1 $\times$ 10^{-6} meters or 0.000039 inches. One human hair is the equivalent of 50 microns.

Types of Communications Systems—There are two types of communications systems—digital (data expressed in digits) and analog (data represented by measurable quantities such as lengths, electrical signals, or voltage).

Wavelength—The length, in nanometers (nm), of one complete oscillation of a plane wave of light. Wavelengths ranging between 850–1625 nm are commonly used in optical communications.

Index of Refraction—Denoted by n, the ratio of the velocity of light in a vacuum to the velocity of light in a medium. n = Speed of Light (vacuum)/Speed of Light (medium)

Mode—The path in which light travels. Single-mode fiber supports only one mode. Multi-mode fiber supports many modes.

Optical Characteristics—Attenuation and dispersion are the two key optical characteristics. Both limit transmission length and dispersion limits speed (information-carrying capacity).

LEADER OF THE PACK

While copper wire is still hanging onto first place in the connectivity race, the myriad benefits of using fiber is quickly propelling this unobtrusive technology to the head of the pack. There are many reasons to use fiber, but, undoubtedly, the main benefit is transmission capacity. In a data-transmissions contest to see which technology can transport the most amount of information efficiently and clearly, optical cable wins every time. In the bandwidth arena, fiber is in a league of its own. Another benefit of fiber is that the data it transmits can travel for much longer distances without the need for regeneration of the signal, thus saving time and money (less hardware development/installation for regeneration sites).

The benefits of fiber don't stop with its bandwidth and range capabilities. The hardware itself is simple to upgrade, easy to install, secure, strong and flexible, and less expensive to maintain than copper systems. Fiber is also immune to electromagnetic interference, guaranteeing more accurate and consistent data transfer.

Upgradable—The only limiting factor to fiber-optic cable is currently available electronics; the fiber itself need not be replaced. With constant developments in transmitter and receiver capabilities, engineers continue to find new ways to tap into the unlimited bandwidth that fiber has to offer. Similarly to the vast areas of the human brain that remain unexplored, we are using only a small percentage of optical potential.

Ease of Installation—Fiber-optic cables are small in size and weigh less than copper wire. This makes for a much easier installation.

Immunity to EMI—Electromagnetic Interference (EMI) can cause copper-based systems to fail. Since fiber-optic cable is a dielectric (non-conductor of electricity), it is immune to EMI.

Secure Medium—Since optical fiber does not generate EMI and is very difficult to tap, it is secure and allows for privacy.

APPLICATIONS

With the incredible bandwidth capabilities of fiber-optic cable, there are a large number of applications suited for this technology. These include telephony, premise wiring systems, cable television, underwater applications (submarines), and utilities.

Telephony, which is a key application for fiber, uses optical cable for

(Continued on page 25)

REID GOLDSBOROUGH

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The Progression of Optical Storage and Broadband Internet Access

Traditionally personal computers have used the physics of magnetism as the primary means of storing programs and data for later use. Floppy disks, hard disks, Zip disks, and backup tapes all work by magnetizing small areas on the surface of the disk.

In recent years magnetism has been complemented by optics as a storage mechanism. High-intensity light sources, such as lasers, burn information into the disc surface. (Disks that employ magnetism are spelled with a "k" at the end; discs that use optics typically end with a "c.")

An alphabet soup of optical technologies is available, including CD-ROM, CD-R, CD-RW, DVD-ROM, DVD-R, DVD-RAM, and DVD-RW, with even more on the way. You might think that making sense of these acronyms requires a Ph.D. Not necessarily, though it can be confusing. Here's a rundown.

The URL for the Optical Storage Technology Association, an industry organization, serves as a fine research location for people who want to keep up to date with the rapid advances in optical storage.

THE COMPACT DISK

CD-ROM—This was the first popular optical disc technology used with PCs. CD-ROM (pronounced see-dee-rahm) stands for Compact Disc Read-Only Memory, which simply means your computer can read data from these discs, but can't write data back.

These discs hold 650 megabytes of data—a megabyte (MB) being approximately a million bytes, a byte being the equivalent of an alphabetical letter or a numeral. You can store 600,000 typewritten pages on one of these discs.

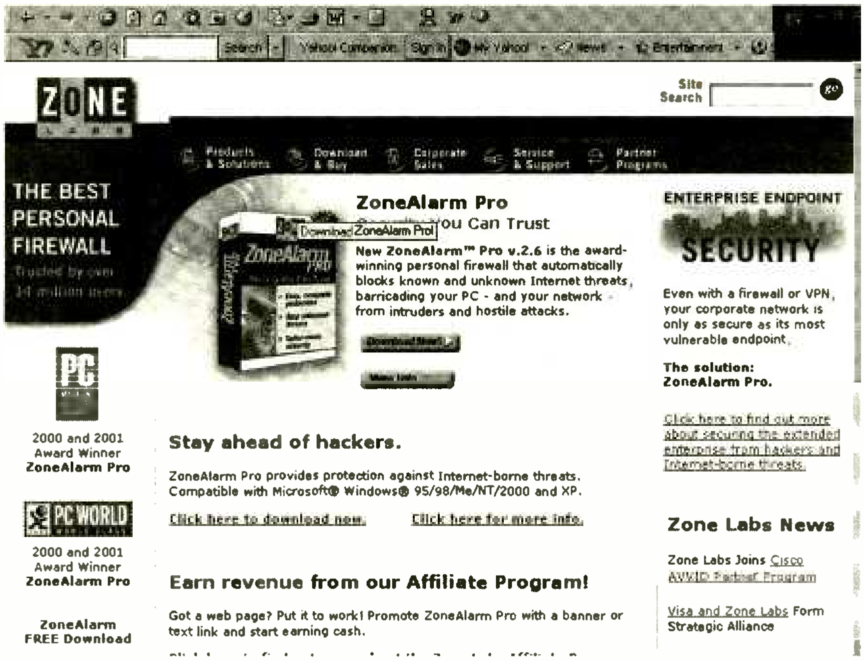
Most computers today still come with CD-ROM drives—drives are the mechanisms that spin the discs—but this technology is being superseded.

CD-R—This is a newer technology that overcame CD-ROM's read-only limitation—CD-R stands for Compact Disc Recordable. Popular uses are copying music and archiving data.

The best feature of these discs is their low cost—20 cents in bulk. The biggest limitation is that you can record data onto them only once. CD-R drives can read both CD-R and CD-ROM discs.

CD-RW—Standing for Compact Disc Rewritable, CD-RW overcame the write-once limitation of CD-R. You can rewrite and erase data multiple times. It's a technology that's becoming increasingly popular in new PCs, in many cases replacing Zip and tape backup drives.

CD-RW now has a cost advantage



The folks at ZoneAlarm offer an excellent freeware firewall for home users. Commercial users, or home users seeking extra protection, can opt to buy the Professional version. This software firewall will beef up the security for your broadband Internet connection.

over Zip for backing up data or moving it from one PC to another. CD-RW drives cost twice that of Zip drives, but the discs themselves are ten times less expensive than the Zip discs and have two times more capacity.

The latest CD-RW drives are as fast in reading data as Zip drives and nearly as fast in writing data. They're faster than tape backup drives and more versatile. CD-RW drives can write to CD-R or CD-RW discs.

THE DIGITAL VERSATILE DISK

DVD-ROM—This is a technology that promised much, but never quite lived up to its potential. Standing for Digital Versatile Disk Read-Only Memory, DVD-ROM uses discs that are similar to CD-ROM discs, but typically hold seven to eight times more data.

Despite the greater capacity of DVD-ROMs, software makers have continued to distribute their programs primarily on CD-ROMs because of the ubiquity of CD-ROM drives. DVD-ROM drives can be useful for watching DVD movies on your PC or playing computer games.

DVD-ROM drives, like CD-ROM drives, can't record data, though they can read most types of CD and DVD discs. The speed ratings of DVD-ROM drives aren't comparable with those of CD-ROM drives—a 12X DVD-ROM drive is faster than a 48X CD-ROM drive.

DVD-R—Similar to CD-R, this technology lets you record data onto discs, but only once. DVD-R discs currently have seven to eight times the capacity of CD-R discs, though both the drives and the discs are more expensive, with the discs costing about $12 each. DVD-R drives can create CD-R discs and create or rewrite CD-RW discs.

DVD-RAM—This is a competing and incompatible technology. You can't read DVD-RAM discs with most other DVD drives and DVD-RAM drives can't create discs that can be read by CD-ROM drives or CD players, a big limitation compared with DVD-R.

DVD-RW—This technology lets you record, erase, and rerecord data. Since it's a new technology, it's expensive, with the discs costing $20 to $35 each. Some DVD-ROM drives can't read DVD-RW discs that have been written to multiple times.

Of the above technologies, CD-RW and DVD-ROM are versatile, compatible, and cost-effective choices. Regarding the newer DVD technologies, "it's impossible to call a winner," says Mary Craig, optical storage analyst for Gartner Dataquest, a market research firm in San Jose, CA.

POINT AND CLICK

Cogent Communications
www.cogentco.com

DirectPC
www.directpc.com

Earthlink
www.earthlink.com

Optical Storage Technology Association (OSTA)
www.osta.org

Zone Labs
www.zonelabs.com

Unless you need to buy immediately, your best bet is to wait to see which technologies are adopted over time by the major computer makers.

HIGH-SPEED ACCESS

As the Web becomes ever more laden with graphics, sound, animation, and video, the need for speed grows ever greater.

If you use the Web only occasionally, you probably don't need a high-speed modem. However, if you regularly use it for research or entertainment, you'll count your lucky megabits the day you get hooked up with a cable or DSL modem.

If you have high-speed access and are forced to return to dial-up access, as I was recently while on a trip, surfing the Web becomes entangling. You're stuck waiting for page after page to download. Using your browser seems like browsing through a magazine with the pages glued together.

For some time now, the biggest obstacle to high-speed Internet access, also called broadband access, has been scant availability. Many people who want it can't get it from their local cable or telecommunications companies because of the slow rollout of the underlying infrastructure.

UP-SHOTS AND DOWN-FALLS

Broadband customers face other problems as well. Partly as a result of the dot-com meltdown, the DSL industry has undergone an implosion, with big names such as Northpoint Communications and Flashcom filing for bankruptcy protection, limiting your choices.

Still, broadband use continues to

grow, nearly doubling over the past year, according to market research company Cahners In-Stat. Excite@ Home, the largest cable Internet service provider at *www.home.net*, is now the second most popular ISP behind AOL, according to StatMarket, another market research firm.

Yet not all people who have high-speed access are happy with it. Broadband service costs roughly two to three times more than dial-up service and that's a good deal considering that download speeds can be ten times faster. Unfortunately some broadband providers, including the well-regarded Earthlink, at *www.earthlink.com*, have raised prices recently as much as 25 percent.

Other problems include installation hassles and long wait times for service, which mirror problems encountered in the past with then high-speed ISDN service and cable TV service. Installation is typically much quicker with cable service, taking an average of five days compared to four to six weeks with DSL service, according to DVG Research.

My experiences with both cable and DSL service have been positive. Occasionally the ISP's e-mail or Web server goes down or service goes out completely. These problems are almost always fixed however, without my intervention, in a few hours. Cable access in general is faster, though it slows down more during peak evening hours.

Anecdotally, DSL users seem to report more installation and reliability problems than cable users, though cable users are exposed to more security risks, which makes DSL a better choice for businesses.

PROTECT YOURSELF IN THIS CHANGING WORLD

With either cable or DSL service, however, it's smart to take security precautions, including using a firewall program such as the well-regarded *ZoneAlarm*, at *www.zonelabs.com*. The software is still free despite the accelerating elimination of other free Internet products and services. A beefed-up pay version, *ZoneAlarm Pro*, makes sense if your PC is a part of a local-area network.

The desirability of high-speed Internet service in the minds of some has translated into its necessity, particularly for lower income people who want it but can't afford it. A number of advocacy groups and industry organizations contend that being a fully participating member of society requires broadband access to the Internet.

Some of the computer industry's biggest companies, including IBM, Intel, and Motorola, are lobbying for legislation that would subsidize broadband in inner city and rural areas. Grand comparisons are being made to the building of the interstate highway system and the rural electric system and even putting a man on the moon.

Despite the hyperbole, the argument for widespread broadband access to the Internet is compelling. Nevertheless, as with all government intervention in the marketplace, care needs to be taken to prevent this from becoming a boondoggle.

In the meantime, work in the private sector continues on access and even higher-speed Internet service.

DirecPC, at *www.direcpc.com*, recently introduced its Satellite Return service, which lets you both download data from a satellite and upload data back. The service can be a good choice if you can't get cable or DSL access.

Cogent Communications, at *www.cogentco.com*, is developing an all fiber-optic system that offers speeds of 100 megabits per second, which is about two hundred times faster than cable and DSL modems and one hundred times faster than typical business T1 connections. The cost: $1000 per month.

Cogent is focusing its efforts initially on ten cities: its home city of Washington, D.C., plus New York, Chicago, Philadelphia, Dallas, Denver, Kansas City, Boston, San Francisco, and Santa Clara.

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TECHNOSCOPE

(continued from page 22)

long-haul trunk lines, interexchange trunks, and subscriber loops. The key advantages for using fiber for telephony is high capacity and long distance between repeaters.

Premise wiring—within and between buildings, to each floor, or to individual workstations—is another area for which fiber-optic cable is suited. Significant advantages to optical premise wiring include sufficient data capacity, immunity to EMI, and small size and light weight of the equipment—making it much easier to handle.

Fiber-optic cable serves as the backbone between head-ends. The fiber makes it possible for cable companies to deliver hundreds of channels to the feeder, which will then supply from 20–2000 homes. Advantages are high bandwidth, improved reliability and fewer amplifiers, improved picture and a platform for future services like video-on-demand, interactive services, and HDTV (high-definition television).

Fiber optics in submarines allows for total communications along coastal regions and between continents. With fiber, submarines now have a much higher data capacity and a long distance between amplifiers. As a result, their communications systems are much more dependable.

Other applications for fiber include utilities; sensors; fiber-optic gyroscopes; remote sensing; temperature, pressure, and movement gauging; and satellite ground systems. The potential capability of fiber is boundless and is growing exponentially every day.

TED NEEDLEMAN

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Terrific Printing on the Cheap

Printers are one peripheral that many users pay scant attention to. Generally, as long as whatever printer you have still works, you tend to just live with it. Most printers don't get replaced until the carriage jams, or it springs a leak. If you have any doubts, take a look at any office supply catalog, and you'll see hundreds of listings for ribbons for dot-matrix printers, which passed out of mainstream usage years ago.

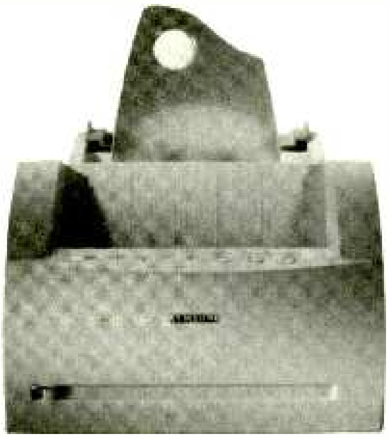
The time has never been better to buy a new printer. Not only are prices less expensive than ever, but features are correspondingly greater than ever. In short, your printer dollar buys you more.

We've been playing around with some of the newest models. What's encouraging is that this column will take a look at a trio of offerings, for different kinds of users, none of which costs more than $200. At that price, you're getting excellent print quality and some other high-end features.

SOMETIMES, YOU GET WHAT YOU NEED

If it's been a while since your last printer upgrade, you're going to be pleasantly surprised at what's now available. Picking the right unit, however, is much more a matter of matching your printing needs than it used to be. The three printers we looked at for this column all cost within $50 of each other, but are very different kinds of units.

If most of the printing you have is still monochrome, in the form of reports and letters, a laser printer may be your best choice. Lasers have traditionally been somewhat expensive, but from both a speed and cost-per-page standpoint, they offer excellent performance and value.



Samsung's ML-1210 is an affordable gateway to the laser printer market. Retailing at $199, the ML-1210 features USB connectivity and true 600-dpi laser quality output

Now, even the purchase price has plummeted. When Brother introduced a $300 laser printer years ago, it seemed that the printer would be pretty much the lower limit of this category. In fact, most of the laser printers introduced since, even by Brother, have cost more than this.

That's changed in the last few months. Mita introduced a $199 laser printer last year, which quickly disappeared from the market when the company was acquired by Kyocera. Samsung was next on the market with a $199 laser, its ML-4500. This was only on the market a few months when it was superceded by the ML-1210. Considering the $199 retail price, you're getting a great deal with ML-1210. Samsung rates the printer at 12 pages per minute in draft mode, and it actually spews paper just about that quickly. The previous under $200 model was parallel only, but the ML-1210 also offers a USB port, which makes it really easy to connect. You have to install the driver through a separate install CD; and the printer will work with Windows, the Mac OS, or Linux.

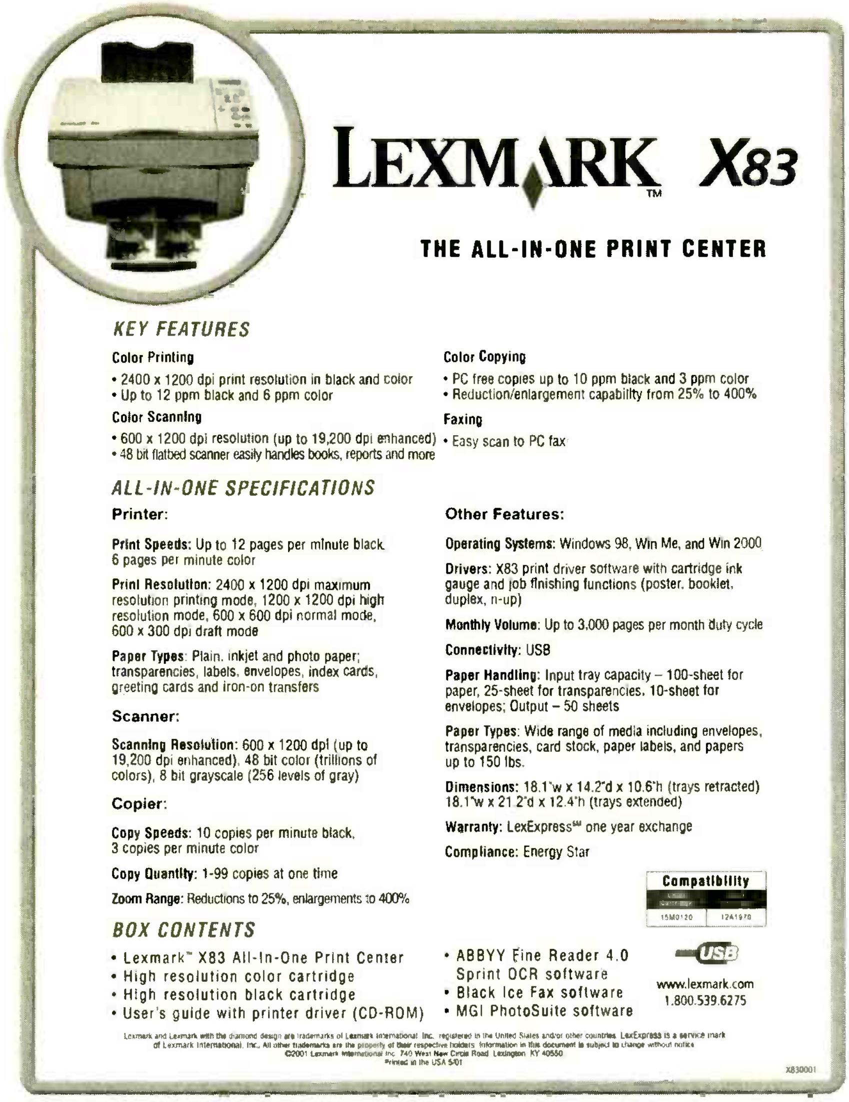
PRINTERS: ONE ON ONE

Samsung's ML-1210 provides true 600-dpi laser quality and is a great value. It is not, however, the only printer in this space. Lexmark also just introduced a similarly priced and featured personal laser printer, the E-210. Unfortunately, our review unit arrived too late to include in this column.

What did arrive from Lexmark on time was the X83, also priced at $199. We're not generally a big fan of multifunction peripherals (MFP), but the X83 may just change our mind. These units basically bundle an inkjet printer and a flatbed scanner into a single unit that has about the same footprint as just one of the peripherals. This makes an MFP an attractive choice when there's not much room, such as in a home office or a student's dorm room.

The problem comes in when the components are not anywhere as good as they would be if you bought them separately. It's sort of like the difference between buying a $50 CD Boombox or a home audio center with a receiver and CD changer.

Lexmark's X83, to its credit, com-


LEXMARK X83

THE ALL-IN-ONE PRINT CENTER

KEY FEATURES

Color Printing
- 2400 x 1200 dpi print resolution in black and color
- Up to 12 ppm black and 6 ppm color

Color Scanning
- 600 x 1200 dpi resolution (up to 19,200 dpi enhanced)
- 48 bit flatbed scanner easily handles books, reports and more

Color Copying
- PC free copies up to 10 ppm black and 3 ppm color
- Reduction/enlargement capability from 25% to 400%

Faxing
- Easy scan to PC fax

ALL-IN-ONE SPECIFICATIONS

Printer:

Print Speeds: Up to 12 pages per minute black, 6 pages per minute color

Print Resolution: 2400 x 1200 dpi maximum resolution printing mode, 1200 x 1200 dpi high resolution mode, 600 x 600 dpi normal mode, 600 x 300 dpi draft mode

Paper Types: Plain, inkjet and photo paper; transparencies, labels, envelopes, index cards, greeting cards and iron-on transfers

Scanner:

Scanning Resolution: 600 x 1200 dpi (up to 19,200 dpi enhanced), 48 bit color (trillions of colors), 8 bit grayscale (256 levels of gray)

Copier:

Copy Speeds: 10 copies per minute black, 3 copies per minute color

Copy Quantity: 1-99 copies at one time

Zoom Range: Reductions to 25%, enlargements to 400%

Other Features:

Operating Systems: Windows 98, Win Me, and Win 2000

Drivers: X83 print driver software with cartridge ink gauge and job finishing functions (poster, booklet, duplex, n-up)

Monthly Volume: Up to 3,000 pages per month duty cycle

Connectivity: USB

Paper Handling: Input tray capacity – 100-sheet for paper, 25-sheet for transparencies, 10-sheet for envelopes; Output – 50 sheets

Paper Types: Wide range of media including envelopes, transparencies, card stock, paper labels, and papers up to 150 lbs.

Dimensions: 18.1"w x 14.2"d x 10.6"h (trays retracted) 18.1"w x 21.2"d x 12.4"h (trays extended)

Warranty: LexExpress℠ one year exchange

Compliance: Energy Star

Compatibility

BOX CONTENTS
- Lexmark™ X83 All-In-One Print Center
- High resolution color cartridge
- High resolution black cartridge
- User's guide with printer driver (CD-ROM)
- ABBYY Fine Reader 4.0 Sprint OCR software
- Black Ice Fax software
- MGI PhotoSuite software

USB

www.lexmark.com
1.800.539.6275

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X830001

Lexmark's X83 combines an inkjet printer capable of producing 2400- × 1200- dpi output on glossy photo paper, with a flatbed scanner that provides 42-bit color depth at a 600-dpi optical resolution.

bines an excellent quality inkjet printer with a scanner of like capability. The printer can generate 2400- × 1200-dpi output on glossy photo paper, though it does take several minutes per page at this quality setting. You can also substitute a photo ink cartridge for the black ink. This gives you several additional shades of color and more photo-realistic output.

The scanner section offers 42-bit color depth and 600-dpi optical resolution. Lexmark has tightly tied the two components together so that the X83 also functions as a photocopier, even when the PC it is connected to is turned off. Copy speed, at a maximum of 10 ppm in black and 3 ppm in color, is not breathtaking. However, it sure beats having to dig up a batch of quarters for the photocopier down at the library when you need to make a copy. Send a X83 back to school with your college students, and they may be able to cover tuition making copies for their dorm mates.

SOMETHING MORE CONVENTIONAL

If neither of the preceding printers rings your chimes, perhaps the new DeskJet 940c from Hewlett-Packard will do the trick. The DJ940c is actually the successor to HP's very popular DJ950 series. It uses the same REt technology to provide 2400- × 1200-photo-quality output on glossy paper. As with other printers in the 9XX model line, an automatic duplexer is available as an option. This fits on the rear panel of the printer and automatically flips the page after the front has been printed, so that the back of the page can be printed with no operator intervention required. We've used this feature on other printers, and it's great if you often print brochures or other double-sided output.

HP rates the DJ940c at up to 12 ppm in monochrome and 10 ppm in color. That's for sparse pages printed in draft mode. Real-world printing goes much slower.

On the other hand, the DeskJet 940c has truly breathtaking color output reproducing digital photos on glossy paper. Plus, it doesn't need any special photo cartridges to do this. The DJ940c has both parallel and USB interfaces and comes with drivers for both Windows and the Mac OS. At only $149, it's a terrific printer for home, small office, or student use. Our only criticism of the HP DeskJet 940c is that the warranty is only for 90 days. The warranties on the Lexmark X83 and Samsung ML-1210 printers are for a whole year.

SOURCE INFORMATION

Hewlett-Packard Corporation
800-552-8500
www.hp.com

Lexmark
800-LEXMARK
www.lexmark.com

Samsung Electronics America
800-933-4110
www.samsung.com/usa

BROOKE A. BERLIN

A Time-Travelers Time Line

Connecting The Philadelphia Experiment And The Montauk Project

By August 12, 1943, members of the United States Navy had finished wrapping large Tesla coils around the USS Eldridge, Navy Destroyer Escort 173, in the Philadelphia Harbor, Pennsylvania. What these men knew was that they were using the electro-magnetic coils to test radar invisibility and stealth technology on ships with electric drives. By creating a rift in the time-space continuum, they planned on being able to further test and observe Einstein's Unified Field Theory (UFT) and the effects of electro-magnetic high-frequency waves on portions of the atmosphere (touched upon in last month's HAARP article). What these men did not know, nor anticipate, is that soon they would be discharged as mentally unfit, discredited, and disillusioned.

Sailing Through Time

The coils were activated, the ship and sailors aboard were engulfed in a pale haze of electromagnetic energy, and then, it all disappeared. Upon reappearance, surviving crewmembers were mentally and physically disoriented—some were burned, while others were literally soldered to the super-structure of the ship and planted into the bulkhead. Several could allegedly walk through walls; some never reappeared nor were ever seen again; and one, Duncan Cameron, jumped ship and landed in the future. Fragments of the event now remain scattered throughout the time continuum, appearing spontaneously in various places at different times. It has been leaked that classified Office of Navy Intelligence (ONI) files describe what the sailors saw and experienced first-hand. The incident was initially named Project Rainbow and ultimately renamed the Philadelphia Experiment.

All that is supposedly left of Camp Hero in Montauk, NY is this remnant of a WWII Sage-radar system used for coastal defense. The terrain of Montauk Point is an extremely rocky bluff overlooking the Atlantic Ocean. Speculators rumor that a nearby bunker leads downward into a hollowed subterranean mountain. Could this be an eastern Mt. Cheyenne?

Invisibility research began at the University of Chicago with the support of such well-known scientists as Dr. John Von Neumann and Emil Kurtenhauer. In 1933, the Institute of Advanced Studies at Princeton, New Jersey, was formed, and, in 1934, the invisibility project was relocated there. People such as Albert Einstein and John Hutchinson joined in the study, which was directed by Nicola Tesla until his resignation in 1942, though his affiliation remained strong through his inventions and ideas. Initial support came through the backing of the Massachusetts Institute of Technology (MIT), the Radio Corporation of America (RCA), and the Brookhaven National Laboratory (BNL).

Dr. John Von Neumann—a Hungarian-born mathematician who is well known as both the inventor of the modern computer and a collaborator on the Manhattan Project, which resulted in the first atomic bomb—directed the technical aspects of the Philadelphia Experiment. With particularly high clearance, Von Neumann had access to the Nazi database of psychological research. With the conclusion of World War II, he continued to research what makes man's mind tick and why man could not be subject to interdimensional phenomena without extreme disaster.

Materializing Thoughts In The Underground

When the government would no longer support the invisibility research, the leaders went directly to the military for backing. Henceforth, Camp Hero, an abandoned and run-down Air Force Base at Montauk Point, the easternmost point on the southern fork of Long Island, NY, became the setting for many of these underground experiments, including the post-war research and tests of Von Neumann (known collectively as the Montauk Project). Von Neumann required the base particularly because it harbored a huge Sage-radar antenna, which emitted a frequency of approximately 420–470 MHz—the same frequency was believed required to enter man's conscious mind.

Eventually Von Neumann's work in the mind sciences brought results. According to speculative sources, human thoughts were being received by vacuum-tube radio receivers designed by Tesla, digitized and relayed into a computer, and stored as coded bits of information. Hardware was developed that allegedly amplified the bits of information enabling Dr. Von Neumann to hook a person up to a computer, have him/her think a thought, and create that thought into a reality—be that reality a person, place, or thing. The time-bending, history-altering possibilities were endless. It was an astonishing feat for a subject to be able to think an object into the present, but what would happen, for instance, when a subject would think of an object yesterday?

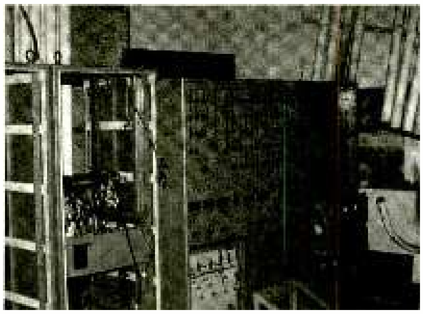
It has been rumored that there was extensive extraterrestrial (ET) involvement in many of the secret operations and that the exchange of technology propelled the projects and furthered their growth. Using both this technology and the new-found power of manipulation, vortexes—openings in the atmosphere resembling a continuous flow of energy around an axis, also known as wormholes—were created in order to simultaneously link different times lines. This would prove critical in the connection between the Philadelphia Experiment and the Phoenix Project—one of the most important divisions of the Montauk Project.

Unleash The Beast

Dr. James F. Corum was utilizing Tesla's Egg of Columbus—an 1893 Chicago Columbian Exposition demonstration explaining the principle of the rotating magnetic field and the induction motor—while others at Montauk were preparing for the second major UFT experiment, both in hopes of replicating and improving the results of radar invisibility previously tested in the Philadelphia Harbor.

On August 12, 1983, exactly 40 years after the Philadelphia Experiment, a vortex was opened that linked the two time lines. However, the generator that was energizing the Tesla coils on the USS Eldridge prohibited the vortex from shutting—the outcome of which would have been complete devastation. Duncan Cameron—the sailor who jumped ship—and his brother, Ed Cameron, both Navy liaisons in the experiment, were convinced to go back in time to the USS Eldrige and destroy the generator keeping the vortex open and the ship in hyperspace.

These two experiments supposedly left an invisible temporal axis (or tunnel through time) in the Navy exercise space connecting the Philadelphia Harbor and Montauk Point. When some of the participants realized the dubious consequences of continuing with this line of experimentation, they conspired on a plan to halt activity. In late August, Duncan got hooked-up and was programmed to unleash an indescribable beast from his subconscious, which manifested, ravaged the laboratory, and literally destroyed the project. Afterwards, there was a series of major debriefings and inevitable brainwashing.



Now that's a circuit breaker assembly! This photo was taken inside the radar tower at Montauk. The two modules at the lower right appear to be power supplies. A bare rack seems to be loaded with cables that once connected to numerous modules. The abandoned site suffers greatly from disrepair and pillaging.

Sightings And Speculations

Other projects continue, and there have been numerous reports of sightings at Camp Hero—people, suspicious construction on an "abandoned" site, and colored aurora-borealis-like streaks of light through the air. Many people feel that Camp Hero and the grounds surrounding it are shrouded in mystery and subterfuge. In a Web article by Jonathan Kostecky, he stated that Camp Hero, commissioned by the U.S. Army in 1942 (though some believe it was earlier), is considered to be one of the most valuable Cold War era artifacts. Its history of ownership is quite scandalous, considering that it was donated to New York State as a public park, while private areas have been retained and marked off by fences. Some land has been developed, and there are people who live within the outer boundaries. There has been discussion whether or not to continue development, though most of the land and water is polluted and contaminated. Many want to see the area restored, especially the 120-foot wide, 70-ton antenna, while many others want to see it just left alone to crumble under the weight of its own past.

What The Government Believes

The only information to be found on the official Navy Web site (*www.navy.mil*) is denial of supernatural occurrences. The Navy acknowledges that the allegations about the destroyer—that it was made invisible and teleported from Philadelphia Harbor to Norfolk, Virginia—do exist, though after extensive investigation of the Records in the Operational Archives Branch of the Naval Historical Center, neither confirmation of the events nor naval interest has been found. The Web site gives the log of the USS Eldridge and states that it was never in the Philadelphia Harbor. It also gives the log of the SS Andrew Furuseth, whose crew supposedly observed the Eldridge in Norfolk, and states that the two ships were never in Norfolk at the same time. While the Navy does affirm that Einstein was a Bureau of Ordinance consultant, it disputes that Einstein's UFT was ever completed and that he was involved in researching invisibility and teleportation. Degaussing—wrapping electrical cables around a ship and sending currents through—was used to cancel out a ship's magnetic field, therefore making it invisible to the sensors of magnetic mines. However, the Navy disagrees that doing so made ships invisible to the human eye, radar, or underwater acoustic sensors.

Now This Is A Night Job

There are three significant men—Preston Nichols, Al Bielek (Ed Cameron), and Duncan Cameron—associated with the Montauk Project, two of whom—the Cameron brothers—are also connected with the Philadelphia Experiment. Other people played important roles in the development of the projects, such as Phil Schneider, an ex-government engineer involved in the building of underground bases and extraterrestrial intelligence experiments. The majority of the people connected to these covert operations claimed to have been brainwashed and robbed of their memories and some, such as Phil Schneider, are no longer alive.

Al Bielek was born Edward A. Cameron II, son of Alexander Duncan Cameron, Sr. and brother of Duncan Cameron, in 1916. The Cameron brothers were raised on Long Island and followed in the footsteps of their father by joining the Navy. After completing training for "Special Assignment" Navy personnel, they were assigned to the Institute of Advanced Studies at Princeton and worked on the invisibility study already underway. Ed and Duncan remained involved in the project through its completion and were on the USS Eldridge on August 12, 1943. After the ship returned to harbor, Duncan was never heard from again and Ed married, had a son, and transferred to Los Alamos, New Mexico. There, he was arrested, charged with espionage—all charges were subsequently dropped—and transferred to Washington D.C. He never saw his family again.

Ed was washed of his memory, time-shifted, and placed with a family under the new identity of Al Bielek. Drafted into the Navy, he got a degree as an electrical engineer from the Newark College of Engineering and worked in that profession until 1998. He continued to work at Montauk with Duncan, who had stepped from the Eldridge to Montauk, without realizing their previous connection. Over time his (i.e. *Al's/Ed's—are we following this folks—Editor*) memories began to flood his consciousness, and he has spent recent years researching and speaking out. Duncan has what is considered "Swiss-cheese memory," meaning that there are many holes in his memory. While specifics remain in darkness, he does remember being aboard the USS Eldridge and being a part of the projects at Montauk.

Preston Nichols was born in 1946 and grew up on Long Island. He received degrees in parapsychology, psychology, and electrical engineering. Going into Defense Electronics, he worked at both the Brookhaven National Laboratory (BNL) and the Airborn Instrument Laboratories (AIL)—a major Long Island military contractor previously run by the Eaton Corporations, but as of 1988, by the Department of Defense. According to Nichols, there are three branches of AIL—covert, commercial, and defense—with locations in such places as Farmingdale and Deer Park. Preston began his involvement with Montauk in 1968, specifically with the psychic aspects. He worked with Al on the chair used when interfacing the mind to a computer.

Siskel And Ebert Give...

Different entertainment outlets have tapped into the large market for sci-fi innuendo. The question you have to ask yourself is, what came first—the fact or the fiction? Are these people taking shreds of reality and turning them into fiction, or vice versa? Many skeptics (including those who also refuse to accept that there could be some truth behind the secret conspiracies of the government, military, and scientific technicians) simply dismiss all discussions of this sort as conspiracy-burdened Sci-Fi. They are the people who turn to Hollywood, animation, and creation to find solace in the thought that what they see and hear is nothing more than someone's imagination. Still, other scientific skeptics (*like the majority of our readers—Editor*) would gladly adopt any theory under one simple condition—hard scientific proof based on correct facts. A string of allegations, rumors, and anecdotes does not make a scientific study.

While skeptics and believers duke it out, the media is reaping the spoils. Fox is currently in its fifth season of the show *Sliders*. Imagine yourself being able to slide through portholes and end up in parallel universes where the date is the same, you are the same, but everything else as you know it is different. The Sci-Fi channel shows re-runs of *Quantum Leap*, based on the principle of stepping into an accelerator and being able to travel back in time.

Sony Entertainment delivered the movie *Men In Black* to theaters across the world. With the ability to wipe out memories and create new ones with the push of a button (sound familiar?) and the cooperation of friendly aliens (wink, wink), two agents were able to monitor the immigration and emigration of extraterrestrial beings on Earth. In 1984 the *Philadelphia Experiment* was released as a movie, documenting the materialization and occurrence of the extraordinary disappearance and reappearance of the USS Eldridge and its crew.

There is an entire series of books (Sky Books publications) written by Preston Nichols with Peter Moon about the Montauk Project and related subjects—connections to other projects, people, and worlds. Other books are on the market, either focusing on the two projects or commenting on them. A plethora of Web sties can be found with interviews, photographs, and updated information.

Reprise: Strange Encounters

I recently met with Preston Nichols to gather and review information. Elaborating on the mechanics of the mind-alteration device that was built, he described how the vortex formed at the center of a particle accelerator and that a delta antenna surrounded the accelerator in a diamond-like configuration. He believes, through personal research, that there is still underground activity out at Montauk. Outfitting a small school bus with radio antennas, control boards, and other needed equipment, he monitors such frequencies as those at the point and other FAA HAARP-like structures similar to the one in the Pine Barrens. Last summer he picked up frequencies of 400–435 megahertz at the point, a frequency used only by the military or aircraft. Considering the known locations of both on the island that are currently active, there is no reason for that frequency to be transmitted at that location.

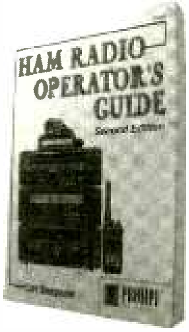
Construction has taken place to expand the dilapidated underground lab; and where once there were six levels of operation, there are now eight. In the early '90s, large ten-foot squares of rock appeared at Montauk Point. When Preston and Peter Moon researched the occurrence, they found three possible answers, only one of which they found believable. The first theory was that a barge brought them in; unfortunately, there wasn't enough water to support a shipment of that capacity. Second was that they were brought in by truck, but when the two questioned people in the area, not a single witness could be found to support it. Finally, they found eyewitnesses that said that the earth practically opened up and the rocks were pushed out. Preston believes that they were cut from the ground to form the 7th and 8th layers and brought to the surface. When asked about the argument that construction isn't possible that far down because of the aquifer lining Long Island, he simply remarked that cement was a beautiful thing. On a similar note, when questioned about the controversy of ownership, Preston informed me that while the land is in fact state park land, their land rights only include the top two feet of land. The land beneath that is privately owned.

Preston continues to talk out, along with Al Bielek, Duncan Cameron, Stewart Swerdlow—one of the programmers of the Montauk boys—and others. As time continues, more information comes out, the holes fill in, and memories are completed. While many questions find answers, the mystery continues to intrigue. Every day there are more questions, some of which may never have answers. Whether you believe in these incredible occurrences or not, ask yourself do you believe in their possibility? What do you think? After all, it only takes one person's thought to change reality. P

NEW LITERATURE

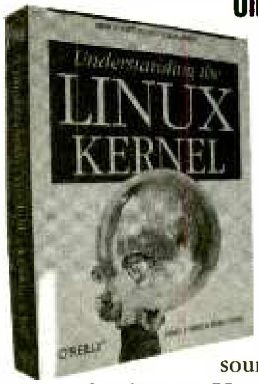
Ham Radio Operator's Guide, Second Edition

by Carl Bergquist
Sam's Technical Publishing
5436 W. 78th St.
Indianapolis, IN 46268
800-428-7267
www.samswebsite.com
$29.95



In the past, it was more difficult to operate your own radio frequency. Now, with the FCC No-Code—Morse code, that is—Technician class, amateur radio operation has become a new favorite pastime. Explore sample test questions, on-air operations, and updated license requirements with this book, which is written from the point-of-view of a novice, while engaging the experienced mind. Learn about clubs, jargon, etiquette, and more.

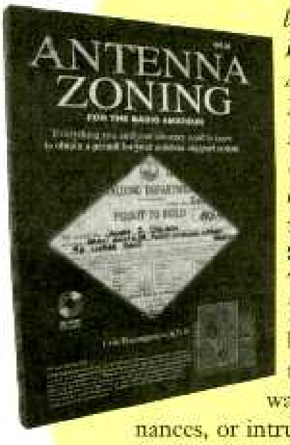
Understanding The Linux Kernel



by Danile P. Bovet & Marco Cesate
O'Reilly and Associates, Inc.
101 Morris St.
Sebastopol, CA 95472
800-998-9938 or 707-829-0515
www.oreilly.com
$39.95

Take a guided tour through the Linux kernel and learn about maximizing efficiency, performing unusual applications, and the source code. Topics covered that are familiar to Unix programmers and users range from memory management and the Virtual and Second Extended Filesystem to inter-process communication (IPC) and program execution. Ways to become a true Linux hacker are outlined here.

Antenna Zoning For The Radio Amateur



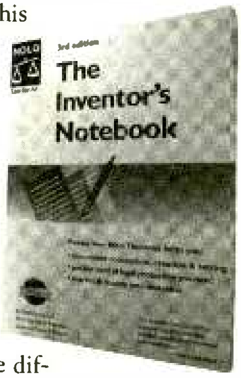
by Fred Hopengarten, K1VR
ARRL
225 Main St.
Newington, CT 06661
888-277-5289
or 860-594-0200
www.ARRL.com
$49.95

Throughout the years Ham radio operators have been shut down by legislation, regulation, and even war. Don't let today's ordinances, or intrusive neighbors, keep you from your passion. This book suggests techniques and strategies that Hams, or attorneys, can use to obtain an antenna-structure permit. Preparing you for what sorts of trouble you may encounter, the book guides you through the process of achieving your radio goals. There is even a section on regulation in Canada.

The Inventor's Notebook, Third Edition

by Fred Grissom & David Pressman
Nolo
950 Parker St.
Berkeley, CA 94710-2524
510-549-1976
www.nolo.com
$24.95

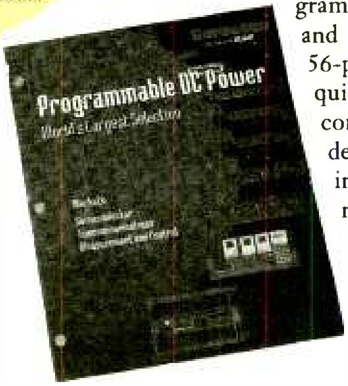
Inventors, educators, business advisors, and even attorneys can use this book to learn how to better organize the invention process and secure legal control of ideas. From documenting and evaluating development to assessing potential, necessary capital, and confident contacts, this book pays close attention to the details that make the difference. Be prepared to address the critical issues between you and your patent.



Comprehensive Programmable Power Supply Catalog

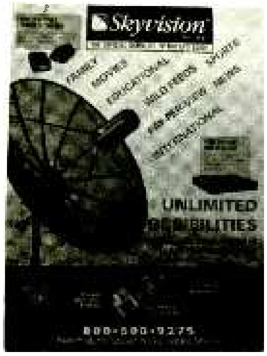
Sorensen
9250 Brown Deer Rd.
San Diego, CA 92121-2294
800-525-2024
www.sorensen.com
Free

This product catalog features the company's line of DC manual and programmable power supplies and electronic loads. The 56-page color catalog is a quick-reference guide, complete with product description and selection information, technical references, and custom services. Both individuals and dealers will find its contents useful.



Fall 2001 Skyvision Catalog

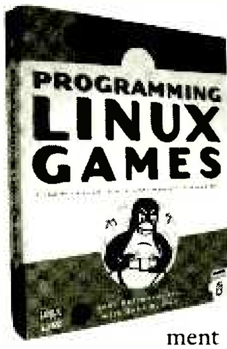
Skyvision
1010 North Frontier Dr.
Fergus Falls, MN 56537-1023
800-500-9275
www.skyvision.com
Free



This catalog offers all the products anyone needs for satellite TV installation. It features big and small dish systems and parts, as well as tools, accessories, and books. Handy tech tips are scattered throughout the catalog. The company also provides replacement manuals for all kinds of analog and digital satellite TV equipment.

Programming Linux Games

Loki Software, Inc. with John R. Hall
No Starch Press
555 De Haro St., Suite 250
San Fransisco, CA 94107
415-863-9900
www.nostarch.com
$39.95



Whether you are a beginner or an expert, if you know that variety and innovation are the keys to successful computer game development and want to improve your ability to play and invent challenging Linux games, this comprehensive guide will take you through the process. Readers learn how to use Simple DirectMedia Layer (SDL) and gaming APIs, how to play sound effects and music, how to distribute their own game to the Linux community, and much more.

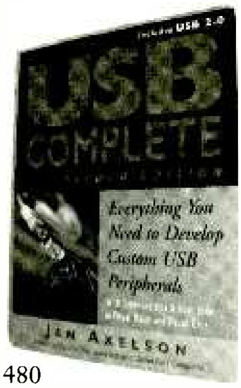
Mural Collection Brochure

Leviton Manufacturing Co., Inc.
59-25 Little Neck Pkwy.
Little Neck, NY 11362-2591
800-323-8920
www.leviton.com
Free

This brochure showcases the company's line of residential grade Decora-style Mural Dimmers. Features and benefits for all models, along with applications, ratings, and availability are all detailed within the pages. The models can be mixed and matched in order to create the perfect lighting ambiance specific to each individual's tastes.

USB Complete, Second Edition

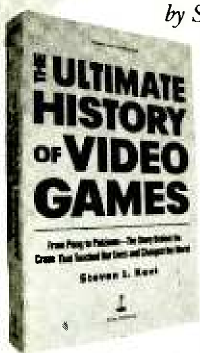
by Jan Axelson
Lakeview Research
5310 Chinook Ln.
Madison, WI 53704
608-241-5824
www.Lvr.com
$49.95



This second edition expands USB knowledge by teaching the four transfer types and three speeds of computer peripheral interfacing. Explaining what developers need to know about version 2.0 specifications and its new speed of 480 Megabits per second, the book also teaches about current controller chips and development tools. There is also information on device testing and how to debug application software and device firmware.

The Ultimate History Of Video Games

by Steven L. Kent
Prima Communications, Inc.
3000 Lava Ridge Court
Roseville, CA 95661
916-787-6972
www.primapub.com
$18.95



Journey through an era, which commenced with Atari, is currently infatuated with Sony Playstation2, and is guessing what the future will bring. Chronicling the passage of power from Pac-Man to Pokemon, this book divulges the inside secrets of electronic entertainment. There are interviews with the designers, programmers, and industry giants; insight into recent developments; and anecdotes on some of your favorite joystick-operated games.

Talk to the World for FREE!

JOHN CARTER AND JAMES HEIDENREICH

Some of the most rewarding construction projects center around communications. Whether it's a Ham transceiver or a fancy laser-based optical receiver, people like to build things that help them communicate. This article will lay out the plans for two unique devices: the *EchoBuster* and the *iPatcher*. Both of these devices can be used together to interface an ordinary telephone with your favorite Internet Talk application.

Choosing Your VoIP. You're in for a real treat if you haven't tried any of the new Internet Talk applications. This is especially true if you've been paying through the nose to talk to a friend or relative for an extended period of time over the dial-up network here in the U.S. Those phone bills can be horrendous, no matter which long-distance carrier you use! If your friend or relative is in a foreign country, it gets compounded exponentially! Read on to find out how to drastically cut those costs and add some exciting features, instead of just simply talking one-on-one.

The fancy name for this new technology is Voice over the Internet Protocol (VoIP), and it has been around for many years. The first attempts to pass speech over the Internet left a lot to be desired, and only the truly dedicated technical people were willing to wade through the problems. We have seen considerable improvement in the voice quality and ease of use with each new software release, and some really exciting things are beginning to happen. Our Web site at *www.jechtech.com/internet_talk.htm* has links to many of these applications that will save you a lot of money on your telephone bills.

Let the EchoBuster and the iPatcher be your link to free communication.

Each application uses its own proprietary algorithms to pass the audio over the Internet, and they each have their own unique set of features. They require both ends to be using their software, so anyone you want to converse with must be running the same program. You should try several applications to see which one best meets your needs. All of the applications we've tried have varying degrees of help available to new users. The ones offering conference calls (a feature where numerous people are on the same call from different lines simultaneously) have special forums set up where there are volunteer users ready to help newcomers learn how to use the application. Imagine having someone in Sydney, Australia help you set up your latest talk application feature! It's amazing and we can only wonder what the future holds!

Our favorite PC-to-PC application is *Securi-Phone* (*www.securiphone.com/english*). It has instant messaging (this lets you type messages and URLs back and forth) and file transfer while you're talking, which lets you exchange pictures, MP3 files, or basically anything in digital format with the person you're talking with! The instant-messaging and file-transfer utilities also encrypt everything automatically, so all calls, messages, and files are handled securely. It also has a very small footprint of only half a megabyte and is very RAM efficient. If you are concerned about your privacy, then *SecuriPhone* is the product for you. *SecuriPhone* offers a trial before you buy the program that can be downloaded for free. My mother and sister have cut their phone bills drastically by using *Securi-Phone*, since they talk at least a half an hour every single day! Plus, they can swap pictures while they're talking! If you try *SecuriPhone*, add me to your contacts list so we can chat (my User ID# is 42350).

A Brief History. Early PC-to-PC applications typically cost a one-time fee of around $50 and worked reasonably well, if you had the patience to set them up. The initial players were *iPhone* from Vocaltec and

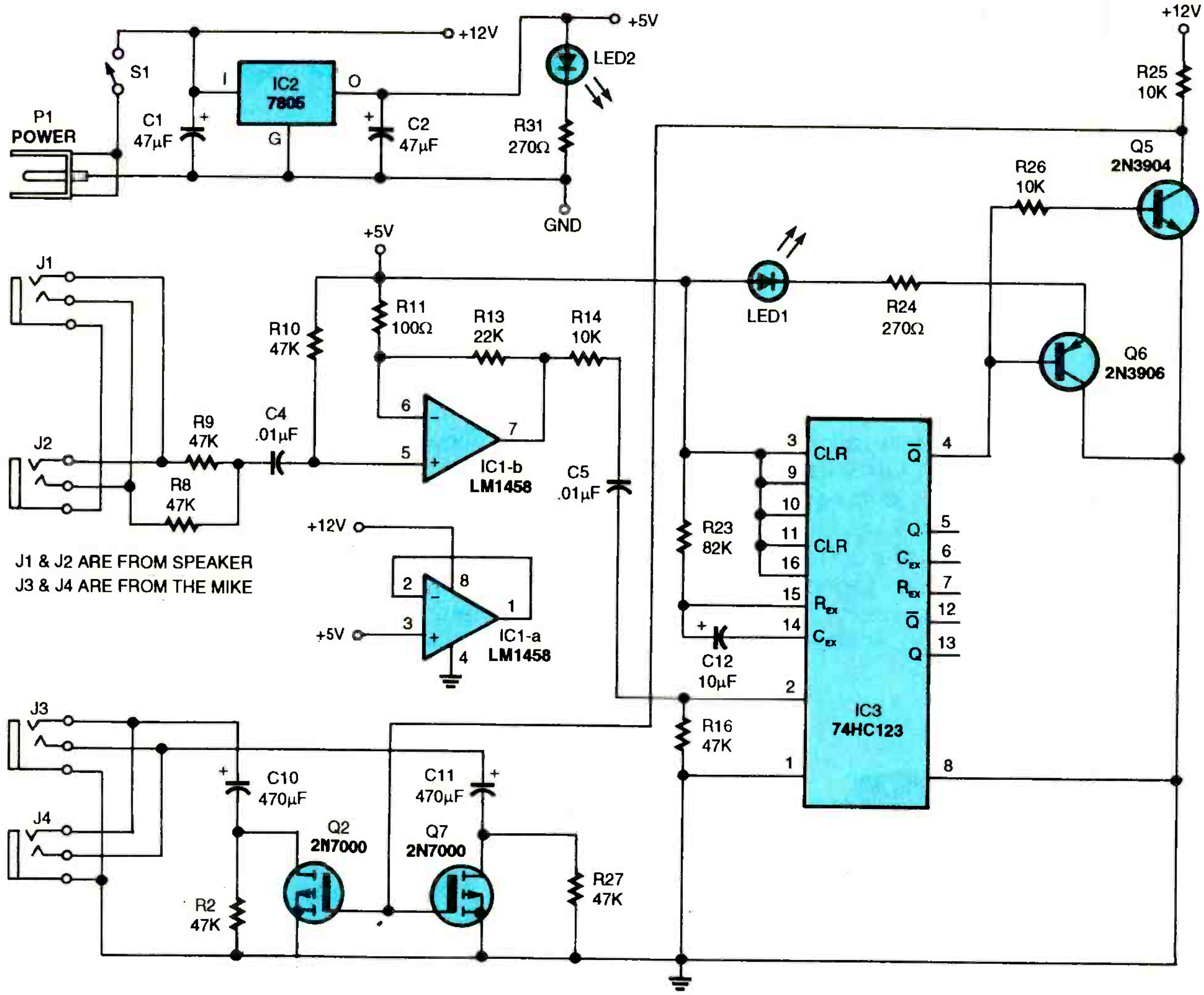


Fig. 1. This is the EchoBuster schematic diagram. Two chips are incorporated into the design; an LM1458 dual op-amp, and a 74HC123 dual retriggerable monostable multivibrator.

WebPhone from NetSpeak, along with some others that didn't capture much of the market. These applications saved their users literally thousands of dollars in toll charges. As of April 2001, there are many free PC-to-PC applications that are quickly gaining market share.

Initially, software and hardware problems made the audio quality poor, since it was sometimes choppy and unreliable. Faster servers, more bandwidth, and more efficient voice-coding algorithms were needed to speed things up. The software and hardware gurus have been hard at work on this; and improvements are being made daily, to the point where now even the most run-of-the-mill applications are getting very useable results. The audio will improve as the technology and the Internet evolves; and, since it is free, it really does deserve a try.

Second Applications. The next type of application for VoIP is the PC-to-Phone call. These applications allow you to call any standard telephone (USA and Canada) from your PC. Some even provide for international calls! The prominent player here is *DialPad*, with over 13 million subscribers and counting! They offer their service for free, and their banner advertisers pick up the tab. Some offer their service for a small per-minute fee instead of using advertising. Again, our Web site has the details. These applications are not fully developed yet because of bandwidth issues. Sometimes you can have a perfect conversation approaching true telephone quality, and other times it leaves a lot to be desired. However, it's free, so you're not out anything but your time. It's definitely worth looking into if the person you want to talk with doesn't have a computer.

System Requirements. Each of these applications specifies what their minimum system requirements are for successful operation. Although they vary slightly, they all use the same basic technology and work with the same variables, so we can come up with a "generic" minimum as a starting point. The first consideration is the microprocessor speed, and the bogey here seems to be 166 Megahertz. So, if your computer isn't at least that speed, you will probably have less than acceptable results. The reason is quite simple. If it's not that fast, it simply cannot handle the "real time" flow of ones and zeros and put them back together in the form of an analog audio signal for you to hear and be heard. A good rule

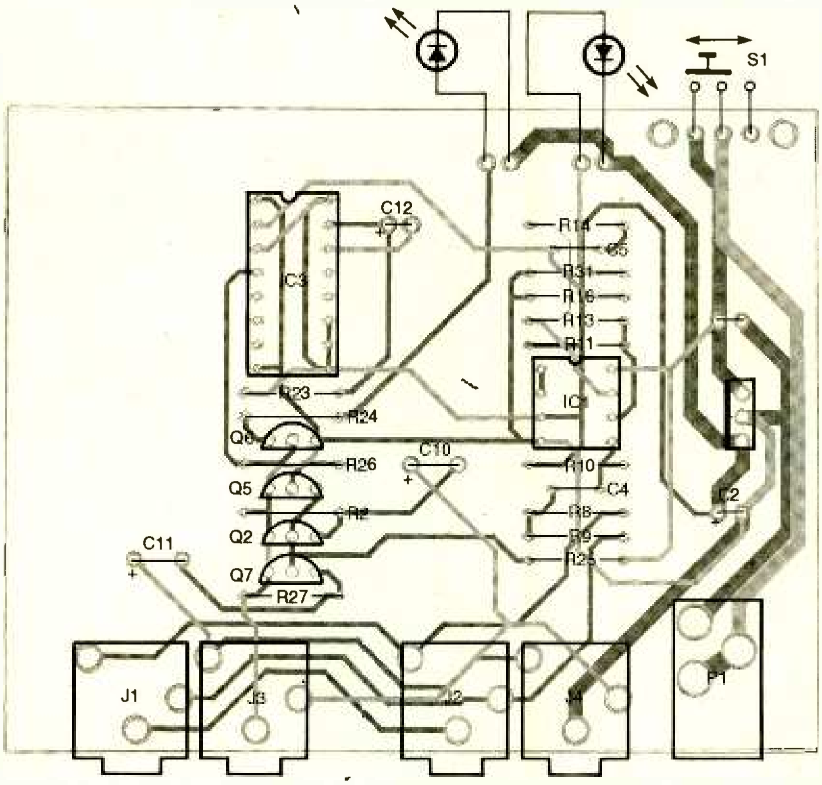


Fig. 2. Here's the parts placement diagram for the EchoBuster. Patience and a steady hand are required for soldering the components to the board.

of thumb for microprocessor speed for nearly all PC applications would be the faster, the better.

Next, your system needs to have a sound card. This takes all of those digital ones and zeros and converts them into an analog audio signal that comes out of your speakers. Conversely, it takes the analog signal generated by the microphone and converts it into the digital signal used by the computer. The standard here seems to be SoundBlaster; and if the specifications of your system state that their sound card is SoundBlaster compatible, you're OK.

Last, but not least, you need a modem. You folks with DSL or cable modems are home-free here, since their speeds are more than adequate. People on a Local Area Network (LAN) are in good shape as well, although there may be some firewall issues you have to deal with. Those of us stuck with the garden-variety dial-up modems need to take a closer look. A minimum connection speed of 28.8 Kilobytes per second seems to be good enough for normal-voice communications. If you're not sure what your connection speed is, simply try the application and see how it works. Luckily for us, nearly all of the package systems sold today are multimedia machines and meet all of the above requirements right out of the box!

The Echo Problem. What do we mean by echo? User 1 talks into his microphone, which is sent over the Internet to User 2. User 1's voice (coming out of User 2's speakers) is picked up by 2's microphone and sent back to User 1. Hence, echo; and it can be very confusing to someone hearing it for the first time. Internet congestion adds some interesting effects (in the form of delay) on top of the echo as well, so suffice it to say, echo is bad and should be avoided.

To avoid this problem, most of these applications typically default to push-to-talk (PTT) operation similar to two-way radio. In the PTT mode, the microphone is muted when you're not "keying" it. Typically, they use either the space bar, CTRL key, or a function key as the PTT button. However, many of these applications have what is called "hands-free" or "speakerphone" option so you don't have to hit any push-to-talk key. All you do is talk, and the software activates it for you automatically. It then becomes a vox (voice operated switch) type of operation, and it works quite well as long as you can deal with the dreaded echo problem.

Another solution to this echo problem is to use a headset or a handset, which doesn't allow the sound to get coupled back into the microphone. They both work well, but are somewhat restricting. Most people would much prefer to use their normal speakers and microphone instead. This is especially true if you want to have the whole family listen in during the conversation. So, if you use the application in the vox-mode with your speakers and microphone, you will soon see the effects of echo! If you have the volume set low enough or if you place the speakers far enough away from the microphone so the sound won't activate the vox, you can probably get by. It's a fine line at this point. Our solution is a device we call the *EchoBuster*. As the name implies, it fixes the echo problem by muting the microphone when there's audio coming out of the speakers. Refer to the EchoBuster section for more details on how to build your own.

Walk And Talk. OK, so now we've dealt with the basic problem of echo, but what if you'd like to get up and move to your easy chair during a conversation? If your easy chair is in the same room, all you do is turn up the volume a bit, get an extension cable for the microphone, and you're in business. If your easy chair is in a different room however, or you'd like to chat from the patio, you need to re-think it.

This is where the *iPatcher Internet Telephone Adapter* comes in. It does two basic things for your Internet Telephone experience. First, it deals with the echo problem by incorporating the echo-busting feature mentioned earlier, plus it lets you connect a dedicated telephone to your computer sound card. By "dedicated" we mean

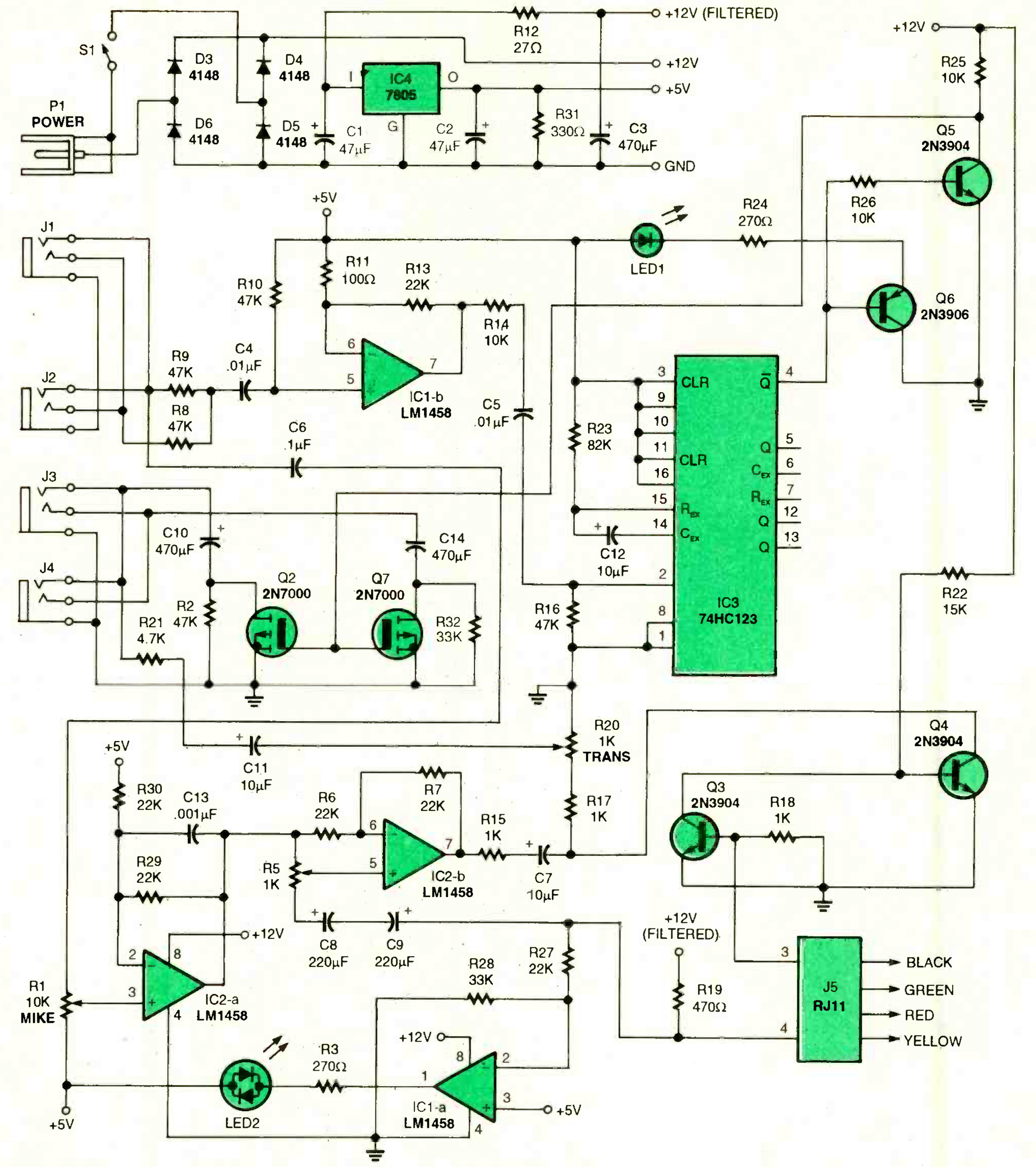


Fig. 3. This is the schematic for the iPatcher circuit. Notice the four-diode voltage-blocking circuit leading to voltage regulator IC4. A careful eye can see the EchoBuster circuitry is nested within the iPatcher.

that the phone will work only with the iPatcher and should NOT be connected to the regular telephone network. Note that this can be a cordless telephone that will allow you to roam around once the call is established. The reason we specify the phone must be dedicated to the iPatcher is because the FCC Rules (Part 68) require certification of ANY device connected to the dial network. This certification can cost upwards of three to five thousand dollars—a sum we simply can't afford, hence, the disclaimer. If you want to use the phone on a regular phone line, simply unplug it from the iPatcher and plug it into your regular phone line receptacle (RJ-11 jack).

You can use a standard wired telephone with the iPatcher, as well as a cordless. Let's say you like talking to folks from one particular easy chair. It's convenient and familiar. So, you simply run a line from the iPatcher to your easy chair and connect up one of those cheap, corded telephones from RadioShack (part number 43-908). You

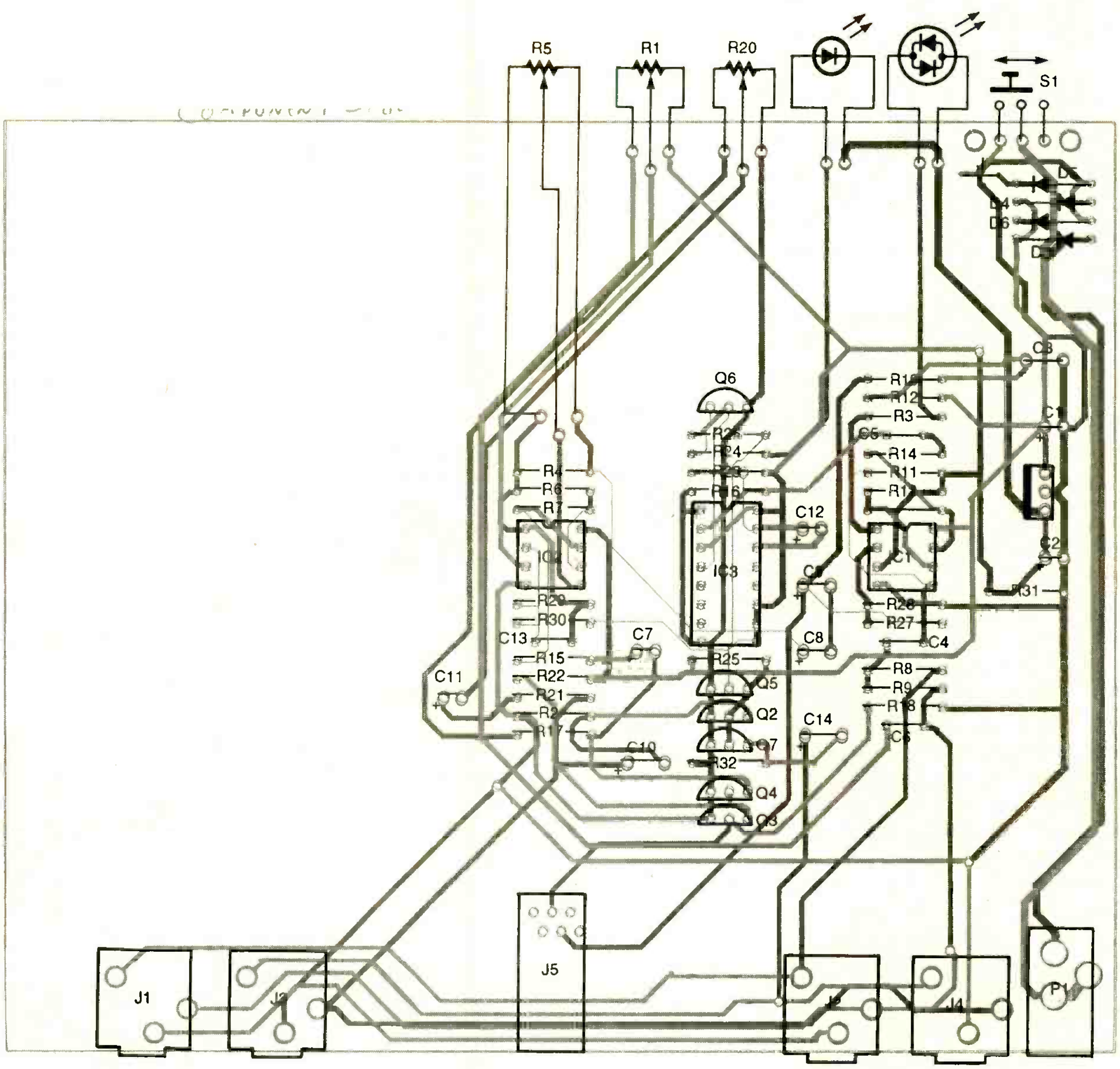


Fig. 4. Here is the parts placement for the iPatcher. Connector J5 is a standard RJ11 telephone jack.

must first establish the call from your computer, but once you've got them on line, simply say, "I'm going to my easy chair," and continue talking from there. Don't forget to hang up the call on your computer when you're finished.

As a side benefit, the iPatcher brings the speaker/mike jacks out from behind your computer to give you easy access for changing external speakers and microphones. Plug standard-patch cables into the sound card once and forget it. Sorry, that does mean bending over your computer one last time with a flashlight to make the initial connections, but you are home-free after that. Refer to the iPatcher section for details on how to build your own.

EchoBuster Theory Of Operation. The EchoBuster achieves echo suppression by detecting audio on either the left or right speaker leads and then shunts the microphone signal to ground. To avoid chopping, due to audio peaks, a one-shot timer IC3-a (R23 and C12 determine the hold-off time) maintains this shunt for about 0.8 seconds after the last detected audio peak.

The regulator (IC2) and associated parts deliver a highly filtered 12 volts (+12 on the schematic) and 5 volts for the EchoBuster's electronics (see Fig. 1). The loop-through jacks (J1 and J2) couple the audio into an amplifier IC1b that amplifies the signal level to a point where the triggering level of the one-shot timer, IC3, can occur. When the one-shot triggers, yellow LED1 illuminates, and amplifier Q5 drives the gates of the N-channel MOSFET microphone-shunting transistors Q2 and Q7. When the gates become high, the source-to-drain resistance of Q2 and Q7 becomes very low, which shunts the AC microphone signal at J3 and J4 to ground. Thus, received audio removes the microphone's signal and the echo caused by it. When the one-shot timer is not triggered, Q2 and Q7 look like an open circuit to the microphone signal.

Keep in mind that you should be using a stereo microphone plug with the EchoBuster. If you use a

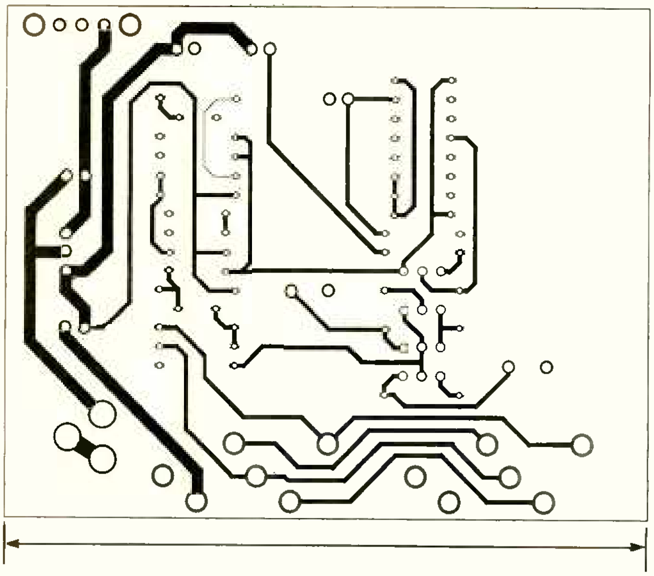


Fig. 5. This is a solder trace diagram for the EchoBuster's "solder side."

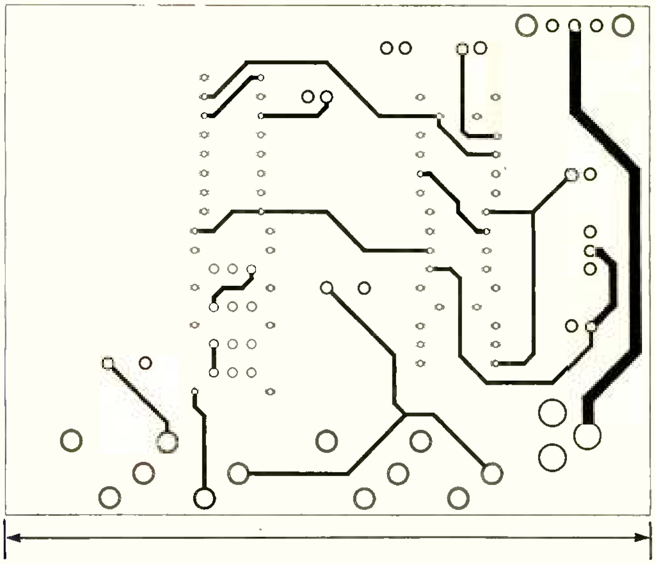


Fig. 6. This solder trace diagram shows the trace on the component side of the EchoBuster.

microphone with a mono jack on it, it will short the whole microphone circuitry to ground due to the way it is configured. A stereo plug has three contacts (tip, ring, and sleeve), while a mono plug has just the tip and sleeve contacts.

EchoBuster Construction. The parts layout for the EchoBuster is not critical. You can use standard perf board to build your own or you can order a printed circuit board from our Web page. Either way, use normal soldering and construction techniques to insure you have the proper components installed and that there are no solder bridges or wiring overlaps. Refer to Fig. 1 and Fig. 2 to insure you have everything laid out properly. If you want to make your PC boards for this project, you can download the plot files for the top and bottom of the board. The top is at *www.jechtech.com/echo-top.pdf*, and the bottom is *at www.jechtech.com/echo-bottom.pdf*. Figures 5 and 6 are the foil patterns for the solder side and component side, respectively. You can get the Acrobat Reader 5 for free from *http://www.adobe.com/products/acrobat/readstep2.html.*

Once you have the unit wired, you should do some preliminary testing. Plug in the AC adaptor (12 V_{DC} at 200 mA). Switch the power switch to the "ON" position. The green power LED should come on, and you may or may not see the yellow (Mute) LED flash on power-up. Measure the input voltage at pin 1 of Q1 to make sure it falls in the range of between +12–18-volts DC as measured to ground. Now, check the output of the regulator Q1 to make sure it is +5 V_{DC} as measured to ground.

Speakers. Make sure the jacks are firmly plugged into their respective jacks, since it will not work properly if they are not fully seated. Again, make sure your microphone has a stereo-type jack (tip, ring, and sleeve) and NOT a mono (tip and sleeve only) jack. Now, run your Internet Talk Application for further testing. First, observe the yellow (Mute) LED. It should light when there is audio coming out of your speakers. If it doesn't light up, then increase the level of the audio coming out of the sound card by going to your Playback mixer-control panel and moving the slider up. We are assuming you are using amplified speakers, which have a volume control on them as well. So, in order to keep the volume at a comfortable level, you may have to turn the speaker volume down to compensate for the increased input level.

If the yellow LED stays on either all the time or nearly all the time, then you should back the sound card output down. What we're looking for is the light to come on

PARTS LIST FOR THE ECHOBUSTER

SEMICONDUCTORS

IC1—LM1458 dual op-amp
IC2—7805 voltage regulator
IC3—74HC123 dual op-amp
LED1—Light-emitting diode, yellow
LED2—Light-emitting diode, green
Q2, Q7—2N7000 FET
Q5—2N3904 NPN transistor
Q6—2N3906 PNP transistor

RESISTORS

(All resistors are ¼-watt, 5% carbon-film units.)
R2, R8–10, R16, R27—47,000 ohms
R11—100 ohms
R13—22,000 ohms
R14—10,000 ohms
R23—82,000 ohms
R24, R31—270 ohms
R25, R26—10,000 ohms

CAPACITORS

C1, C2—47 µF, electrolytic
C4, C5—.01 µF
C10, C11—470 µF
C12—10 µF, electrolytic

ADDITIONAL PARTS AND MATERIALS

J1–J4—¼-inch stereo jack (Mouser 1613507)
S1—Power switch (Digi-Key EG1917)
Power pack (12 VDC/200 mA); two (2) interconnect cables ¼-inch stereo on each end; case with front and rear panels

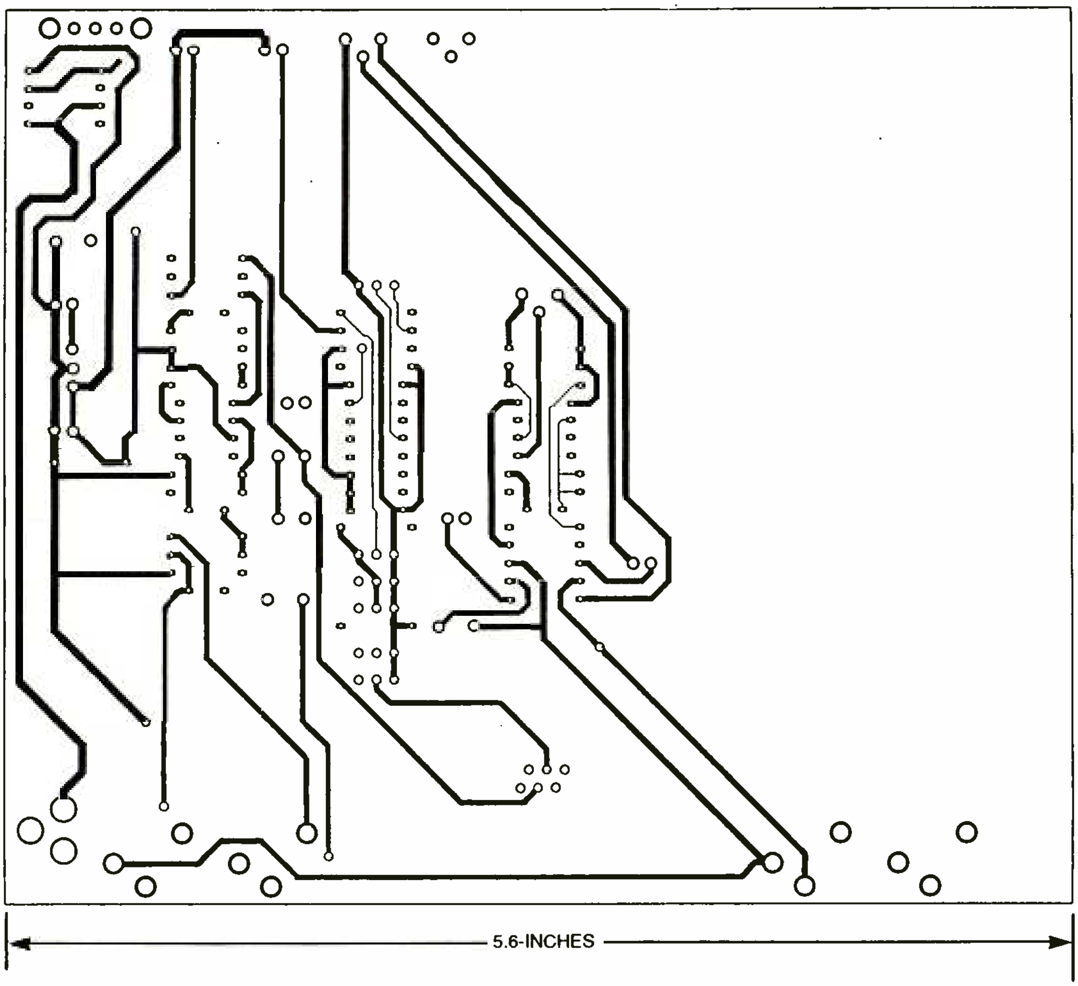


Fig. 7. The iPatcher's "solder side" trace is shown above.

only when there is audio coming out of the speakers. It should go out when there is no audio there. You should be able to reach a good compromise between the sound card output level and a comfortable listening level using these two level controls.

Now you need to configure the microphone using the Record Control Panel of Windows. Double-click on the small, yellow speaker icon in your task bar at the bottom of your screen. This should bring up the Play Control Panel with the various audio controls. Make sure there is a check mark in the MUTE box at the bottom of the microphone control. Without a check mark in this box, any audio going into the microphone will automatically come out of the speakers like a karaoke machine, and that is not what we want to happen. Set the microphone level slider up to about 75% of full scale.

While you're there, click on the Advance button of the microphone and make sure there is a check mark in the Mike Boost (20 db) box.

If you don't have the small, yellow speaker icon on your task bar, you can find the control panel by going to the Windows START function in the task bar (lower-left side of the screen).

If you are still unable to find it, consult your sound card documentation to find out how to access these controls.

When the yellow (Mute) LED is on, that means the microphone is being effectively shut off so that it can not pick up the audio and send it back down the microphone lead to your sound card which ends the echo problem. Keep in mind that while the Mute light is on anything you say into the microphone will NOT be sent out since it is muted. It won't take long to get the hang of it, and using the EchoBuster will become second nature to you.

iPatcher Theory Of Operation. The iPatcher achieves echo suppression by detecting audio on either the left or right speaker leads and then shunts the microphone signal to ground. To avoid chopping, due to audio peaks, a one-shot timer (R23 and C12 determine the hold-off time) maintains this shunt for about 0.8 seconds after the last detected audio peak.

In Fig. 3, diodes D3–D6 form a polarity-guard circuit, which enables the use of any polarity 12-V_{DC} supply. The regulator and associated parts deliver a highly filtered 12 volts (12V filtered on the schematic), and 12 volts and 5 volts for the iPatcher's electronics.

Speaker lead audio is coupled by loop-through jacks J1 and J2 into an amplifier IC1-b that amplifies the signal level to a point where the triggering level of the one-shot timer, Q3, can occur. When the one-shot triggers, yellow LED1 illuminates, and amplifier Q4 drives the

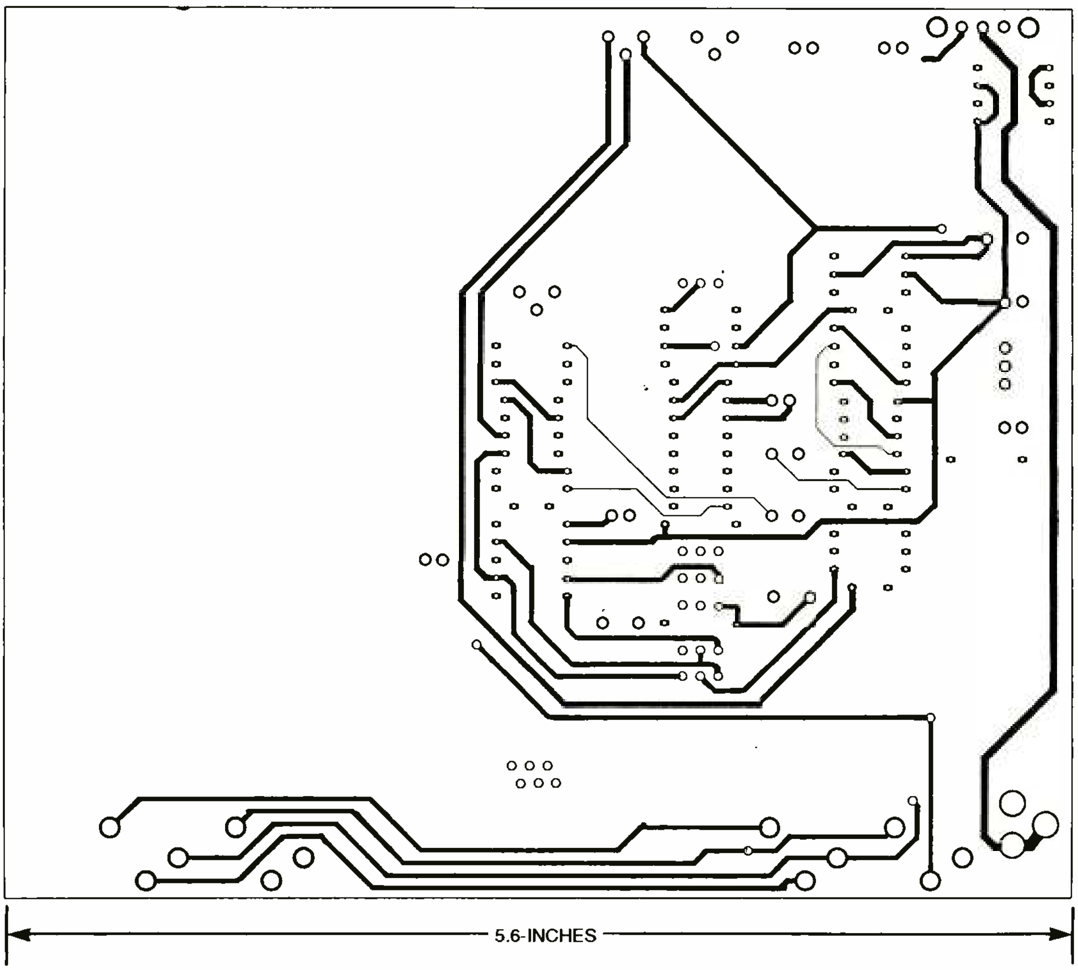


Fig. 8. This is the component side solder trace for the iPatcher.

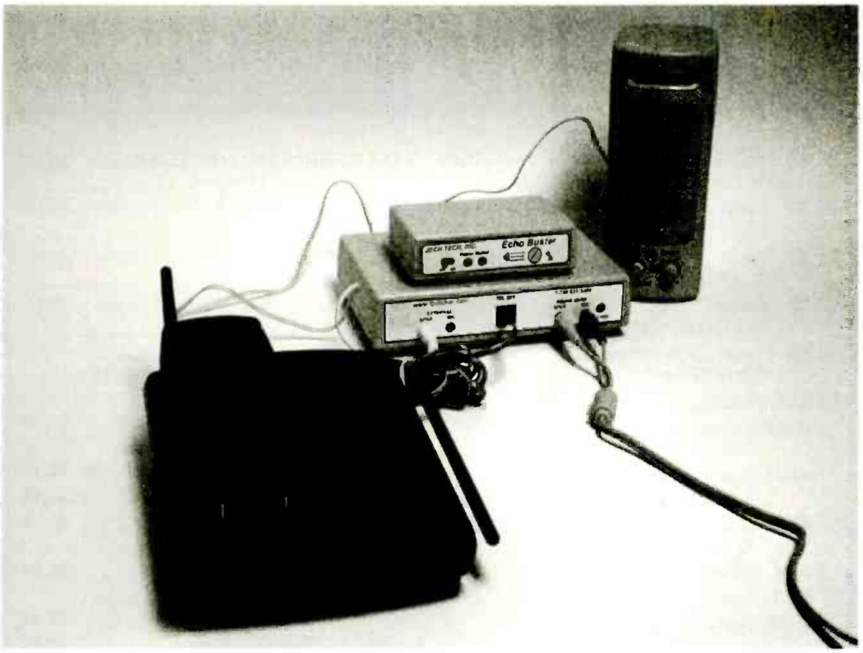
gates of the N-channel MOSFET microphone shunting transistors Q2 and Q7. When the gates become high, the source-to-drain resistance of Q2 and Q7 becomes very low, which shunts the AC microphone signal at J3 and J4 to ground. Thus, received audio removes the microphone's signal and the echo caused by it. When the one-shot timer is not triggered, Q2 and Q7 look like an open circuit to the microphone signal.

Audio from the speakers is sent to the telephone, J5, an RJ-11 jack, through volume control pot R1, amplifier IC2-a, and to the telephone earpiece via C8 and C9. Resistor R19 provides loop current, and comparator IC1-a provides on-hook and off-hook indications for tri-color LED2. The speaker signal is also applied to a hybrid IC2-b that attenuates this signal by about 30 dB. Note that this attenuation is in the path to the sound card's microphone input, J3 and J4. Resistor R5 is adjusted so that the output of the hybrid (IC2-b, pin 7) is minimized for speaker lead audio. Applying a 1-kHz sine wave to J1 or J2 and adjusting R5 until the AC signal at pin 7 is minimum can make the adjustment. This effectively reduces echo before the one-shot timer's trigger level is reached.

The telephone mouthpiece signal goes through C8 and C9 and through (without attenuation) the hybrid. Adjustment R20 sets the transmit level to the sound card's microphone input. When the phone is off the hook, telephone loop current flows through R19, through the telephone, and then through the base-emitter junction of Q3. Transistor Q3's collector is low, which cuts off Q4. Contrarily, when the phone is on the hook, Q3 is off and Q4's base-emitter junction is forward biased by R22. This causes Q4 to stop any speaker audio from reaching the mike leads.

iPatcher Construction. Figure 3 shows the schematic of the iPatcher, and Fig. 4 is the iPatcher parts layout. If you are going to use breadboard, you can place the components wherever it's convenient, since parts placement is not critical. If you want to save yourself those headaches, you can order a bare printed circuit board from our Web site. Observe all of the standard construction practices and check your work for solder bridges before applying power. If you want to make your own PC boards, the plot files for the iPatcher are available at *www.jechtech.com/ipatcher-top.pdf* and *www.jechtech.com/ipatcher-bottom.pdf*. Figures 7 and 8 are foil patterns for the solder side and component side, respectively. You can get the Acrobat Reader 5 for free from *http://www.adobe.com/products/acrobat/readstep2.html.*

Testing Your Completed iPatcher. Plug the 12-volt DC power pack into the power jack on the rear of the iPatcher. The red MODE LED



The EchoBuster and iPatcher are shown above. A cordless phone is attached to J5 of the iPatcher.

should light with the power switch set to the ON position. The yellow (MUTE) LED may flash briefly on power up. Measure the voltage from pin 1 to ground of the 7805 (IC4) to insure it is between 12-18-volts. Then, check the voltage on pin 3 of Q1 to insure that it is 5 volts. If you don't get these voltages, then you must determine what the problem is before proceeding. It could be due to a defective regulator (7805), solder bridges between the foil tracings, or a defective power pack. Once these voltages appear to be within range, you're ready to move on to the next phase.

Using The iPatcher. Hook the iPatcher up to your phone and PC's soundcard. Make sure all of the plugs are firmly seated into their respective jacks. Also, make sure the plug on the external microphone you are using is a stereo plug (tip, ring, and sleeve) and not a mono plug with just the tip and sleeve. If you use a microphone with a mono jack, it shorts out the microphone completely, due to the way the jacks are wired. Now set R5 (the on-board potentiometer) to mid-range.

With everything set up, run any application that outputs audio to the speakers. This can be a music CD or a .wav file playing on the Windows Recorder. The yellow LED should light up when there is audio coming out of the speakers. Start and stop the audio to see if the LED turns on and off with the audio on and off. If not, you need to troubleshoot the circuitry of IC1-b (LM1458) and IC3 (74123A), along with Q5 and Q6, to determine what the problem is. Pick up the telephone and see if you hear the audio there. Now adjust the RECV pot on the front of the iPatcher for a comfortable level in the telephone set.

Most of you will be using amplified external speakers and you can adjust the output level using the gain controls on the speakers. Keep in mind that there is also a

PARTS LIST FOR THE iPATCHER

SEMICONDUCTORS

IC1, IC2—LM1458, dual op-amp
IC3—74HC123, dual retriggerable monostable multivibrator
IC4—7805, voltage regulator
LED1—Light-emitting diode, yellow
LED2—Light-emitting diode, tri-colored
D3-D6—1N4148 silicon diode
Q2, Q7—2N7000 FET
Q3-Q5—2N3904 NPN Transistor
Q6—2N3906 PNP Transistor

RESISTORS

(All resistors are ¼-watt, 5% carbon-film units, unless otherwise noted.)
R1—10,000-ohms potentiometer (Mouser 323-409-10K)
R2, R8-R10, R16—47,000 ohms
R3—220 ohms
R4—Not Used
R5—1000-ohms potentiometer (Digi-Key DJA13CT-ND)
R6, R7—22,000 ohms
R11—100 ohms
R12—27 ohms
R13, R27, R29, R30—22,000 ohms
R14, R25, R26—10,000 ohms
R15, R17, R18—1000 ohms
R19—470 ohms
R20—1000-ohms potentiometer (Mouser 323-409V-1K)
R21—4700 ohms
R22—15,000 ohms
R23—82,000 ohms
R24—270 ohms
R28, R32—33,000 ohms
R31—330 ohms

CAPACITORS

C1, C2—47 µF, electrolytic
C3—470 µF, electrolytic
C4, C5—.01 µF
C6—.1 µF
C7—10 µF, electrolytic
C8, C9—220 µF, electrolytic
C10, C14—470 µF, electrolytic
C11, C12—10 µF, electrolytic
C13—.001 µF

ADDITIONAL PARTS AND MATERIALS

J1-J4—¼-inch stereo jack (Mouser 1613507)
J5—RJ-11 phone jack
P1—Coaxial jack (Digi-Key CP-002A)
S1—Power switch (Digi-Key EG1917)
Power pack (12 VDC/200 mA); two (2) interconnect cables; ¼-inch stereo on each end; case with front and rear panels

Note: Printed circuit boards, complete kits, and assembled and tested units are available on our Web site at *www.ipatcher.com.* You can call us at 800-631-0349 to place a credit card order.
JECH TECH, INC., Attn: iPatcher, 13962 Olde Post Road, Pickerington, OH 43147

level control on the sound card, which can affect output levels as well, and that these two controls (sound card and speaker) work independently of one another. The RECV control on the iPatcher only affects the audio level in the telephone ear-piece.

You are now ready to run whatever Voice over the Internet application you want to use the iPatcher with. I will use DialPad as an example, keeping in mind that this applies to any application you're using. Set the SEND pot on the front of the iPatcher to mid-range. Place a test call to someone as you normally would. Once the party answers, pick up the phone and talk normally. Watch the yellow LED to make sure it comes on when the other party is talking. If it doesn't light, you probably need to increase the level of the audio coming out of the sound card. If it comes on and stays on, you need to reduce the incoming audio level. Click once on the yellow speaker icon in your task bar and move the slider up or down to get the desired level.

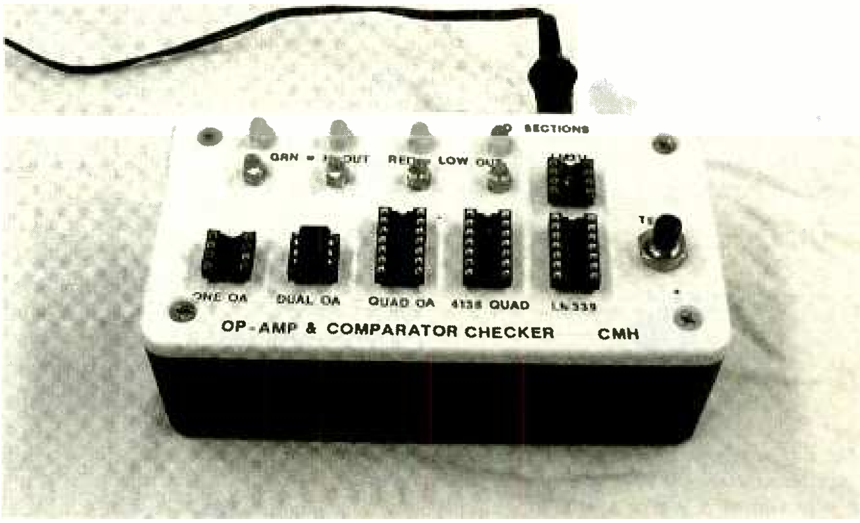
If the person you called can't hear you, turn the SEND control on the iPatcher clockwise to increase the level. You may have to increase the microphone level on the Play Control Panel from 75% to full scale to achieve the proper level.

That completes the setup, and you're ready to start enjoying your Internet conversations with the freedom to roam around while talking. P

Op-Amp and Comparator Checker

CHARLES HANSEN

Weed out faulty chips before they fail.



Introduction. This project allows you to take advantage of surplus circuit board and IC grab bag bargains. It will perform a quick and highly reliable test for the majority of single, dual, and quad op-amps as well as for the LM339 and LM311 comparators.

The *Op-Amp and Comparator IC Checker* described here tests industry-standard single, dual and quad op-amps, as well as quad op-amps with the RC4136 pinout arrangement (RC4136, TL075, OP-09). It also has provisions for testing the LM311 comparator and the LM339 quad comparator. It will not, as presently designed, test dual 14-pin op-amps like the 747, transconductance op-amps such as the CA3080, or Norton current feedback op-amps such as the LM3900 and CA3401. These could easily be accommodated by adding additional suitably connected test sockets, however.

How it Works. As shown in the schematic diagram (Fig. 1), power for the Checker is supplied to power jack J1 by a 9-V_{AC}, 500-mA AC plug-in power adapter. I recycled an adapter from a non-working video game, but the adapter in the parts list is an equivalent.

Since there is no on-off switch provided, be sure to unplug the AC adapter power supply before removing or installing an IC for test and wait until the LEDs go out. Alternatively, you can add a DPDT power switch to the checker, between capacitors C1 and C2 and the test sockets. The 9-V_{AC} adapter is dual half-wave rectified by D1 and D2 to provide a ±12-V_{DC} dual supply for the Checker circuitry. Capacitors C1 through C4 filter the DC supply.

The operation of the Checker can be described by means of an op-amp plugged into the single op-amp test socket, SO1. The schematic for this op-amp is shown in Fig. 2. The Checker operates by performing an open-loop test with each op-amp connected as a comparator. The +12-V_{DC} supply will be applied to pin 7 and the –12-V_{DC} supply will be applied to pin 4. Inverting-input pin 2 is grounded. The non-inverting input test signal is derived from a voltage divider consisting of R1, R2, and R3, which provides approximately –1 V_{DC} at pin 3. The C5 capacitor provides filtering for the input test signal to remove power-supply ripple.

Output pin 6 is connected to anti-parallel-connected red and green light-emitting diodes LED1 and LED2, in series with current-limiting resistor R4. If the op-amp is working properly, the –1-V_{DC} input voltage at pin 3 will drive output pin 6 to –12 V_{DC}, causing red LED1 to conduct.

Pressing switch S1 will remove the short across R3, changing the divider ratio so that approximately +1 V_{DC} appears at pin 3. The positive voltage at pin 3 now drives output pin 6 to +12 V_{DC}, causing red LED1 to go out and green LED2 to conduct. If this does not occur, it is highly likely that the IC under test is faulty.

The test method for the dual and quad op-amps is the same, except additional input and output connections are wired to these sockets. Depending on how many op-amp sections are contained in the IC under test, one to four LED pairs will be active in the test. The schematics for dual and quad op-

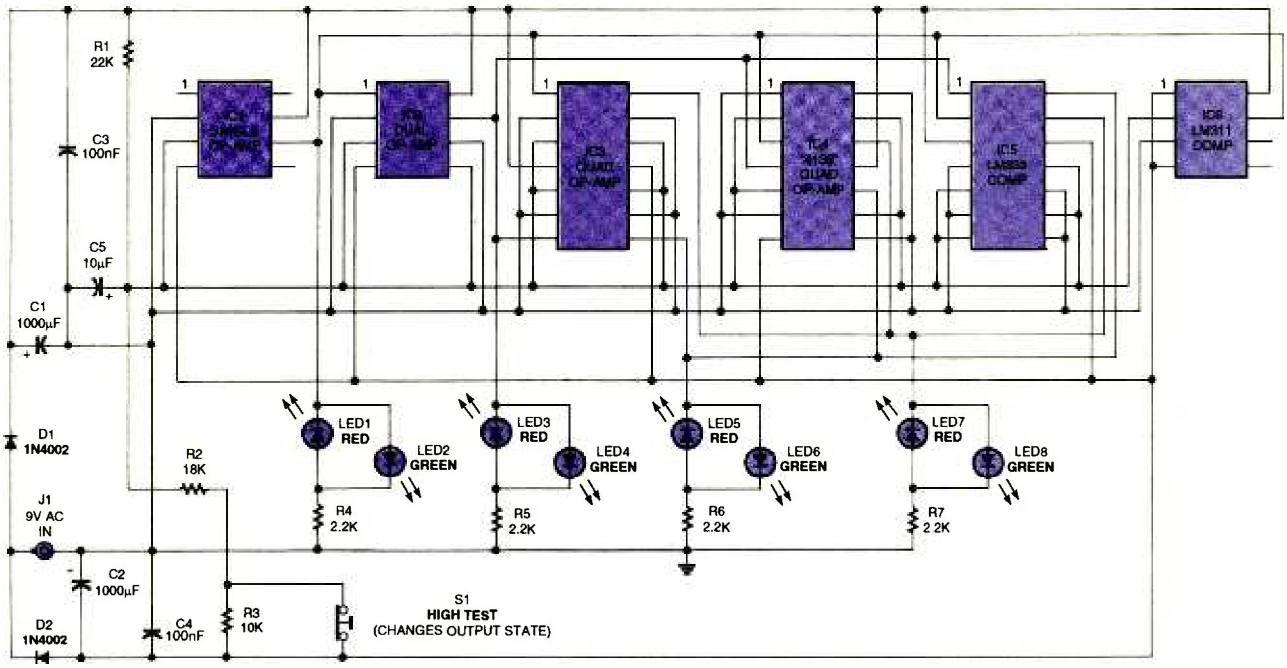


Fig. 1. The schematic above is for the Op-Amp and Comparator Checker. The only ICs required will be the units under test. Eight LEDs are used as visual indicators.

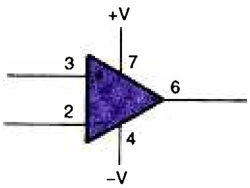


Fig. 2. Here is a basic schematic for an op-amp chip. Notice there are two voltage inputs; one positive and one negative.

amp connections for sockets SO2 through SO4 are shown in Figs. 3 to 5.

The test for comparators is simpler. The NPN open-collector output stage of the LM339 can only sink current. There is no active output source capability to drive the green LEDs. The output stage of the LM311 can be connected to either sink or source current, but SO6 is connected in the sink configuration in the Checker for consistent operation of the red LEDs. Since the comparators will only sink current, the red LEDs will initially be illuminated and will go out when the TEST switch is pressed. The schematics for comparator sockets SO5 and SO6 are shown in Figs. 6 and 7.

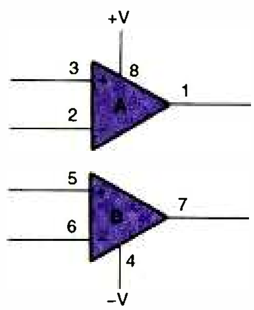


Fig. 3. Here is a basic dual op-amp. One amp works on a negative supply voltage, while the other amp runs on a positive supply voltage.

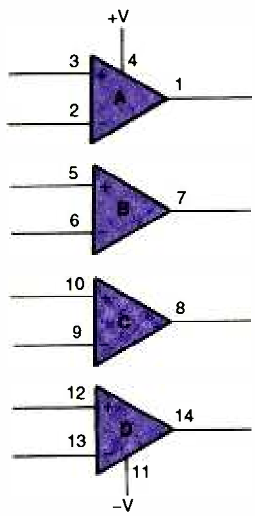


Fig. 4. A quad op-amp is shown above. Each pair shares one supply voltage.

The input test voltage is kept to ±1 V_{DC} to prevent any latch-up of FET-input op-amps and to ensure the IC under test is indeed providing voltage gain as evidenced by LED illumination. The high-gain open-loop test method will allow testing of op-amps such as the NE5534, which are not unity-gain stable.

Construction. The IC test sockets and the LEDs are mounted on the project enclosure cover and interconnected by wire-wrap. Switch S1 is also mounted on the cover. An enclosure must be selected with sufficient room for the perf board or PC board and chassis-mounted

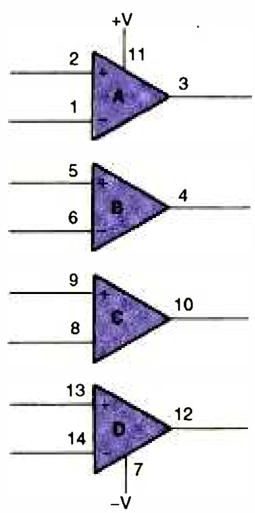


Fig. 5. Here are the pin-outs for RC4136, TL075, and OP-09 style op-amps. The configuration is similar to standard op-amps, but the pin numbers differ.

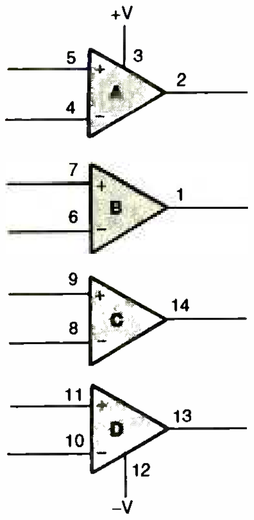


Fig. 6. The schematic above shows the pin-outs for an LM339 comparator. Note its similarity to a quad op-amp.

components. There must be enough depth available for the IC socket leads in the cover to clear the circuit board in the base of the enclosure. A 2½- × 4¾- × 1¾-inch enclosure was used for the prototype, and any excess length on the socket leads was clipped off after wiring was completed.

A 0.1-inch grid perf board was clamped to the cover and used as a drilling template for the sockets and LED leads. A number 58 twist drill (0.042-inch diameter) is required to drill the holes in the cover. After painting and lettering the cover, the sockets were installed and held securely in place with a drop of hot glue.

The power-supply board in the prototype was built on a wire-wrapped perf board, but a PC-board layout is also provided in Fig. 8. The circuit layout is not critical. Figure 9 shows the parts layout and wiring to parts located off the PC board.

In keeping with good assembly practice, install the least sensitive parts first, followed by the more sensitive parts. All four PC-board mounting holes have sufficient clearance for a 4-40 screw with flat washer. In the prototype, ⅜- inch plastic spacers were used to mount the power-supply board low in the enclosure near the power jack. The PWB is designed for this same mounting method.

Next, solder in the passive parts (resistors, then capacitors). Finally, install the diodes. Double-check the orientation of the polarized components.

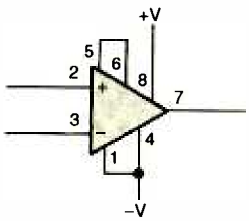


Fig. 7. The LM311 comparator has an output sink built into its design. This device resembles an op-amp with a control loop.

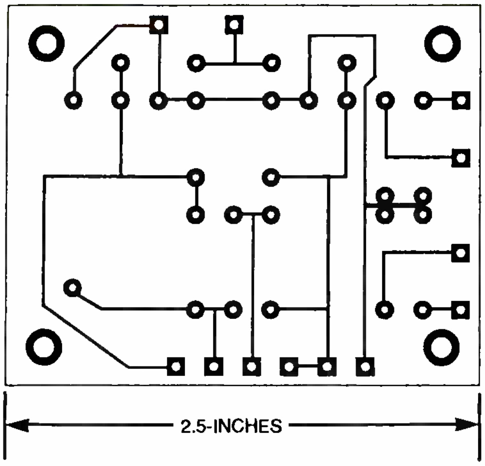


Fig. 8. This simple foil pattern can be used to etch a PCB. As always, the components can be breadboarded or connected via copper hook-up wire.

Testing. After construction, connect the AC power adapter and measure each test socket for proper connection of the +12- and −12-V_{DC} power supplies, which may measure higher with no loading on the power supply. Confirm that −1-V_{DC} test voltage exists at each non-inverting input socket pin. Press S1 and verify that the test voltages change to +1 V_{DC}. Finally, connect each output pin alternately to the -12 and +12 supply voltage and verify that first the red LED lights and then the green LED.

Using the Checker. Unplug the AC adapter power-supply plug and allow several seconds for the power-supply capacitors to discharge before removing or installing an IC for test. **DO NOT INSTALL TWO ICs AT THE SAME TIME.** Since all similar section outputs in each test socket are wired in parallel, there is nothing except the devices internal resistances to limit the current if one device has failed and opposing polarities appear at the parallel-connected outputs.

(Continued on page 61)

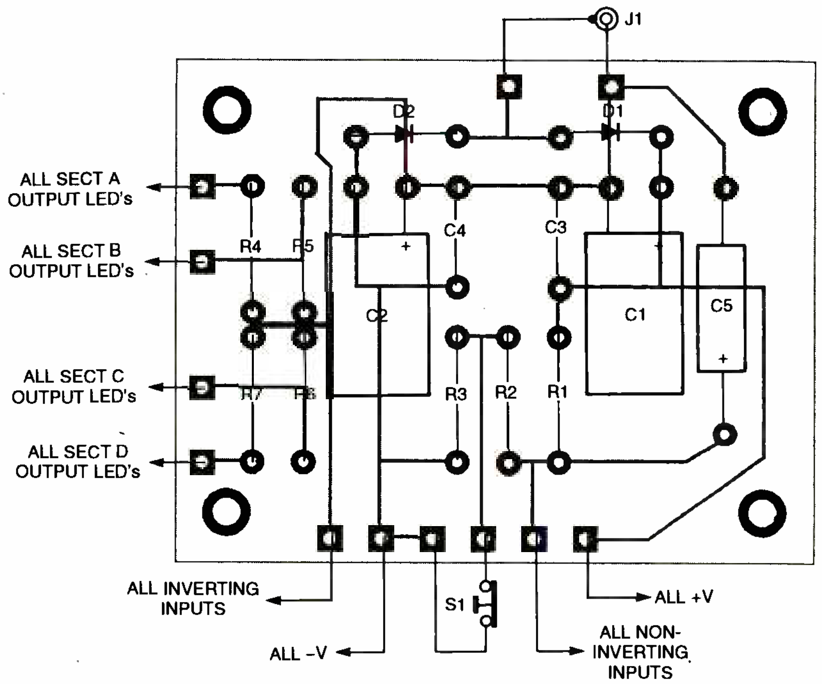


Fig. 9. If a PCB method is adopted, then this parts placement diagram will be useful.

Thanks

The instant I opened up the August 2001 issue, I noticed the same thing that reader Ed King noticed: The bell circuit of Fig. 3 has no clapper. It's missing the ground. I looked back in the copy I sent in, and sure enough, no ground. For some reason, it didn't make it from my "scribble schematic" to the electronic version. The junction of Q1 emitter, C1, and R2 should be grounded, i.e., connected to the negative terminal of the power supply. Thanks for your note, Ed.

Rippling the Caps

Q *In "Q & A," September 2000, there's a statement regarding voltage regulator design that says, "Excessively large ripple levels can burn out a filter capacitor." I would like to know what that means. Does this have to do with peak ripple exceeding the maximum voltage rating of the capacitor?—S. B., via e-mail*

A Let's use a typical half-wave 60-Hz "linear" supply as an example for exploring this area. Suppose that we have a perfect 33-microfarad filter capacitor in our circuit. At 60 Hz, the capacitive reactance, Xc, of the capacitor will be $1/(2\pi fC)$ or about 80-ohms. At first one would say that if the ripple level on this supply was 40 volts, we would have ½ amp of current through the capacitor and that would be 20 watts of power being dissipated by the cap. Now, don't forget that being a perfect cap, this is 20 watts of reactive power; and any power that is apparently "consumed" by the cap is just dumped back into the circuit at a later date, so no power is actually consumed.

No capacitor is perfect. Capacitors tend to have a very high resistance in parallel with that capacitance, which we call leakage. Also, there is a small inductance in series with the capacitance that is caused by the leads; as well as, a small series resistance made up of the leads and plate material, which we call effective series resistance (ESR). Therefore, an ideal capacitor has infinite leakage resistance, zero inductance, and zero ESR. Some capacitor types are better than others when it comes to perfecting these individual characteristics.

A problem can occur if the cap develops (or initially has) a high ESR—a quantity that we normally want to be as low as possible. If the ESR increases to 10 ohms, we'll effectively have 10 ohms plus the Xc of 80 ohms in series, which is about 90 ohms total resistance. This will allow a current of about 440 milliamps to flow through that series resistance and being resistive, it will dissipate about 2 watts in the form of heat. Two watts of heat in a little bitty 33-microfarad, 63-volt capacitor could heat it up and cause it to vent or even burst. By the way, I know that I was very liberal by simply adding the Xc and ESR together to arrive at a total resistance. In reality that would be incorrect, but for illustration, it gives us a figure that's close enough without presenting a course in RC circuits.

On-Site Education

Q *Now that I've seen the other general electronics forums on the Internet, are there any educational sites out there where one can learn electronics?—D. S., Marion, VA*

A Strangely enough, here I am an electronics instructor and I've never researched that topic. I suppose that's because I don't allow unilateral student access to the Internet in the classroom. I've found that the legal liability to which I'm exposed in this day and age of litigation more than offsets the benefits that it would provide.

I have run across a few sites that may be of help to you. Howard Sharp's Twisted-Pair site has a few tutorials (*www.twysted-pair.com*), as does Ian Purdie's (*www.electronics-tutorials.com*).

A couple of schools have some curriculum "on the air." Hazelwood School (Missouri) has a science department section (*www.hazelwood.k12.mo.us/~grichert/sciweb/applets.html*) and Sault College of Applied Arts and Technology has an engineering site that is under development. There, only three subjects in digital-logic systems are active at this time (*http://scorpion.saultc.on.ca/faculty/~ed/ELN115main.htm*).

Although it's not a tutorial *per se*, you can download a crippled Karnaugh map program at *http://puz.com/sw/karnaugh* and find a wire table at *www.drzyzgula.org/bob/text/fr.tom/awg.txt*.

The various electronics forums offer a lot in the form of questions and answers. Browsing through those can be very educational, although you do have to watch out for erroneous posts which could be misleading. Even my posts aren't always sterling. Those forums were discussed in the "Q & A" column in the July 2001 issue. In addition to those forums, there are several in the Yahoo groups covey:

http://groups.yahoo.com/group/General_Electronics, *http://groups.yahoo.com/group/electronics*, and *http://groups.yahoo.com/group/aus-electronics*.

Also, you can go to *www.yahoogroups.com* and search for "electronics" because there are a lot more forums than those.

As an example of the educational value of a forum, check out our own Gernsback Forum at *www.gernsback.com/HyperNews/get/forums/ElectronicBench.html*. There, thread #3578 has a lot of great information on soldering from guys that have been doing it for a long time.

Decibels and Gain

Q *At an Internet site, I was reading about antenna gain where it said that a 3-decibel (dB) gain is a two-fold increase in power, 6 dB is a four-fold increase, and 9 dB is an eight-fold increase. Suppose that I have a transmitter that has a 5-watt output into a standard dipole antenna. Does that mean that if I feed an antenna with a 6-dB gain, I'll have 20 watts coming out of the antenna?—P.C., New Iberia, LA*

A Well, yes and no. An antenna gets its "gain" by taking as much of the signal as possible and concentrating it in one or more directions. A standard AM clear-channel broadcast station has 50 kilowatts (KW) of power. A station such as KMOX in St. Louis, located such that the audience is distributed evenly in all directions from the station, has a single transmitting tower so that the signal is radiated in an omnidirectional pattern, or a full circle. The 50 KW of power is sent out in all directions. Compare this to station WWL just east of you in New Orleans which has two towers. The phasing of the two towers causes the most signal to be broadcast to the north, just a little bit less to the east and west and very little to the south, since Gulf shrimp and the residents of Coatzacoalcos are not likely to pay any attention to WWL's radio ads. For all practical purposes, WWL's antenna will have some gain by focusing all of the transmitter power through a radiation pattern of only 270 degrees versus all 360 degrees of an omnidirectional pattern.

The gain of an antenna then depends upon eliminating radiation in some directions and concentrating it in others. A half-wave dipole, with radiation in two directions, is usually considered the standard by which other antennas are measured, having a declared gain of 0 dB. A Yagi antenna, using reflectors and directors, tends to reduce emission from the "rear" and "sides" of the antenna and concentrate it to the "front." The more directors (elements in front of the driven element) the Yagi has, the narrower the angle of radiation from the front and the more concentrated that radiation will be at the point to which the antenna is aimed. All of the power going into the antenna is being concentrated in one small area. It's just like comparing a flashlight lamp with no reflector versus one with a reflector. They both put out the same amount of light. It just seems that the lamp is brighter with the reflector because all of the light output is being concentrated in one direction rather than everywhere. A 3-watt lamp appears to have the same brightness as a 12-watt lamp when installed in a flashlight, meaning that the flashlight provides a four-fold increase or a 6-dB gain in light concentration.

Yes and no. Yes, it appears that you are putting out four times more power if the antenna has a 6-dB gain—if you're right in the cross-hairs of the antenna. No, the actual power being radiated is the same because you're eliminating the radiation from the rear and sides of the antenna and simply concentrating that radiation toward the front.

WWL wants to do this to slightly increase their coverage area where their listeners are. An amateur radio operator wants high directivity so that he can punch a lot of signal out to the one person with whom he's communicating without unnecessarily interfering with the communications of others on the same frequency who are located off in a different direction.

Don't forget that the same antenna for transmitting is often used for receiving and in that application, the gain and directivity attributes still apply. In the receive mode, the antenna is "hotter" and rejects signals from directions other than where it is pointed.

As a side note, remember that every time the power is doubled, you get a 3-dB increase. It's interesting that an amateur radio operator can inexpensively double his power from 8 watts to 16 watts, an increase of only 8 watts, and will have a 3-dB gain. If KMOX were legally allowed to double their power to 100KW, an increase of 50KW, it would cost them a lot of money and still be only a 3-dB gain. At a receiver location, if both stations were being received at the same strength, both will have appeared to have increased their signal by an equal amount.

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.

Counter Schematic

Q *I am looking for a schematic or service data for a Fordam 550-Mhz frequency counter. Any help would be appreciated.—J. T., via e-mail*

A I think that the spelling of your "manufacturer" is probably "Fordham," Fordham Radio Supply, 260 Motor Pkwy., Hauppauge NY 11788-5134. After doing a quick search through my manuals sources ("Q & A," February 2001), I did find three Internet manual sites that may have what you need. They all list a counter as "Fordham 550," and it may be your best shot. It appears that it may include service information, but you'll want to verify that with the vendor before you order. Here are the three sites: *www.manualsplus.com*, *www.w7fg.com*, and *www.sarrio.com*. The manual is running around $15–20.

One of the problems with inexpensive items of test equipment is that they are imported somewhere from Asia and then relabeled with the vendor's (e.g. Fordham) brand name. If you look through several catalogs, you begin to see signal generators, counters, and all-in-one test instruments that look like twins, but have different manufacturer names. Usually what you get with one of these is an Operators Manual and no other information. If you're very lucky, there might be a schematic diagram included that would require a microscope to read. Rarely will you find a parts list or a calibration procedure.

Some big-name test equipment manufacturers imported equipment like this for their "pond scum" line of equipment, targeted to less-sophisticated or financially-disenfranchised customers. They all quit doing that when they realized that even they couldn't get support from their Asian suppliers. For those of you contemplating the purchase of new test equipment, let this be a "heads up." You get what you pay for. Yes, that new Asian counter or function generator is dirt cheap, but you may have no help available if it ever needs repair or adjustment.

Sources for Parts

Q *I just got interested in building electronic circuits about a month ago. I've been reading up on everything I can. Do you have any must-reads for the electronic hobbyist beginner? Also, I got the idea to shop at thrift stores and pick up old electronic devices and strip them for parts. Is this worthwhile or are electronic components cheap enough to purchase? If nothing else, I figure it would give me training in soldering and desoldering.—J. H., via e-mail*

A In my nail-biting, cliffhanger July episode of "Q & A," I provided my bibliography and with the books listed in the main sidebar, it should provide a lot of good theory for you. I don't know that tearing apart boards provide that much appropriate practice, even in desoldering, for the object in harvesting components from a board is to save the component. That's just the opposite goal of true desoldering for board repair where you want to save the board. Completely different techniques are used. However, that is a good source for parts and is economical as long as you're considering your time to be free. Rather than buying the salvage material, why not check with television and computer repair shops around town to see if they have any discards that they'd be willing to donate to a beginner?

Salvage is how I've gotten the bulk of my components. Older boards that are just covered with integrated circuits (ICs) look tempting for stocking your parts drawers, but consider that you'll only use but one or two ICs per board and that may be a few years down the line. Liberating ICs from their native homes is difficult enough that you might consider putting an ID number on each board, inventorying all the ICs on each, and recording this in a book. Then store the boards in a box and put it out of the way. When you need an IC, look it up on your record, retrieve the board, remove that one IC, scratch it off your inventory, and put the board back into the archive. You'll save a lot of time that would otherwise be spent desoldering ICs that you'll never use.

Negative Logic

Q *In active-high TTL logic, what voltage represents true and what voltage represents false?—T. B., New Zealand*

A This is a bit of a double-sided question here, so let me approach the answer from two directions. Remember that for the most part, there are only two voltages in a digital or binary system—a low voltage and a high voltage. In general, TTL is what is known as a positive-logic system and the vast majority of today's designs use positive logic. In a positive-logic system, the more-negative-less-positive (which I'll call "lower") voltage represents a logical zero, or LOW, which is often labeled "false." A less-negative-more-positive ("higher") voltage represents a logical one, or HIGH, which is often labeled "true."

B	A	Y
0	0	1
0	1	1
1	0	1
1	1	0

Fig. 1. A 74LS00 NAND gate as conventionally drawn in a data book or most schematics has "active HIGH" inputs.

In TTL, a logical LOW (false) is anything under 0.8 volts and a logical HIGH (true) is anything over 2.0 volts. The domain between 0.8–2 volts is undefined. Some chips will treat a voltage in that undefined window as a HIGH and some won't deal with it at all.

In your question, you use the term "active-high logic." I might add that "active HIGH" means that an input's function (reset, load, or set, etc.) is initiated when the input goes to a logical HIGH. "Active LOW" means that an input's function is initiated when the input goes LOW. For instance, the "parallel load" function of a 74LS193 is active LOW, and the chip will parallel load data when that input goes LOW; on the other hand, the "master reset" input of the 74LS193 is active HIGH, and that chip will reset when that input goes HIGH. On the traditional symbols for logic devices, an active LOW input or output is represented by an inverting "bubble" on the logic line and an active

B	A	Y
0	0	1
0	1	1
1	0	1
1	1	0

Fig. 2. A 74LS00 DeMorgan NAND gate has "active LOW" inputs and has the identical truth table of the NAND gate in Fig. 1 and, in fact, may be one of the gates from the same 74LS00 package.

B		A		Y	
0V	LOW	0V	LOW	5V	HIGH
0V	LOW	5V	HIGH	5V	HIGH
5V	HIGH	0V	LOW	5V	HIGH
5V	HIGH	5V	HIGH	0V	LOW

Fig. 3. A 74LS00 chip operates as a NAND *gate in the positive-logic system for which it was designed.*

HIGH has no inverting bubble.

DeMorgan gate equivalents are the gate representations of this "active HIGH" and "active LOW" designation. A 74LS00 NAND gate, as presented in a standard TTL data book, has the symbol and truth table shown in Fig. 1. The 74LS00 DeMorgan NAND gate and its associated truth table are shown in Fig. 2. Notice that both of these NAND gates may actually be within the same 74LS00 chip. The only difference between the two is how the schematic symbols are drawn and how we perceive their operation.

In the case of the standard NAND gate in Fig. 1, we see that if "A" is HIGH and "B" is HIGH, the output will go LOW. All other input conditions will give you a HIGH. In the case of the DeMorgan NAND of Fig. 2, if "A" is LOW or "B" is LOW, then the output will go HIGH. All other input conditions will give you a LOW. The truth tables are the same.

We look at the traditional NAND gate and see how HIGHs at the input affect the output; we also see that when the inputs are satisfied, the output goes LOW (it has an inverting bubble). We see how LOWs at the inputs affect the output of the DeMorgan NAND gate (the inputs have inverting bubbles); and we also see that when the input conditions are satisfied, the output will go HIGH (it has no inverting bubble). Gates are drawn either way on a schematic to help technicians understand how various logic lines and gates will be affected. Not all schematics will use DeMorgan gates—you'll notice that until this date of publication (which I'm sure will live in infamy in the eyes of the editors), you didn't see a DeMorgan gate in the pages of **Poptronics** or any of its predecessors.

Many people confuse an "active LOW" input with "negative logic." "Active LOW" is not negative logic. Negative logic, which is obviously the opposite of positive logic, is when a logical HIGH is assigned when the output of the logic device is at a more negative voltage, and a logical LOW is when the output goes to a more positive voltage. The 7400-series TTL devices were assigned positive logic action where +5 volts (the more positive voltage) is a HIGH and 0 volts (the more negative level) is a LOW. Had it been assigned the function of negative logic, a LOW would have been +5 volts while a HIGH would have been 0 volts.

However, just to confuse the issue (and this is trivial stuff, so ignore it if you want), the 7400-series can be used in a negative logic system. You keep the normal +5 volts on the Vcc pin and ground on the ground pin (if you reverse those, you'll destroy the chip), but the logic assignments for the gates get switched around. A 7400 positive-logic NAND gate has a NOR function in negative logic; a 7408 positive-logic AND gate has an OR function in negative logic; a 7432 positive-logic OR gate has an AND function in negative logic; a 7402 positive-logic NOR gate has a NAND function in negative logic. XOR in positive logic becomes XNOR in negative logic; XNOR in positive logic becomes XOR in negative logic. Inverters are still inverters and buffers are still buffers in either system. Luckily, negative logic systems are little but history.

Figure 3 shows how a 74LS00 will act if we assign "LOW" and "HIGH" to the logic levels in its normal positive logic system. Figure 4 shows how that same gate will act if we do the same thing in a negative logic system.

As far as using TTL or CMOS logic in a negative logic system, electrical performance will be identical. The choice of using negative or positive logic seems to me to be more of a philosophical decision based upon logical preferences. Negative logic always seemed backward to me, a person who wants "positive," "true," "up," "right," "correct," "logical HIGH," "yes" and "truth-justice-and-the-American-way" to be logical synonyms while "negative," "false," "down," "left," "wrong," "logical LOW," and "anarchy" to be an opposite set of logical synonyms (i.e., the two groups are antonyms).

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.

B		A		Y	
5V	LOW	5V	LOW	0V	HIGH
5V	LOW	0V	HIGH	5V	LOW
0V	HIGH	5V	LOW	5V	LOW
0V	HIGH	0V	HIGH	5V	LOW

Fig. 4. A 74LS00 chip operates as a NOR *gate if it is used in a negative-logic system. It is very important to note that even though the assignment of LOWs and HIGHs are reversed, Vcc and ground connections to the 74LS00 chip remain the same whether in a positive- or negative-logic system.*

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SCOTT M. SAVAGE

Contactless Angular Measurement

Recently, I was building a robot for a competition that needed the ability to go down a hallway without running into the wall. Simple. I walk down hallways every day, and I very rarely run into the wall. However, the robot is effectively blind, which changes things considerably. Just how does one get the robot to *see* when it is parallel to the wall and heading straight down the hallway, versus not parallel and heading for the wall?

After contemplating various methods and considering that the competition penalizes the robots for touching the wall, I decided that the robot would need to detect its angle with respect to a wall without actually touching the wall. This would enable the robot to correct its course while in motion and while staying in the middle of the hallway. If, for some reason, the robot finds itself more than 20 degrees off, it could stop, spin until parallel to the wall, and then resume movement.

The question now was how to get distance detection sensors arranged in such a way that they would be able to detect the angle.

Positioning The Sensors

The first idea I had on positioning the sensors was to place two sensors on my robot, one pointing to the right and one pointing to the left, as shown in Fig. 1. With these in place, the robot can quickly determine if it is in the center of the hall. Using this information, it can determine if it needs to turn right or turn left. This was a fast solution, but it did not detect if the robot was parallel to the wall, which left this problem: If the robot is in the center of the hall, but not parallel to the wall, the robot would make the assumption that it needs to go in a straight line when it really needs to turn.

The next idea was to move the two sensors out in front of the robot. This would detect if the front of the robot

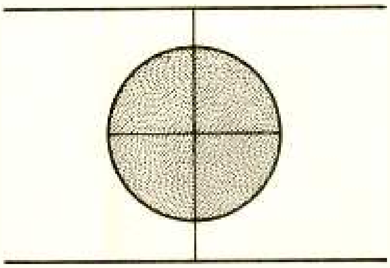


Fig. 1. When the robot is sitting in the middle of the hall, both sides will be the same distance from the wall.

needed to move to the left or to the right. While this appeared to be a better solution, it still left the same problem.

The solution was to place one sensor on the front of the robot facing towards one side and a second one on the back of the robot facing towards the same side. This would detect how far the back of the robot was from the wall and how far the front was from the wall. Using this method, the sensors would provide two different distances if the robot were not parallel to the wall.

As shown in Fig. 2, when the robot is parallel to the wall, both of the sensors return the same reading because they are the same distance from the wall.

However, when the robot is at an angle from the wall as shown in Fig. 3, one of the sensors will return a larger reading than the other.

By using a little trigonometry, the angle between the robot and the wall could be determined. To derive this

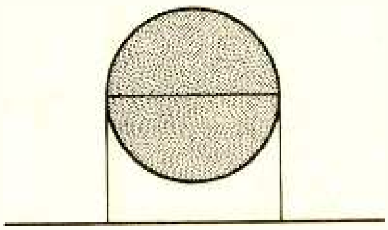


Fig. 2. When the robot is sitting parallel to the wall, both the front and the back are the same distance from the wall.

angle, the ratio of the difference between the two measurements to the walls and the distance between the two sensors are used in an Arctangent calculation—Arctangent(Y/X).

A Quick Lesson In Trigonometry

Arctangent is defined as the angle (A) that corresponds to a specific ratio created by dividing the length of the side opposite the angle (Y) by the length of the side adjacent to the angle (X). An Arctangent diagram is shown in Fig. 4. Arctangent literally means "the Arc (angle) of the Tangent (Ratio)."

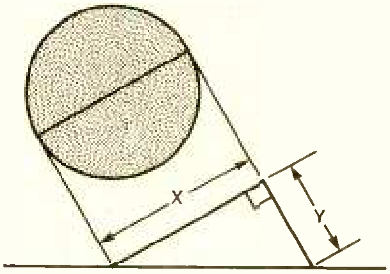


Fig. 3. When the robot is sitting at an angle to the wall, the front and back are different distances from the wall.

A mathematical comparison chart of Arctangent and Sine is shown in Fig. 5. The chart is marked off in 10° ticks, spanning a total of 360°, where the left side is 0° and the right side is 360°. Most of you should already know what a Sine wave looks like and, therefore, should be able to pick out the Sine wave on the chart. However, the Arctangent wave looks totally different. It starts out flat and then decreases sharply, flips to the top of the chart, and then sharply declines back to a flat line.

Notice that that closer to 0°, the flatter the slope on Arctangent is. I already decided that if the robot's course-correction angle is more than 20°, the robot should stop, turn, and then resume. This meant that I only needed a formula for in-motion course correction that was

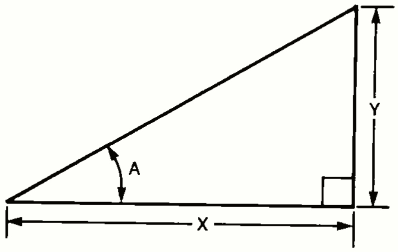


Fig. 4. Arctangent is the angle (A) that corresponds to the ratio of the length (Y) divided by the length (X).

concerned with the first 20° of Arctangent.

Figure 6 shows a zoom-in of the first 20° of the chart shown in Fig. 5. Since the first 20° of Arctangent is so flat, it is possible to substitute a constant value for the Arctangent function altogether.

The ratio that is needed for Arctangent to return 20° is 0.364. To determine the value to use as the constant, the angle of 20° is divided by the ratio, which yields a constant of 55. The actual formula is:

$$20/0.364 = 54.95$$

where 54.95 is rounded to 55. By using 55 as a constant, the formula:

$$\text{Degrees} = 55 * (Y / X)$$

can be substituted for the formula:

$$\text{Degrees} = \text{Arctangent}(Y / X)$$

for angles under 20°.

To verify that the formula with the constant would work in place of the formula with Arctangent, the two formulas were computed with both 20 and 10 degrees:

Arctangent (0.36397) = 20° and (55 * 0.36397) = 20.01835

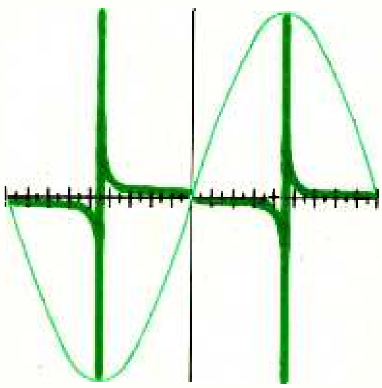


Fig. 5. Arctangent and Sine.

Arctangent (0.17633) = 10° and (55 * 0.17633) = 9.69815

Despite a small error rate, these formulas are essentially equivalent and therefore the formula with the constant can be used.

Using The Sharp GP2D12 Infrared Distance Sensor

Now that we have the formula to use, the next step is to get the numbers into it. The distance sensor I selected was the Sharp GP2D12 Infrared Distance Sensor.

This sensor determines the distance between itself and an item placed in front of it. It has a limited range of 80cm (2.6 feet), but for the requirements of the competition, this would be more than adequate. The sensor reports the distance by returning a non-linear analog voltage that can be read by an analog-to-digital converter. The problem with the non-linear result that it returns is that the ratios will wind up not being correct for the trigonometric calculations. What is needed is a way to make the result linear. The OOPic II shown in the sidebar has a software object called oIRRange, which takes the non-linear reading from the Sharp GP2D12 and converts it into a linear distance reading of 64 steps per foot.

To connect the Sharp GP2D12 to the OOPic, one Analog-to-Digital I/O Line is used as shown in Fig. 7. The OOPic's +5-volt power can be used for one GP2D12. Since two or more will put a strain on the OOPic's voltage regulator, you will need a larger voltage regulator. A capacitor in the value of 4.7μF is placed between the sensor's output voltage and the ground.

To use a Sharp GP2D12 in an OOPic program, the oIRRange Object must be created and configured as shown in Listing 1.

"Dim IR As New oIRRange." This line initializes a new instance of the oIRRange object and names it "IR". This object knows how to read the Sony GP2D12 and convert its result to a distance of 64 steps per foot.

"IR.IOLine = 1." This line instructs the IR object to use I/O line number 1. On an OOPic, I/O line 1 can be found on the 40-Pin connector on pin 7.

"IR.Operate = cvTrue." This line instructs the IR object to start taking readings. Once the object is operating, any time that IR.Value is used anywhere in the program, such as in a formula, the current distance measurement is returned.

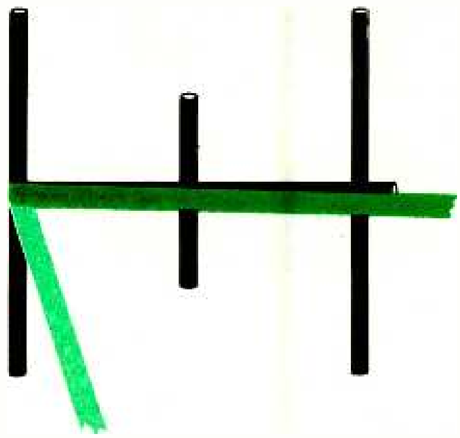


Fig. 6. The first 20° of Arctangent and Sine.

Measuring The Angle

A test jig was made to test the angle of the robot in reference to the adjacent wall. It was constructed using two GP2D12s that were mounted on a strip of wood 10.125 inches apart (see photo).

The distance between the sensors of 10.125 inches was chosen, because my robot was 10 inches in diameter and the GP2D12s were going to be mounted on the outside edges. Since the oIRRange objects return distance in 64 steps per foot, a value that represented the distance between the sensors measured in 64 steps per foot would also be needed to properly calculate the required ratio. The distance between the sensors can be converted by multiplying the distance of 10.125 by (64/12), which calculates the distance between the GP2D12s in 64 steps per foot. The resulting value was 54. Referring back to Fig. 2, the distance between the sensors is the X-value, so 54 is plugged into the formula:

$$[\text{Degrees} = 55 * (Y / X)]$$

which results in a formula of

LISTING 1

```
Dim IR As New oIRRange
Sub main()
  IR.IOLine = 1
  IR.Operate = cvTrue
  ' At this point, any time that IR.Value is read,
  ' it will be the current distance measurement.
End Sub
```

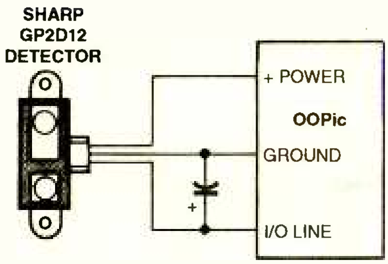


Fig. 7. Hookup diagram for connecting a Sharp GP2D12 to an OOPic.

[Degrees = (55 * (Y / 54))]

This formula can be reduced by dividing 55 by 54. The result of 55/54 is 1.0185, which can be rounded to 1 and plugged back into the formula:

[Degrees = (Y * 1)]

This, of course, can be reduced to a formula of:

[Degrees = Y]

The difference between the two distances obtained from the two oIRRange objects is calculated simply by subtracting the two values. (FrontDistance – BackDistance) This number is the Y-value in the formula. After plugging this in, the formula for determining the angle to the wall works out to be:

[Degrees = FrontDistance – BackDistance]

That sure was a lot of work to come up with a calculation that simple.

Don't assume that this reduced formula will work for all cases. It relies on a coincidental relationship between the two values that are used in the original trigonometric formula. The 1st -value that is required for this coincidence was the 64 steps per foot that the oIRRange object returns. The 2nd was the distance between the sensors of 10.125 inches. If you take the time to work the math back the other way, you will discover that the optimal distance between the sensors is 10.3125 inches; however, this change makes the result only 2 hundredths of a degree more accurate.

LISTING 2

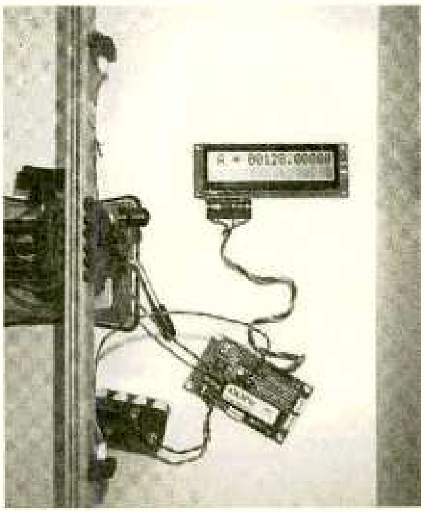
```
' Note: This program uses Version
4.00 of the OOPic compiler.
' Instructions for connecting the LCD
can be found at:
www.oopic.com/lcd.htm.

Dim LCD As New oLCD
Dim FIR As New oIRRange
Dim BIR As New oIRRange

Sub main()
  Call IOSetup
  Do
    LCD.Locate(0,0)
    LCD.String = " A = "
    LCD.String = STR$(128+FIR-BIR)
  Loop
End Sub

Sub IOSetup()
 ' This routine sets the IO lines that are
used.
  LCD.Iogroup = 3    'I/O group used for
nibble out to LCD
  LCD.Nibble = 1
  LCD.IOLineE = 27
  LCD.IOLine.RS = 26
  LCD.Operate = cvTrue
  FIR.IOLine = 1
  FIR.Operate = cvTrue
  BIR.IOLine = 2
  BIR.Operate = cvTrue
End Sub
```

Displaying The Results

To see the calculations in operation, I wrote the program shown in Listing 2 that displayed both positive and negative angles as positive numbers. A value of 128 was added into the formula to make the negative numbers show up as positive numbers, resulting in the following calculation:

[Degrees = 128 + Front Distance – Back Distance]

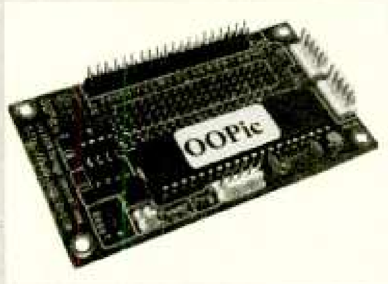
With this calculation, a reading of 128 is now considered parallel to the target.



The test jig configured with 2 Sharp GP2D12s parallel to a wall.

NEW PRODUCT RELEASE

The OOPic has been enhanced to make robotic control easier. The OOPic II has over 30 **new** built-in functions (objects) to control hardware, such as stepper and DC motors; and read sensors, such as IR Distance detectors, compasses, and flame detectors. New objects and enhancements to existing objects have also been made to the OOPic's unique virtual circuit feature. In addition to the



The OOPic II has a large number of robotic sensor software objects, including one that reads the Sharp GP2D12.

objects, a new bank of memory has been added for variable storage space. Like its predecessor, the OOPic II has a multi-tasking operating system and an Object-Oriented language to simplify the task of controlling the hardware in your project. The OOPic II is 100% code-compatible with the original.

Next Month

Next month, we will discuss how to control the motors on the robot in such a way that they correct the robot's course based on the angle. In that article, Magnevation's Dual PWM board will be used to control two DC Motors that will move the robot down the hall.

On the Web

Both the OOPic and the Sharp IR Distance Detector are available from Acroname Robotics at *www.acroname.com.* LCD modules are available from BGMico at *www.bgmicro.com.* More information on the OOPic can be found at: *www.oopic.com.* Information on Magnevation's Dual PWM board can be found at *www. magnevation.com.*

mailto: serviceclinic@gernsback.com

SAM GOLDWASSER

Basics Of High-Voltage Probe Design

BOX: The devices described in this article involves the use of materials and substances that are hazardous to health and life. **DO NOT** attempt to implement or use the information contained in this article unless you are experienced in the construction and safety considerations that apply to high-voltage devices of this nature. Although all possible measures have been taken to ensure the accuracy of the information presented, Gernsback Publications Inc. is not liable for damages or injuries, misinterpretation of directions, or the misapplications of information.

There are all sorts of times when being able to determine the value of a high-voltage DC source is desirable. Most multimeters have a maximum range of 750–1000 volts. (One exception is the workhorse Simpson 260, which has a 5000-volt range). Whether testing a TV with a dim picture, a HeNe laser power supply that does not work quite right, or troubleshooting some home-built, high-voltage project, the ability to measure 10, 20, 30, or more kV can come in handy. This month we deal with the design of simple HV probes that can be used to safely extend the range of either an analog or digital multimeter.

Warning

The microwave oven is perhaps the most dangerous equipment you are likely to encounter around the house. The high-voltage (up to 5000 volts) along with the high-current (1 amp or more) availability make this an instantly lethal combination. It is highly recommended that **NO** measurements be made on a powered microwave oven. Only after the plug has been pulled and its high-voltage capacitor has been safely discharged should you even think about touching or probing anything. Most troubleshooting can be done with an ohmmeter at most. See the document "Troubleshooting and Repair of Microwave Ovens" at my Web site, *www.repairfaq.org*, for more information. By comparison, other consumer electronic equipment, like TVs and monitors, are tame. While still very dangerous, they don't have quite the deadly quality of the microwave oven!

Read the document "Safety Guidelines for High Voltage and/or Line Powered Equipment" at my Web site before attempting to work with high-voltage systems. High voltage can jump amazing distances when you least expect it. The direct or indirect consequences of this can ruin your entire day or a whole lot more.

Basic Considerations

CAUTION: DMMs may not be particularly forgiving of voltages on their inputs exceeding their specifications. Auto-ranging DMMs may be even more likely to blowout as they are selecting the correct range—if there even is one. Depending on your electrical and mechanical components, the chance of excess voltage due to arc-over, leakage, or component breakdown may be a major consideration. My analog VOM has survived many close encounters with HV. You should not assume the same for the typical low-cost or even expensive DMM. There is a reason for the high cost of commercial HV probes—these kinds of factors are incorporated (hopefully) in their design.

A simple high-voltage probe for a DMM or VOM may be constructed from a pair of resistors. This is suitable for DC measurements, but without compensation, will have an unknown AC response due to the very high impedance and stray capacitance forming a filter—low-pass or high-pass depending on the amount of stray capacitance and input capacitance of your meter or scope. However, this simple design is sufficient for the majority of consumer electronics work, which are mostly DC measurements. I have not characterized the AC response of this probe design. However, if there is AC riding on your high voltage, it may mess up your readings if there is no compensation provided as it may act as a high-pass filter.

To design the voltage divider, you must take the input impedance of the meter into account. There is a minor, but significant, difference between DMMs and VOMs.

DMM: Z-in is usually constant, often 10M ohms.

VOM: Z-in is the voltage range (full scale) times the ohms/volt rating of the meter.

Figure 1 shows the basic circuit: R1 together with R2 parallel to R3 form a voltage divider where R3 is the internal-resistance of the DMM or VOM on the scale for which the probe is designed.

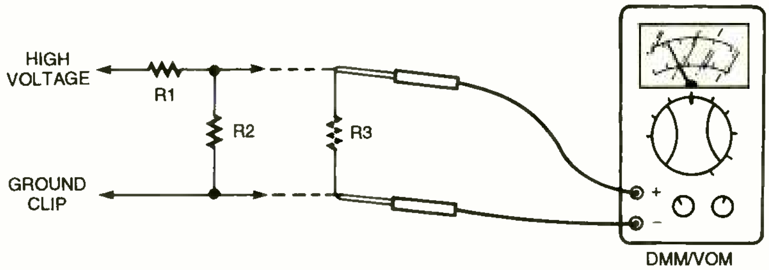


Fig. 1. This is a basic circuit for protecting your multimeter from some high voltages.

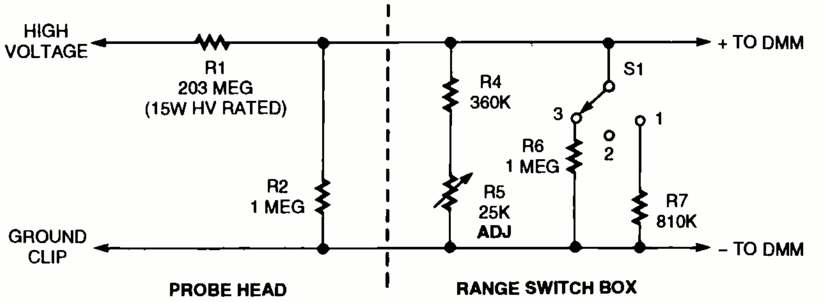


Fig. 2. Here is a home-built HV probe switch selectable to use a VOM or DMM. It is comprised of a probe head circuit and a range switch-box circuit.

While R2 is not strictly needed, it is recommended that it be included and approximately equal to the Z-in of the meter on the scale you will be using. The reason to include R2 is to insure that high voltage can never reach the meter. The ground clip should be securely connected to the metal chassis of the device being tested—the frame of a microwave oven or CRT grounding/mounting strap of a TV or monitor—before it is powered up. Both R1 and R2 should be located in the probe head.

The only difficult part is locating a suitable resistor for R1 that has high enough resistance and is physically long enough so that arc-over is avoided. However, don't expect them to pay much attention to you for an order of five resistors! It may be possible though, to obtain free samples if you explain what you're doing—and their lawyers don't get involved! If this doesn't work out, electronics surplus outfits occasionally come up with odd lots of strange components, such as these, and they even show up on eBay from time to time.

The high-value, high-voltage resistor can also be constructed from several equal lower-value resistors in series if they are all approximately the same size. Another possibility is salvaging the focus-divider networks from dead flybacks or TV/monitor voltage-multiplier assemblies. Even if the unit was discarded as being faulty, where there are no internal shorts in the HV rectifier or resistive network itself, the entire unit can be used intact.

In addition to basic safety precautions when working around high voltages, some form of equipment protection should be considered to provide an arc-over path to ground, should there be arcing over the surface of the resistor as well as if the resistor should somehow decrease in value. There is no telling what can happen under less-than-ideal, damp, or dirty conditions.

A "corona," "arc," or "discharge" ring could be placed around the resistor near the low-voltage end securely connected to the ground cable. The idea is that any arcing over the surface should find this as its destination before obliterating your meter.

A variety of devices could be placed across R2 to limit the maximum voltage present in the event of a breakdown. Suitable devices include neon light bulbs (NE2s without resistors); zener, avalanche, or ordinary diodes; or other semiconductor junction devices. Traditional surge suppressors like MOVs and Tranzorbs may work, but their off-state impedance may be too low compared to R2. The neon bulb is good, since its impedance is essentially infinite until its breakdown of 90 volts or so is reached. In some cases, these devices will be destroyed (semiconductors may short), but they will have served their protective function and are a small price to pay to prevent you and your meter from being blown up.

Frequency Response

Probe compensation similar to that used on oscilloscope probes can be implemented. However, the determination of the capacitor values is beyond the scope of this article. To put it simply, the ratio of the capacitance C1:C2 (where C1 is across R1 and C2 is across R2 parallel to R3) needs to be equal to the ratio of R2 parallel to R3 to R1 (or equivalently, to the inverse of the voltage-divider ratio). Capacitor C2 includes the stray capacitance and input capacitance of the meter or scope probe. The capacitor across R1 would need to sustain the HV, so that is another complication. Since a 10x scope-probe usually has an input impedance of 10M, the same design as used for the DMM would work with a scope. Although I have not pursued this issue, it sounds like based on the ratio (1000:1 would mean that C1 would need to be extremely small, probably smaller than the stray capacitance of the R1 and the associated wire) you would need to add a capacitance for C2 and to make sure that there will be enough stray capacitance such that no physical C1 will be needed.

If you are only interested in DC measurements, putting a 0.1 µF capacitor across R2 should smooth out any 50/60 Hz or higher-frequency ripple.

The implementation of full-probe compensation is left as an exercise for the motivated student.

Here are some simple high-voltage probe design examples.

50,000-Volt Maximum Using A 10-Megohm Z-In DMM

By my rule above, I will select R2 to be 10 megohms. Fine adjustment of calibration could be made by making R2 out of a combination of a fixed resistor and a multiturn pot.

To minimally load the circuit under test, R1 should be as high as practical. Practical here means low enough so that leakage over its surface is not a problem and so that a reasonable voltage can be developed across R2 parallel to R3 and high enough so that loading of the equipment being tested will not change the readings by more than a few percent.

Placing R2 parallel to R3 yields 5 megohms. Selecting R1 to be 4995 megohms will give a 1000:1 ratio so that 50,000 volts will read out as 50 volts on the DMM. A measurement of 4995 megohms is high enough that loading of a 250-megohm focus network should not be an issue (5%). A ratio of 1000:1 is easy to remember. You could go to something higher if loading is still a concern, but then leakage current over the surface of R1 becomes an even greater concern. Even 5000 megohms is about as close to an open circuit as you can get—any contamination whatsoever will change the calibration significantly. You may find that using a resistance around 1000M will result in less of a problem and accept the circuit loading that this value implies.

For all practical purposes, you can use 5000M instead of the exact value of 4995M. The error of about 0.1 percent will be less than the error spec of most portable DMMs and much less than the error spec of any VOM. Plus, you probably aren't going to risk your expensive precision-bench multimeter on this lunacy anyhow!

50,000-Volt Maximum Using A 30K Ohm/V VOM

This is a little more complicated because you need to pick a range and then calculate the Z-in for that range. For example, for the 100-volt range of a 30K ohm/V VOM, the Z-in will be 3 megohms. For the same 5000-megohms R1 and 10-megohm R2, you would get a reading of 23 volts (roughly) on the 100-volt scale for a 50-kV input. The divide ratio in this case is about 218.

It is a simple matter to determine a scale and an R2, such that the actual high-voltage measurement is easily calculated from the meter reading. What you want is the ratio of R1 to R2 parallel to R3 to be a nice round number. Note that switching ranges will produce some peculiar behavior due to this current division between R2 and R3. A unique R2 must be selected for each range of interest. You are already using nearly the maximum sensitivity of the meter, and switching to a lower range will only slightly change the position of the needle unless you construct a range switch box as shown in Fig. 2.

In reference to Fig. 2:

S1—SPDT center off toggle switch.

All resistors except R1 are ¼-watt, 2 percent.

50,000-volt maximum based on the particular R1 I had laying around (1000:1-voltage division).

S1-1 is RadioShack DMM on 3, 30, or 300-volt scale (10M Z-in).

S1-2 is VOM, 25-volt scale (30K ohm/V, 750K Z-in).

S1-3 is VOM, 100-volt scale (30K ohm/V, 3M Z-in).

Modifications to use a higher-value R1 are straightforward.

Simple Circuit

I have constructed a high-voltage probe from the surplus-bleeder resistor from a defunct video terminal. For the probe tip, I used a discarded probe from a VOM. The resistor and probe tip were mounted inside an insulating plastic tube with R2 included at its base. A ground cable with an alligator-clip provided the connection to the chassis. There was a second pair of wires with banana plugs connected to the meter via a switchbox, which could select between a DMM or a couple of different scales on a VOM. Potting the entire HV head is a good idea to minimize the possibility of arc-over. Remember that 50,000 volts can jump several inches (two inches in dry air approximately). See above text for other suggestions on equipment/you protection (which is not shown).

This circuit uses only a 203-megohm high-voltage resistor. Since the internal resistance of a typical focus-divider network is 200–300 megohms, this probe would obviously load such a circuit excessively.

Calibration

Unless you have a calibrated HV supply, a working TV for which you have the service manual makes a good starting point. The proper high-voltage is usually specified to within 5–10%. If you have a line-transformer based HV supply (e.g., neon sign transformer, rectifier, or capacitor), then this would be pretty accurate based on your power-line voltage. For a DMM with a constant input resistance, you can use a low voltage (like a few hundred volts) on a lower range and extrapolate for the HV range. However, for a VOM, you cannot use this technique, since changing ranges also changes the parallel resistance of R2 parallel to R3. You are already using nearly the full sensitivity of the meter.

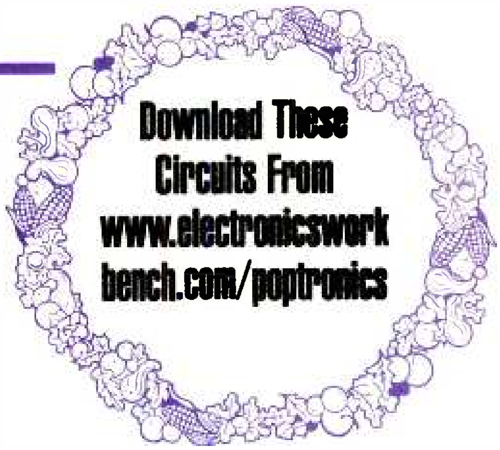
Wrap-Up

If you will be making HV measurements regularly, by all means invest in a real HV probe for your multimeter. What is described above can be built and used safely, but probably won't have the accuracy, consistency, or frequency response of a good commercial probe. Aside from purchasing a new HV probe, these do show up surplus as well as on eBay, possibly at greatly reduced prices. Even if a model isn't available for your particular multimeter (which is likely), it should be possible to adapt almost any commercial probe to work with it, requiring at most a scaling factor when taking a reading.

There is some additional information on HV probe construction, frequency compensation, and commercial HV probes on my Web site, *www.repairfaq.org*. As always, I welcome questions, comments, and corrections (via e-mail only please, sam@repairfaq.org).

mailto: basiccircuitry@gernsback.com

CHARLES D. RAKES



MORE BATTERY-TESTING CIRCUITS

Here we are again, ready to continue our battery-testing adventure. Last visit we covered a few voltage-monitoring circuits along with loading methods. We're going to start this session off with a simple pulsed on/off battery-life testing circuit, followed by a slightly more complex pulsed system with many additional timing features. Then, we'll move on to constant-current discharge circuits, which just may be the very best method for meaningful life testing comparisons.

Our first on/off load-testing circuit is shown in Fig. 1. A 555 IC timer is connected in a simple low-frequency astable oscillator circuit with the on/off rate controlled by R4 and S1. The timing may be varied from several cycles a second to many seconds a cycle. The two loads are switched across the test batteries by Q1 and Q2.

The circuit is not adaptable for testing single 1.5-volt cells: however, two 1.5-volt batteries may be operated in series and tested. Of course, the batteries must be the same make and age when testing. Almost all batteries with output voltages of over 3 volts are made up of two cells or more to obtain the labeled output voltage. The ever popular 9-volt alkaline battery contains six 1.5-volt cells connected in series to develop an output of 9 volts.

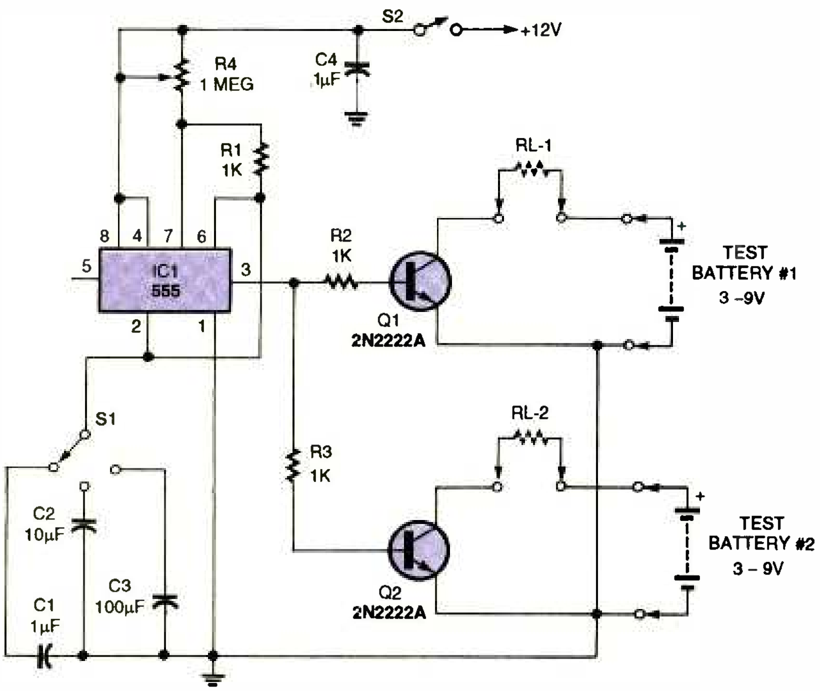


Fig. 1. This simple circuit uses a 555-timer chip and a low-frequency astable oscillator circuit controlled by R4 and S1. Be sure the batteries are from the same manufacturer when testing.

PARTS LIST FOR THE PULSED LOAD TESTER (FIG. 1)

SEMICONDUCTORS
Q1, Q2—2N2222A NPN transistor
IC1—555 timer IC

RESISTORS
(All resistors are ¼-watt, 5% units.)
R1–R3—1000-ohm
R4—1-megohm potentiometer

CAPACITORS
C1—1.0-µF, 25-WVDC, electrolytic
C2—10-µF, 25-WVDC, electrolytic
C3—100-µF, 25-WVDC, electrolytic
C4—.1-µF, ceramic disc

ADDITIONAL PARTS AND MATERIALS
S1—SP3P rotary switch
S2—SPST switch
Batteries and load resistors, see text

Each time the 555's output at pin 3 goes high, both Q1 and Q2 go into saturation, switching RL 1 and RL 2 to ground. This places the loads across the batteries. The low collector-to-emitter saturation voltage has very little effect on testing batteries of 3 volts and greater. Playing with the value of R1 can vary the circuit's on/off percentage some. The fastest on/off rate is when S1 is in position 1 and R4 is near its minimum resistance value—the opposite is true for the slowest on/off rates.

An improved circuit, with a precision variable on/off timer feature, is shown in Fig. 2.

The same basic 555 oscillator circuit we just looked at in our first circuit

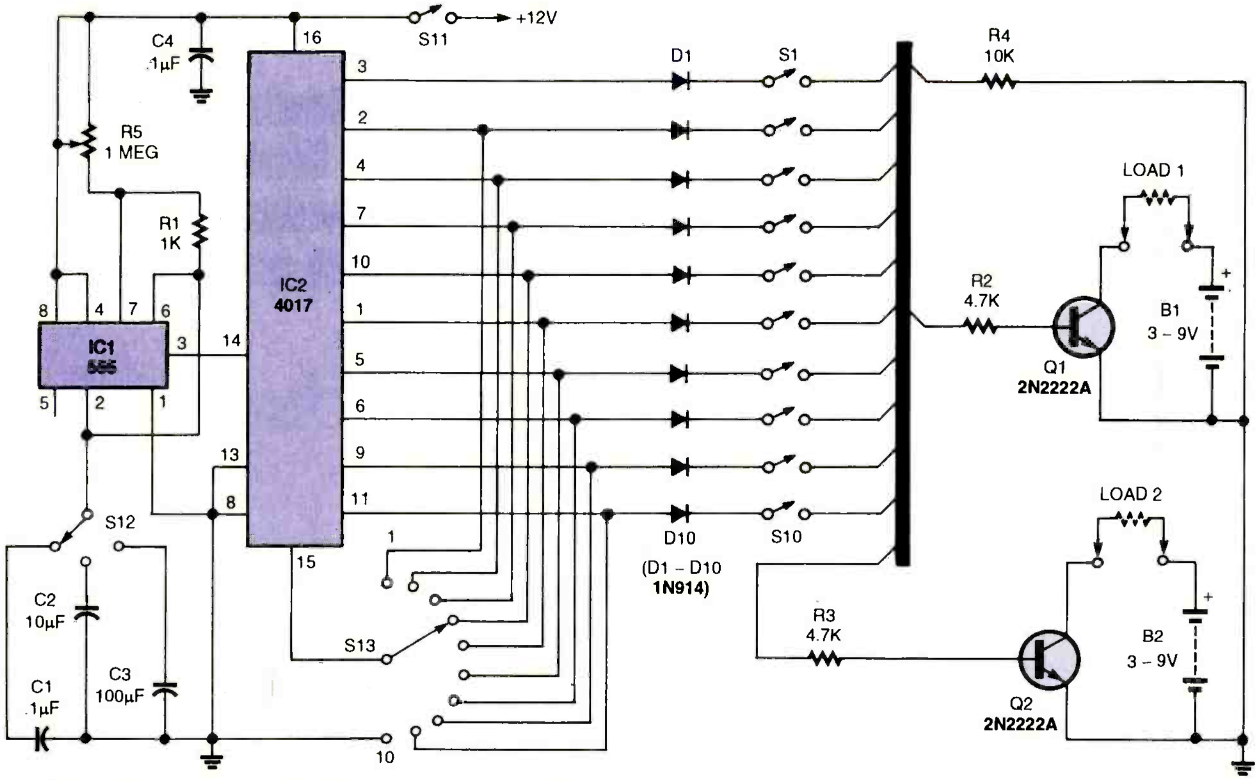


Fig. 2. This circuit incorporates a 4017 divide-by-ten counter into the circuit from Fig. 1. Switch S13 controls the cycle frequency by setting the number of steps before the cycle is repeated. Position ten will connect pin 15 to ground, which will cause a continuous test of all ten steps.

PARTS LIST FOR THE IMPROVED ON/OFF TEST CIRCUIT (FIG. 2)

SEMICONDUCTORS

Q1, Q2—2N2222A NPN transistor
IC1—555 timer
IC2—4017 decade counter IC
D1–D10—1N914 silicon diode

RESISTORS

(All resistors are ¼-watt, 5% units.)
R1—1000-ohm
R2, R3—4700-ohm
R4—10,000-ohm
R5—1 megohm potentiometer

CAPACITORS

C1—1.0-µF, 25-WVDC, electrolytic
C2—10-µF, 25-WVDC, electrolytic
C3—100-µF, 25-WVDC, electrolytic
C4—.1-µF, disc ceramic

ADDITIONAL PARTS AND MATERIALS

S1–S11—SPST switch
S12—SP3P rotary switch
S13—SP10P rotary switch

serves here as a clock-pulse generator for the 4017 divide-by-ten counter. Each time the 555's output goes positive, the 4017's output goes forward one step. This continues for ten sequential steps, which produces a positive output at each of the 4017's outputs. All other outputs are low, with only one high at a time. A good analogy is a single-pole rotary switch with ten positions. Our circuit basically does the same thing electronically, which is easier, faster, and definitely more reliable.

The 4017's ten outputs are isolated from each other with coupling diodes, D1–D10. These diodes keep the 4017's

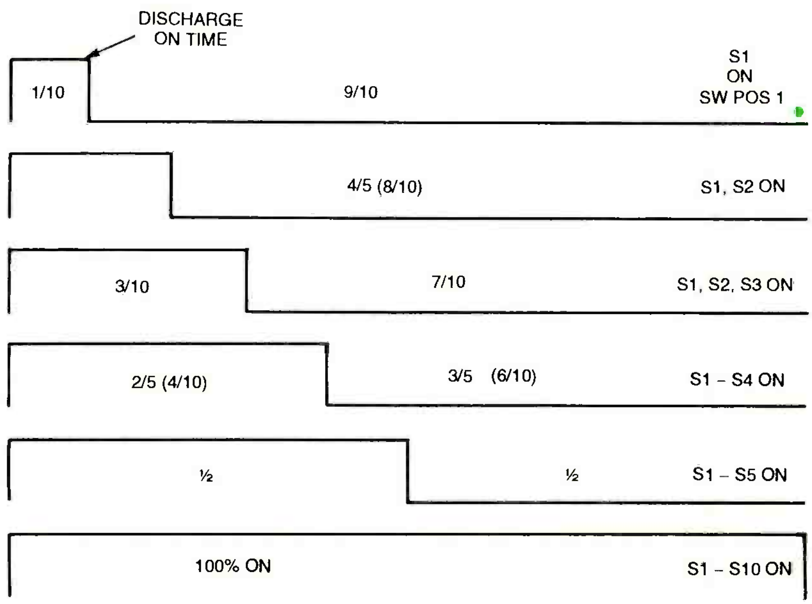


Fig. 3. Here are the waveforms that should appear at the output bus. When all the switches are closed, a steady high will be present.

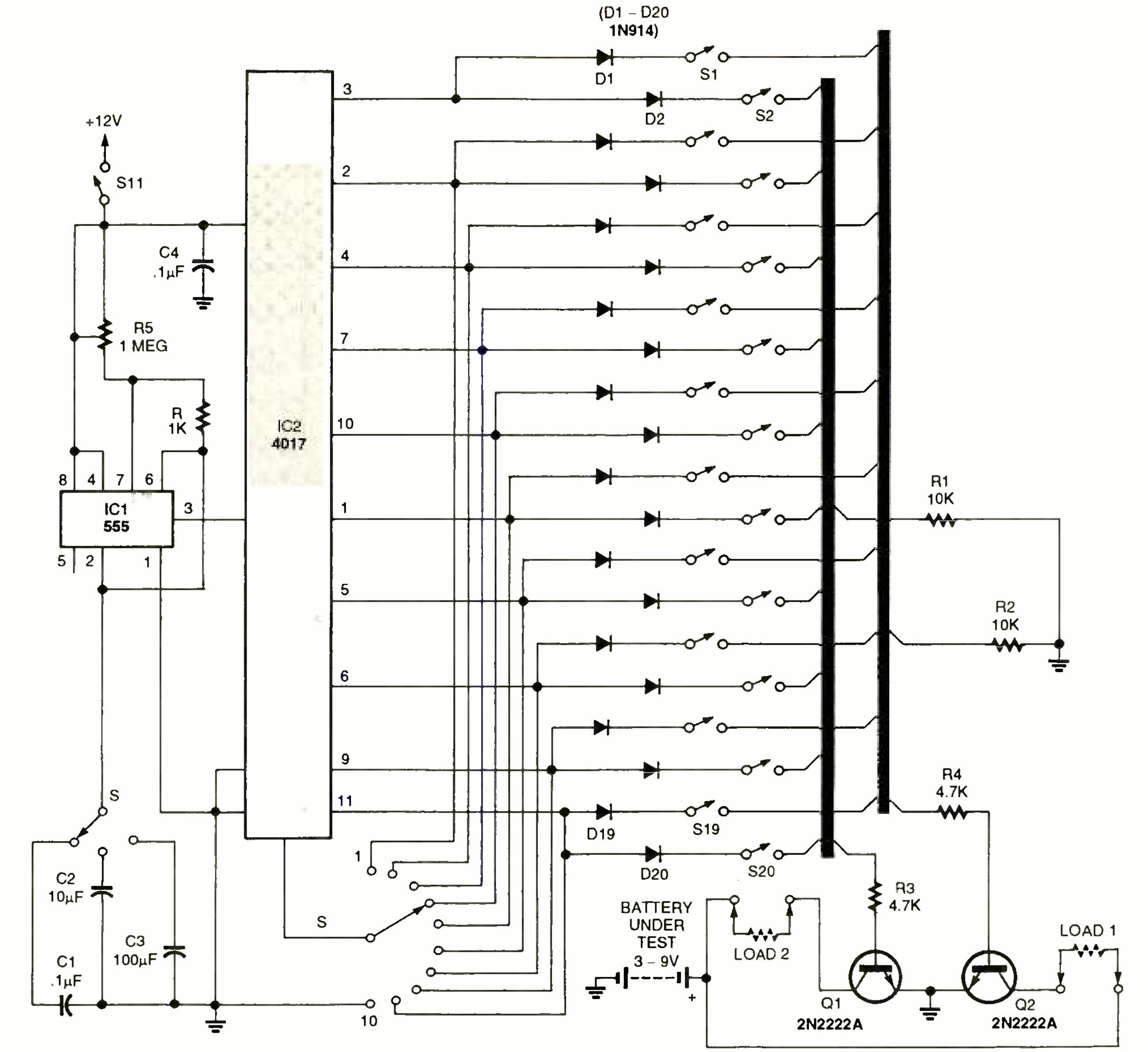


Fig. 4. This version of the circuit allows two loads to be tested in a timed sequence. Notice each pin of the 4017 has two diodes—one for each load.

PARTS LIST FOR THE MORE COMPLEX TESTER (FIG. 4)

SEMICONDUCTORS

D1–D20—1N914 silicon diode

Q1, Q2—2N2222A NPN transistor

ADDITIONAL PARTS AND MATERIALS

S1–S20—SPST switch

R1, R2—10,000-ohm, ¼-watt, 5% resistor

R3, R4—4700-ohm, ¼-watt, 5% resistor

activated output from feeding its positive voltage back into the other nine low outputs. The diodes also allow any or all of the outputs to be switched on to drive the load-switching transistors, Q1 and Q2.

Pin 15 of the 4017 determines how many steps the counter will take before repeating the sequence. Returning pin 15 to circuit ground allows the counter to step through all ten positions.

The drawing in Fig. 3 illustrates how the waveform appears at the output buss. This positive-output pulse drives Q1 and Q2 on, placing the load resistors across the batteries during this time period. The following outputs are true when S13 is in position 10. Closing S1 produces a positive output for $1/10$th of the total cycle time, which is the same time period as a single clock pulse. With S1 and S2 closed, the output pulse is twice as long and so on and on until all switches (S1–S10) are closed for a 100% on time.

The position of S13 determines the number of steps that occur before the cycle is repeated. In position 1 the output makes single steps over and over at the clock rate. All other outputs are out of the loop. Position 2 allows two steps to occur and then repeat. In the 10^{th} position, the output moves through ten steps and then repeats over and over as long as power is applied.

The reasoning behind all these vari-

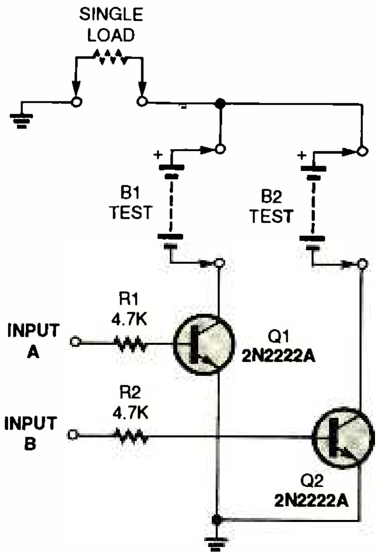


Fig. 5. Here is an add-on circuit for Fig. 4. A single load can be applied to two batteries, but not at the same time. Using the same load to test each battery should give a more accurate measurement.

PARTS LIST FOR THE SINGLE-LOAD CIRCUIT (FIG. 5)

Q1, Q2—2N2222A NPN transistor
R1, R2—4700-ohm, ¼-watt, 5% resistor
B1, B2—Test batteries

able test parameters is to have the ability of simulating a real-world load to the batteries under test.

If two different makes of batteries are being compared, it is very important that both loads are operated with identical on/off timing. Almost every application that is battery-powered offers a unique load.

The incandescent light bulb used in the majority of flashlights is just one example. The flashlight bulb is definitely a resistive load; however, it is in no way a simple fixed-value resistor. The initial turn-on current of a typical bulb is several times its normal operating current. The resistance of a lamp is very low with no current flowing. The bulb's resistance rises to a much higher value when rated voltage is applied. Only batteries with a low internal resistance should be used to power this type of load. Any device that has a DC-operated motor also demands a higher output current to start the thing moving. One of the most demanding popular devices around today is the digital camera. They eat batteries three times a day and go to bed hungry. Battery-operated clocks and other low-current demanding devices are often powered by a single 1.5-volt alkaline battery or a small-size, long-life lithium battery.

Now we'll get back to some examples using our versatile battery-life tester. A battery-operated device that demands maximum current for only a short portion of its total operating time is difficult to simulate with a fixed resistor load, but it's a relatively easy job for our tester. Switch S13 to position 10, close S1, and connect the batteries to the test terminals. Select the desired load resistance (take a look at last month's column) and connect it to the load terminals. Do the same for both load 1 and load 2. This set-up will apply the load to the batteries for ¹⁄₁₀th of the total cycle time. Setting the 555 oscillator to a one Hertz per second would place the batteries under load for one second and off for nine seconds. If more on time is desired, switch on S2 or more of the output switches. A much slower repetition rate may be in order. Slowing the clock down to one Hertz per minute will give a ten-minute platform for the load testing. Study the device's load demands and try to match it as closely as possible with the tester's timing adjustments. Use one of the battery voltage-monitoring circuits offered in our last visit.

Expanding The Possibilities

A slightly more complex version of the life tester is shown in Fig. 4, which allows two different loads to be applied to the batteries in a timed mode. Two sets of isolation-diode strings and switches are provided to allow setting up the load circuit for two separate load resistors. Also not shown is a duplicate-output circuit. Just construct two output circuits, which includes Q1, Q2, R3, R4, and the load resistors. Now two batteries may be tested at the same time.

Here's how the test circuit may be set up to apply a heavy initial start-up load, followed by a lower-value operating load. Set S13 (see Fig. 2) to position 10 and close (Fig. 4) S1, S4, S6, S8, and S10. These settings will apply the heavy load (load 1) for ¹⁄₁₀th of the time and the lighter load (load 2) for the remaining ⁹⁄₁₀th of the time. Components S11, S12, S13, and R5 of Fig. 2 operate the same way in Fig. 4.

One Load, Two Batteries

Another add-on circuit, see Fig. 5, for the tester in Fig. 4 allows a single load to be applied to two different batteries during a life-test period. Of course, both batteries cannot be connected to the single load at the same time. Just connect input "A" in Fig. 5 to buss 1 in Fig. 4 and "B" to buss 2. The odd-numbered switches in Fig. 4 operate buss 1, and the even-numbered switches operate buss 2. Never have a single output of the 4017 switched to both inputs of the transistors at the same time. As long as only one switch per output is on, you're ok.

Here's one reason to use a single load on both batteries with our time-sharing circuit. The load can now be any device the batteries are normally used to operate. Using the same load for each battery can insure a fair jury in determining which battery is best suited for the test load. Using power Darlington transistors in place of Q1 and Q2 will allow test currents over one amp. You can use either a 2N6043 or a 2N6059 (both are Darlington transistor) for higher load currents.

The timing circuit can be set to a

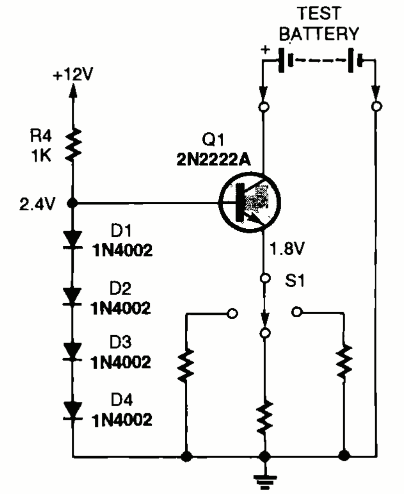


Fig. 6. Using Ohm's Law, one can calculate the required values of resistors R1, R2, and R3 within this constant-current test circuit. The four silicon diodes in series provide a voltage reference for Q1's base.

PARTS LIST FOR THE CONSTANT-CURRENT CIRCUIT (FIG. 6)

Q1—2N2222A NPN transistor
D1–D4—1N4002 silicon diode
S1—SP3P rotary switch
R1–R3—See text
R4—1000-ohm, ¼-watt, 5% resistor

very low clock rate, which will allow the load to be operated in a near normal manner. A flashlight is a good load for alkaline batteries and can be cycled off and on at a very slow rate. Set the circuit's clock to about one pulse per minute and switch S3, S5, and S7 on for setting up output buss 1. Switch on S14, S16, and S18 for output buss 2. This set up will operate the flashlight from test battery B1 for three minutes and then be turned off for two minutes and on for three minutes with test battery B2. This sequence will be repeated as long as power is applied to the test circuit.

Jacking Up The Current Demand

Using a constant-current load on the test batteries will speed up the testing process. A fixed-resistor load only draws the maximum test current for a short time. As the battery voltage begins to drop, the resistor receives less current, which allows the battery to loaf along during the remainder of the test. A constant-current load demands the same output current from the battery regardless of its output voltage.

Figure 6 shows a simple constant-current circuit that is suitable for battery-load testing. The test currents using the 2N2222A transistor should be no higher than about 50 mA. Four 1N4002 silicon diodes are connected in series and serve as a voltage reference for Q1's base. The voltage at the base of Q1 is about 2.4 volts, and the voltage at the emitter is about 1.8 volts. The constant-current load level is set by the value of Q1's emitter resistor. Using Ohm's Law (R = E/I) will give us the needed resistor value to set each switch position for a desired load current. A 10-mil load requires a 180-ohm emitter resistor. A 50-mil load current would require a 36-ohm resistor. Any current value in between is easily determined by the above formula.

It's time to close for this visit, but tune in again next month. We'll continue with the constant-current testing and testing rechargeable batteries as well. **P**

OP-AMP

(continued from page 45)

PARTS LIST FOR THE OP-AMP AND COMPARATOR CHECKER

SEMICONDUCTORS

D1, D2—1N4002 silicon diode
LED1, 3, 5, 7— Light-emitting diode, red
LED2, 4, 6, 8— Light-emitting diode, green

RESISTORS

(All fixed resistors are ¼-watt, 5% units, unless otherwise noted.)
R1—22,000-ohm
R2—18,000-ohm
R3—10,000-ohm
R4–R7—2200-ohm

CAPACITORS

C1, C2—1000-µF 25v, aluminum electrolytic capacitor
C3, C4—100-nF, ceramic disc
C5—10-µF 12-volt, aluminum electrolytic capacitor

ADDITIONAL PARTS AND MATERIALS

J1—3.5-mm power jack, or jack to mate with selected 9-V_{AC} adapter
S1—Normally-closed push-button switch (RS 275-1548)
SO1, SO2, SO6—8-pin DIP IC socket
SO3, SO4, SO5—14-pin DIP IC socket
9-V_{AC} 500-mA wall plug-in adapter (JAMECO 10129 or equivalent), printed-circuit materials, project enclosure, wire, solder, hardware, etc.

Install a single op-amp such as a 741 in SO1, and reconnect the power adapter. Red LED1 should be on. Press S1 and LED1 should go out and green LED2 should go on.

Disconnect the power, remove the IC in SO1, and repeat the above procedure for a dual op-amp such as the 1458 in SO2. Red LED1 and LED3 should be on initially, followed by green LED2 and LED4 when S1 is pressed.

Next, repeat for a quad op-amp such as an LM324 in SO3 and then a 4136 quad op-amp in SO4. In each case, all four red LEDs will initially be lit, followed by all four green LEDs when S1 is pressed.

Repeat for the comparators —the LM339 in SO5 and then the LM311 in SO6. As described earlier, only the red LEDs will be functional and will go out when S1 is pressed. The LM311 will illuminate only LED1. The LM339 will illuminate all four red LEDs. **P**

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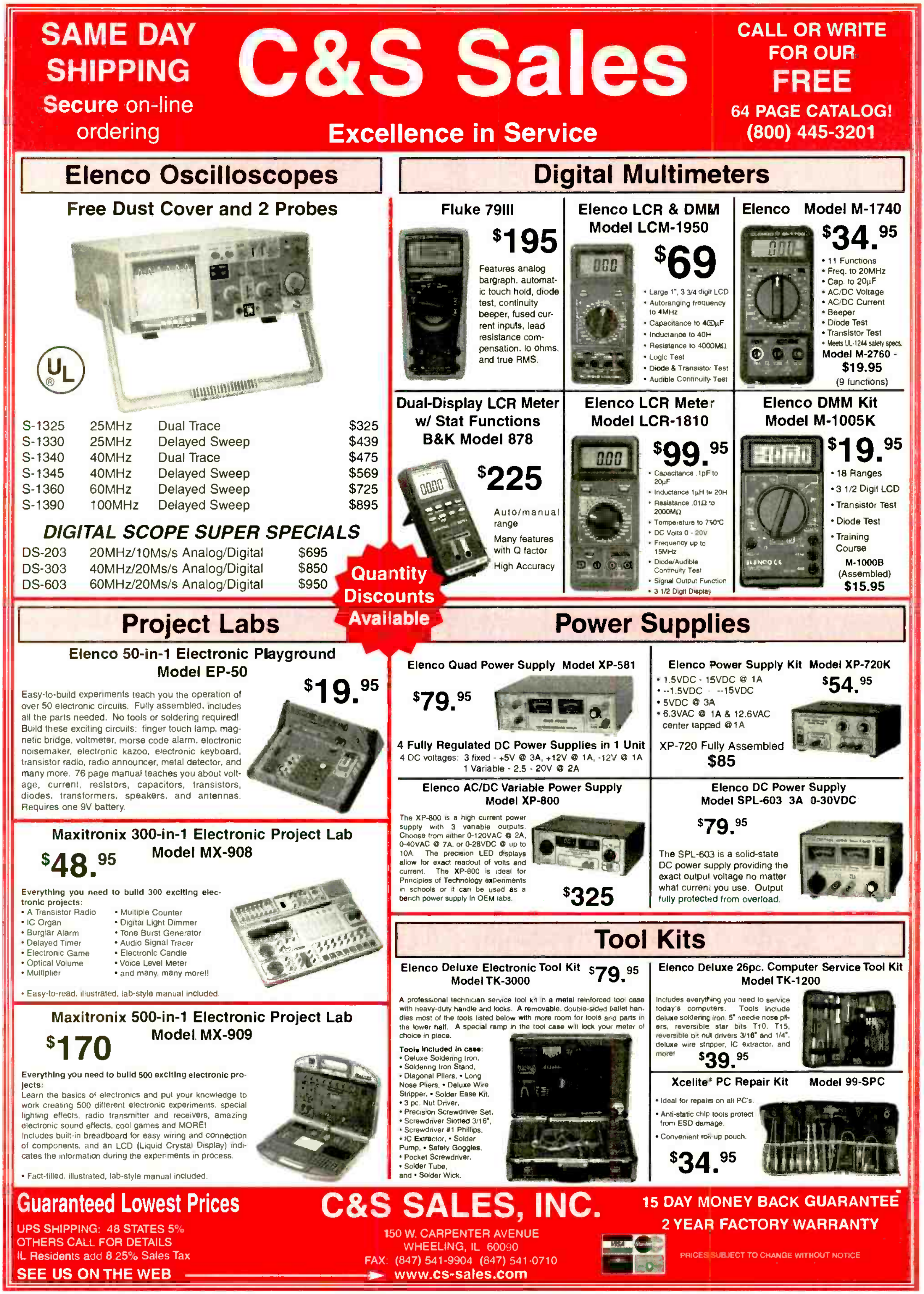

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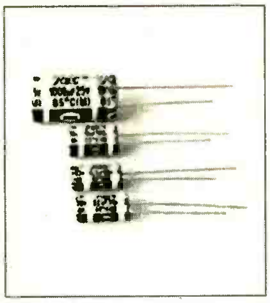

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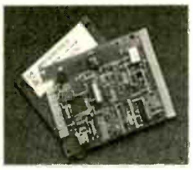

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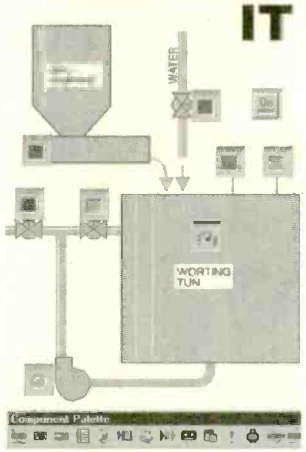

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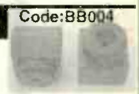

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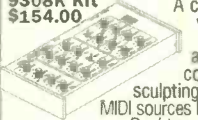

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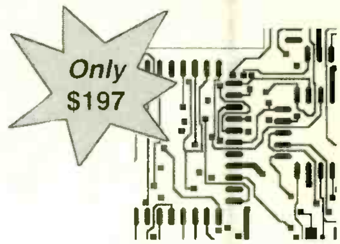

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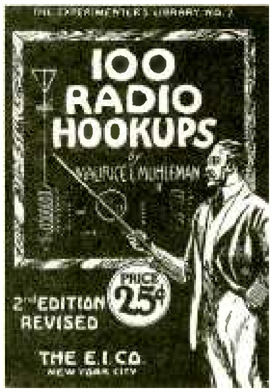

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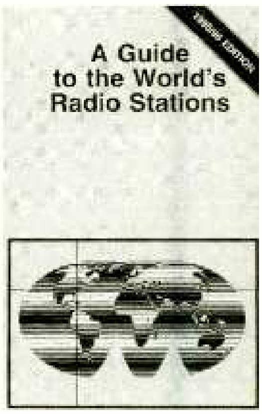

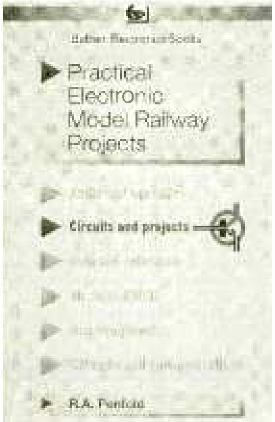

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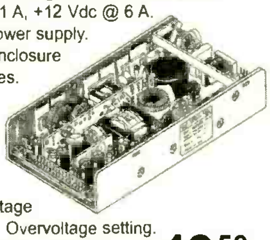

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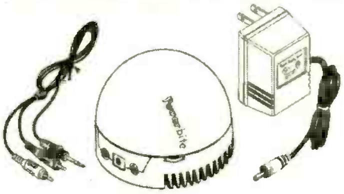

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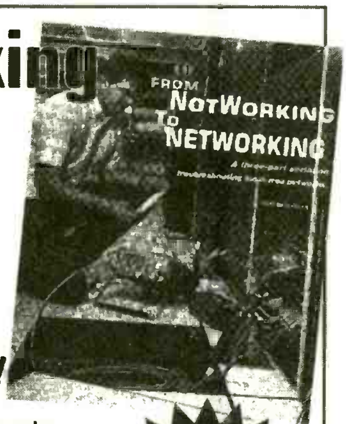

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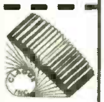

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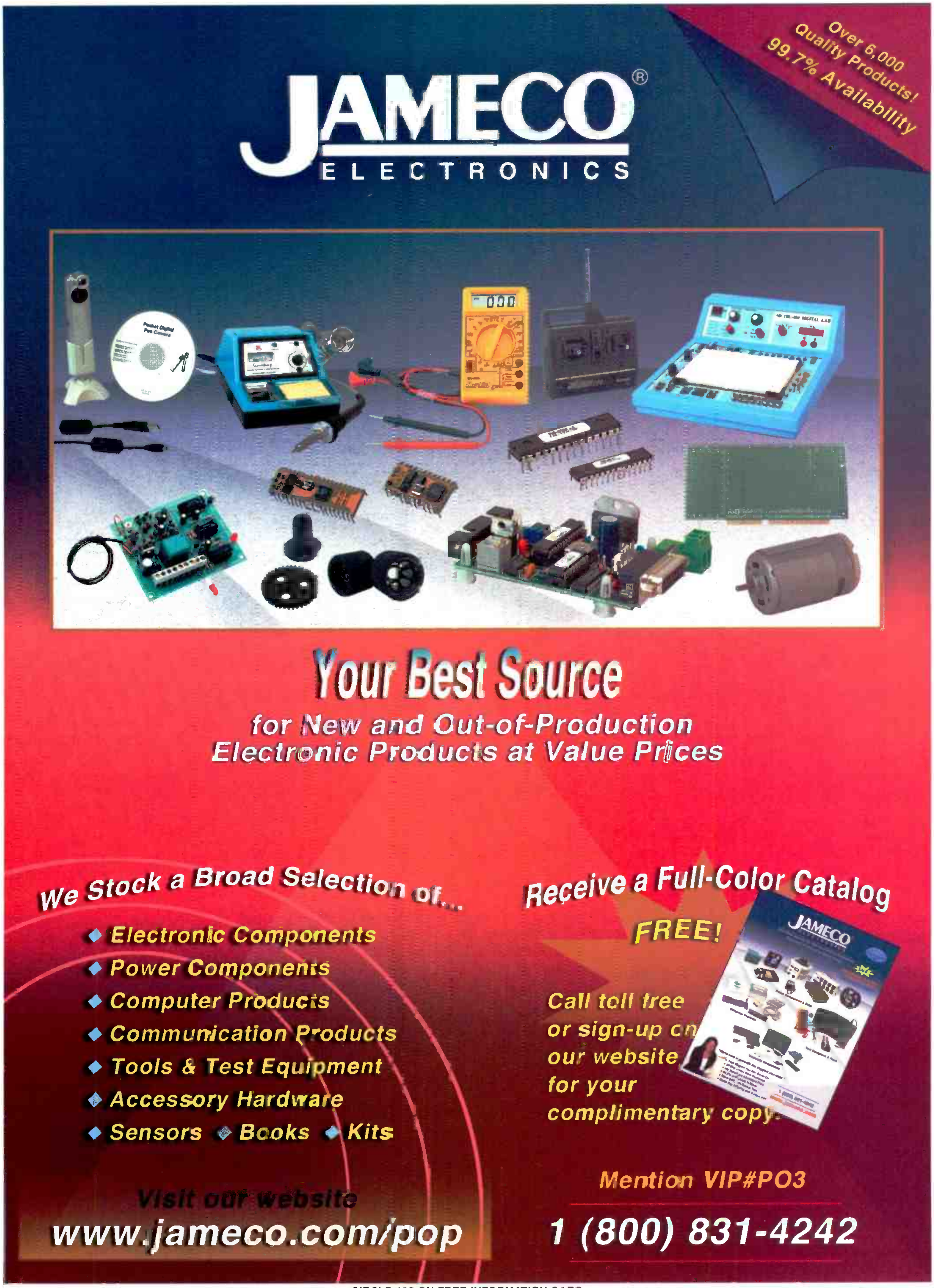

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