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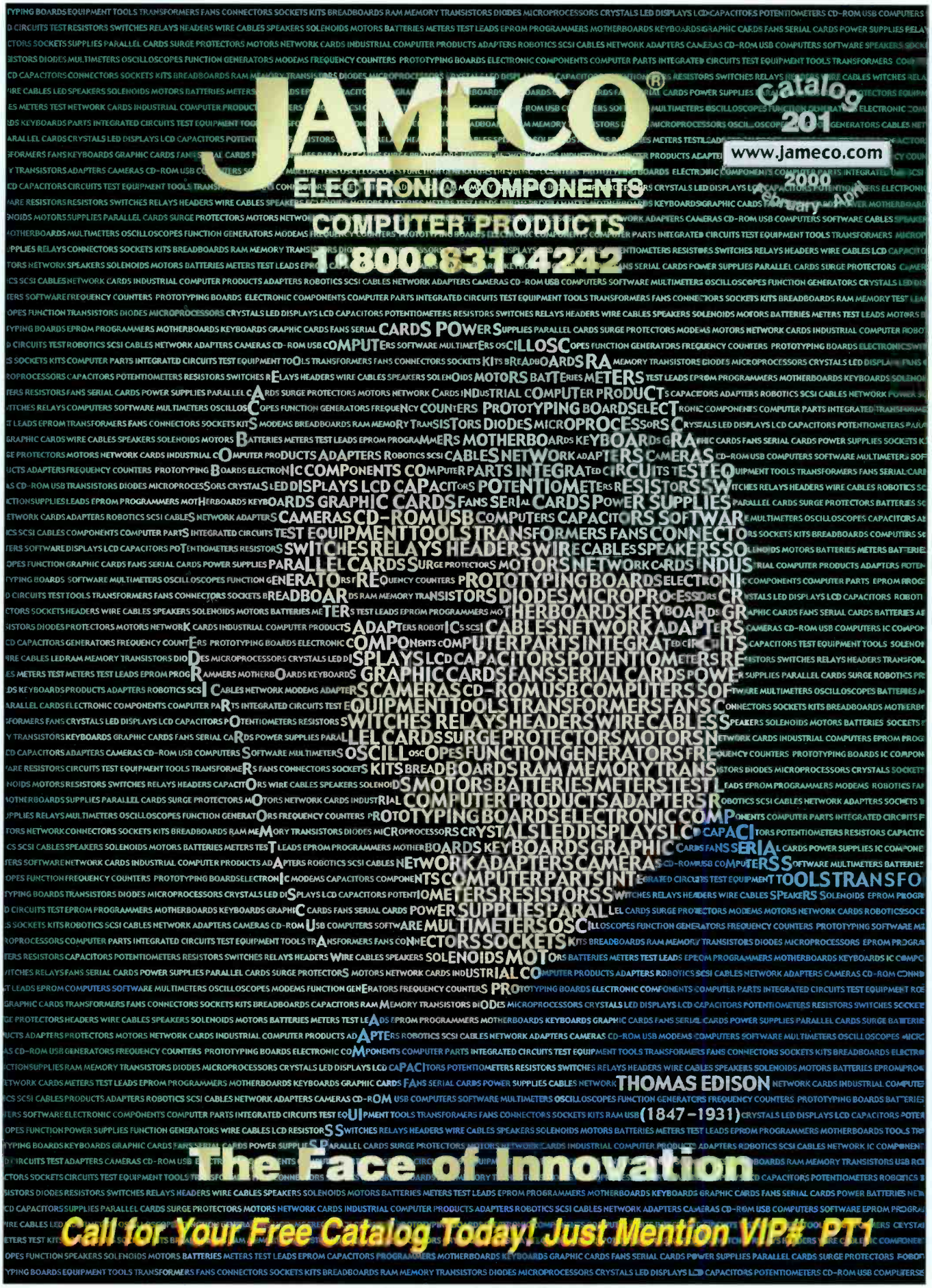

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Electronics Now

April 2000, Vol. 1, No. 4

Popular Electronics®

Poptronics

THE MAGAZINE FOR THE HANDS-ON ELECTRONICS ACTIVIST!

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Why use generic oscillators to troubleshoot audio gear? Use our custom device that's fine-tuned for this specific task and get better results every time.

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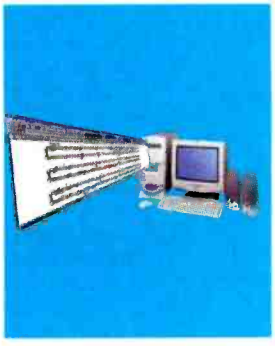

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BUSINESS AND EDITORIAL OFFICES
Gernsback Publications, Inc.
500 Bi-County Blvd.
Farmingdale, NY 11735
516-293-3000
Fax: 516-293-3115
President: **Larry Steckler**
Vice-President: **Adria Coren**
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Editorial

Listen Up

Yes, I'm talking to you. Can't hear me over that music you're playing in the background? Great—that means you'll love this issue. Actually, if you're reading in a quiet room, the magazine you're holding is likely for you, too.

How's such an apparent paradox possible? Simple: Those of you cranking the tunes right now will love the way our features this month can improve your enjoyment of music. And those of you with the stereo turned off ... well, you just might find a new reason to light up your amplifier's power LED.

Welcome to our Audio Special.

In the following pages, you'll learn how to build some devices that can help you improve your existing equipment and find new uses for it. Our fine-tuned *Audio Signal Generator* (page 20) eliminates the frustration of troubleshooting audio gear with just any oscillator. Next up, you'll learn how to change the inputs of your computer's sound card forever by adding the *PC Microphone Swapper* (page 24). And don't forget the importance of cables—our *Audio Cable Tester* (page 29) helps you locate the noisy ones that need to go.

Then, moving on to *PC Tech*, you'll find out how to use your computer to record CD-quality songs, make wonderful-sounding MP3s, burn CDs from LP recordings, and much more.

In short, we've gathered a plethora of hands-on advice that just might make an audiophile out of you (if you're not one already!). While the world of electronics has become increasingly more visual, there will always be a place for aural experience. We hope you enjoy the slice of it that we bring you this month.

Of course, we've crammed in tutorials on other topics, too. Robotics experimenters will love the space-age telepresence project we're beginning in *Amazing Science*, as well as the programming information in *Robotics Workshop*. And, for the mad scientist in each of us, this month's *Basic Circuitry* features high-voltage circuits.

Need we say more?

Join us next month for more cutting-edge, hands-on electronics. **Poptronics** is just getting warmed up.

Konstantinos Karagiannis
Editor

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LETTERS

Is That The "Red" Shade of Gray Or The "Green" Shade of Gray?

There was an error that I noticed in the "Telephone Hold and Line-In-Use Project" that appeared in the February 2000 issue of **Poptronics**.

The author got the polarity of the telephone wires backwards. The correct polarity is for the red wire to be negative and the green wire to be positive—the reverse of what you would expect from electronic convention.

Also, it should be noted that most newer wiring uses blue with white dots in place of red and white with blue dots in place of green—"a boon to those with red-green color blindness."

CLIVE TOBIN
via e-mail

What Once Was Old Is New Again

How about a special Year 2000 Commemorative Edition of *Popular Electronics* featuring the most unique or novel projects that the magazine has presented since its inception? What an education it could be for your younger readers! In addition, it would be wonderful for the long-time readers who remember their first electronic project. It could bring back memories of the thrill of hearing a broadcast through our headsets after we tuned in the crystal radios that used a razor blade instead of a crystal!

I can think of several nifty projects that you have published over the years that I'm sure many people would love to read about or simply re-visit. Remember the "Flame Speaker?" Incredible fidelity...from a flame! Or how about the "Lava Lamp" (*Popular Electronics*, March 1991) project?

There was also the circuit that randomly increased and decreased the voltage to a bulb. By connecting three of those circuits to a red, blue, and green bulb behind a frosted-glass panel, we could have an endless display of randomly-changing colors. Maybe that concept could be expanded into a frequency-sensitive kaleidoscope?

Please give this some serious thought. I believe you'd have a collectible on your hands.

Thank you for a wonderful magazine that has always given me food for thought.

RON N. FRIESEN
Abbotsford, BC

If I Put Wheels On My Workbench, Will It Need A License Plate?

With the change of the millennium upon us, giving readers the chance to read the best of both magazines for a single subscription is very much appreciated. Trying to keep up with two magazines can be difficult for people who are in tight financial circumstances.

Perhaps it would be a good idea to have more articles and information on automobile electronics in your magazine. That way more repair technicians might become readers.

Many technicians do not have the time to experiment on their own; they only have time to make repairs. With all of the amazing electronics technology presented in your articles and columns, you could, hopefully, introduce material on the latest developments in servicing automobiles. Perhaps something similar to "Service Clinic" for cars. The time has come for old and new automotive circuitry and technology from Japan, Europe, and America to become available to the hands-on activist.

TONY NEIBURG
Minneapolis, MN

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. And now there are more ways than ever to contact us at **Poptronics**.

You can write via snail mail to:

Letters
Poptronics
500 Bi-County Blvd.
Farmingdale, NY 11735

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

Send e-mail to:

popeditor@gernsback.com

Of course, e-mail is *fast*.

Check the end of your favorite columns, too. Many of them list individual e-mail addresses for their respective authors.

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

Haves & Needs

I need an owner's manual for a Genometer Model TV50A (Signal Generator) made by Superior Instrument, New York.

Thank you for any help you or your readers can give me.

ADOLF PROKOP
14511 W. Greystone Dr.
Sun City, AZ 85375-6122

I'm impressed with the new look of **Poptronics**. Good luck with future issues.

If I remember correctly, *Popular Electronics* had a feature where people needing help finding a particular electronics item could publish that request. If there is such a feature in **Poptronics**, I would appreciate your printing this letter.

I collect and restore ARC-5 receivers (also known as "Command Sets"). I have been able to acquire 50 of these little jewels. I would like to have 50 more, preferably in original condition, but any condition that can be used is fine.

JOHN BROUSSARD
312 Guilbeau St.
Breaux Bridge, LA 70517
Tel: 337-332-8316

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GIZMO®

Camcorder Plus

Keeping one foot firmly planted in the VHS-dominated world of today, while the other steps into the digital world of tomorrow, the *DualCam GR-AMX710* ($799.95) from JVC combines a VHS-C camcorder and a digital still camera in one convenient unit. The integrated design allows the camcorder's powerful 320X zoom and special effects features to be used when taking digital photographs. The supplied VHS Playpak adapter enables motion video that is recorded on Compact VHS cassettes to be played back on any VHS VCR. The DualCam comes with all the cables and software needed to transfer, catalog, retouch, and manipulate digital still images on a Windows PC.

The internal digital still camera uses a 2MB flash memory that stores up to 60 standard-mode or 30 fine-mode (640 × 480 pixels) VGA images. "Snapshot" modes include full-screen, pin-up, four- and nine-frame multi-picture, and rapid shooting of consecutive shots. In full-screen and pin-up mode, you can record a digital still shot and simultaneously insert that image (accompanied by a shutter-like click sound) into the video you're recording. Or you can opt to insert stored digital stills into VHS video footage at key points, in effect, dividing the video into "chapters." Video and still images can be viewed and edited on the built-in 2.5-inch LCD monitor; no external connections are required.

JVC Company of America, 1700 Valley Rd., Wayne, NJ 07470; 973-315-5000; *www.jvc.com.*

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"Big-Screen" Pager

If "big screen" immediately calls to mind a television, think again. Motorola's *Model CP1250* word-message pager ($209) brings new meaning to the phrase. The pager features an eight-line screen, capable of displaying up to 26 characters per line. It is powerful enough to receive and display graphics such as logos, charts, and graphs, as well. The display automatically lights up in low-light conditions, and the pager's zoom function can transform eight lines of text into four lines of enlarged type for easy reading.

Designed for mobile business professionals who need to manage large amounts of data, the CP1250 delivers advanced information services such as financial news, stock prices, news headlines, weather, sports scores, and entertainment news (where available by subscription). Motorola's FLEX Info protocol creates separate "maildrops," each of which holds several topics. A bookmark feature provides easy access to the stored information.

The pager can store 26 personal messages and up to 15 different information services. A phone-list "folder" retains names and phone numbers from saved messages. A "to-do" folder turns messages into a checklist of tasks, and an event folder can be used to schedule events and set reminder alarms.

Motorola, Inc., 1500 Gateway Blvd., Boynton Beach, FL 33426-8292; *www.motorola.com/pagers.*

CIRCLE 51 ON FREE INFORMATION CARD

Workout Music

Exercise your ears while you tone your body with the *Activ ACT7850* portable CD player ($99) from Philips. The rugged, splash-resistant, compact unit is designed to meet the challenges of the great outdoors without sacrificing sound quality or good looks. Rubber gaskets keep out moisture and dirt. The heat-resistant cover handles surface temperatures up to 194 degrees, and the non-slip case and rubber buttons are easy to use even in extreme conditions.

Take the ACT7850 hiking, biking, skiing, or jogging—its 25-second electronic shock protection prevents skipping in all types of environments. Three-stage Dynamic Bass Boost allows you to adjust the bass to meet your preferences. The CD player is compatible with both CD-R and CD-RW discs, so you can enjoy your own customized music mixes while you work out.

Royal Philips Electronics, 64 Perimeter Center East, Atlanta, GA 30346; 707-821-2400; *www.philips.com.*

CIRCLE 52 ON FREE INFORMATION CARD

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Two-Channel Tuner/Preamp

Not everyone needs—or wants—a multi-channel receiver. Many audiophiles prefer components designed specifically to reproduce stereo music, not dialog and special effects. B&K accommodates music lovers with its *PT-3* ($598).

The two-channel AM/FM tuner and preamplifier serves as an audio control center that is easy to configure and use, thanks to its "set it and forget it" preset system. The system allows you to recall your favorite settings for volume, bass, treble, balance, loudness, and headphone mode when changing radio stations or any of the sources plugged into the unit. In addition, manually tuning AM/FM stations or using the remote to directly enter the frequency is also an option. You can customize the input and preset names; even the "power-on" titles that come up on the display can be set to your taste.

The PT-3 has six audio inputs, variable level high-pass and full-range outputs, and an infrared input system for total system integration. RS232 control is an available upgrade. The tuner/preamp matches up with B&K's stereo amplifiers, which have rated output powers of 60-, 125-, 200-, and 250-watts-per-channel.

B&K Components, Ltd., 2100 Old Union Rd., Buffalo, NY 14227; 800-543-5242 (or 716-656-0026 in New York State only); *www.bkcomp.com.*

CIRCLE 53 ON FREE INFORMATION CARD

A/V Surround Processor/Preamp

For those who prefer never to be without multi-channel surround sound, there is Parasound's *AVC-1800 Audio Video Controller* ($1195), capable of handling both Dolby Digital and DTS formats. It automatically detects the source's digital "ID flag" and adopts the correct decoding process accordingly. Advanced digital-domain Dolby Pro Logic decoding ensures backward compatibility with many of today's videotapes and TV broadcasts. A rear-panel 5.1-channel analog input provides an upgrade path for future format development.

The surround processor/preamplifier includes a sensitive AM/FM tuner with 29 programmable presets and "preset scan" for easy retrieval of favorite stations. There are inputs for three audio-only and four A/V analog sources. The A/V inputs handle both composite and S-video signals. Two coaxial and two optical digital inputs are provided. Two A/V analog outputs complete the array. With dedicated rear-panel jacks and internal routing for infrared control signals, the AVC-1800 boasts dual-zone multi-source capability.

Parasound Products, Inc., 950 Battery St., San Francisco, CA 94111; 415-397-7100; *www.parasound.com.*

CIRCLE 54 ON FREE INFORMATION CARD

CB Lives

More than 30 million citizen band radios are in use today, and Cobra Electronics hopes to introduce even more people to CB with its *HH-38WXST* handheld model ($119.95). The compact radio is designed for convenient, affordable communications between people who enjoy outdoor sports and recreational activities. The 40-channel CB radio outputs four watts of power to ensure maximum range. It provides access to weather information from the National Weather Service channels that offer 24/7 broadcasts of localized forecasts, regional weather summaries, and weather warnings.

The HH-38WXST is equipped with Cobra's SoundTracker technology, which is said to reduce static and airwave noise by up to 90 percent. Its transmission signal is processed to move more efficiently through cluttered airwaves with increased range and stronger signal reception. The Dual Watch function permits monitoring of any two channels simultaneously, while Full Channel Scan allows one-button scanning of all 40 channels.

Cobra Electronics, 6500 West Cortland St., Chicago, IL 60707; 773-889-8870; *www.cobra-elec.com.*

CIRCLE 55 ON FREE INFORMATION CARD

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Prototype

To The Rescue:
Saving Victims of Terrorist Attacks

Rescuers who become victims of a terrorist attack can't save lives.

Picture this scenario—there are mass casualties following the release of a nerve agent in a shopping mall or a theme park or a subway. Rescue personnel must be prepared to deal with such emergencies; they won't get a second chance.

Emergency medical technicians (EMTs) and firefighters may soon be able to practice responding to such attacks, using a virtual-reality (VR) training tool.

After seven years of virtual-reality research, computer scientists at Sandia National Laboratories have developed the BioSimMER. This VR application immerses first responders in a 3D, computer-simulated emergency setting—a small airport in which a biological warfare agent has been dispersed following a terrorist bombing. Simulated casualties with a variety of symptoms are scattered throughout the airport.

Through goggles that display the scene's images, all the rescuers' senses, as well as their decision-making abilities, are involved in the computer simulation. The sensors worn on arms, legs, and waist allow the players' motions to be fed back into the simulation.

According to project leader Sharon Stansfield, the VR tool can help emergency personnel make better decisions if they are ever called to respond in a real chemo-bio attack. "With virtual reality, you can practice over and over again, like in a video game. You can make mistakes; you learn. If someone dies, you can hit the reset button."

Lydia Tapir of Sandia demonstrates BioSimMER, a virtual reality application that allows rescue personnel to practice responding to a terrorist attack involving the release of a biological agent following a bombing. Through her goggles, she sees the scene shown on the screen behind her where a virtual patient exhibits realistic symptoms from a severe head wound. (Photo by Randy Montoya)

Saving "Cyber Casualties"

"Cyber casualties" with realistic symptoms and real-time changes in their conditions were created by researchers, who worked closely with Sandia physician Dr. Annette Sobel. One virtual casualty has a visible chest wound, while another has symptoms that indicate head trauma. A third victim suffers from inhalation of staphylococcal enterotoxin B (SEB), the airborne biological agent used in the simulation. The fourth casualty has signs of SEB exposure, but closer examination shows psychological shock instead.

During simulation, the players must triage, diagnose, and take care of the medical needs of each casualty. They use the clues provided by visual indicators, such as a victim's movements, labored breathing, skin color, and vital signs. If they are wrong or not fast enough, consequences are immediate—the patient could die.

Decisions and Consequences

After making a diagnosis, the rescuers administer medical treatment by reaching for and using tools in a virtual medical kit. Players may perform other

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tasks, such as initial decontamination procedures, placing masks over a patient's nose and mouth, or positioning sensors or other monitoring equipment on or near the patient. Most important, they need to learn to protect themselves.

"A player who dies a quick cyber death will not likely forget the importance of personal protective equipment in the future," Stansfield said.

Although textbooks and live exercises are valuable in training emergency personnel, this VR tool offers other advantages. As Stansfield explains, "We tend to understand what we see with our eyes and do with our hands. The strength of VR is being able to train on things you can't do otherwise, particularly in highly contaminated or highly stressful situations. We don't think BioSimMER should replace live exercises, but it can provide an inexpensive way for emergency personnel to practice."

Achieving a Suspension of Disbelief

Although its graphics aren't as refined as the latest 3D video games, the VR application offers an element of realism that video games can't. "In video games, the world is imaginary," the project leader said. "But a VR world is a representation of a real place with representations of real people moving in real-time. Everything in that world must move and respond as if it were real and bound by the law of physics."

Creating a virtual world with such physical realism requires some trade-offs, Stansfield added, but the ultimate goal is to create a suspension of disbelief. "You've got to make the player believe, at least temporarily, that he or she is in the situation you are presenting."

First Field Test and Future Forecasts

The airport used in the simulator is a fictitious one-story, three-gate airport, based loosely on a real airport in central New York. The research team simulated how the airborne biological agent would spread through that airport following an explosion dispersing the agent.

More than 20 first responders recently got their first chance to test drive BioSimMER at the National Emergency Response and Rescue Training Center at Texas A&M University. The virtual reality trainer builds on previous Sandia VR work, including applications for training battlefield medics and for law enforcement small teams tactical training.

Researchers plan to continue developing and refining the system and scenarios. Currently, work is focusing on making the user's interaction with the virtual world easier and more realistic. Although BioSimMER is a research prototype, they hope to make a version available to users in the near future. PT

Air Monitor

Recently developed by researchers at Los Alamos National Laboratory, a portable, ultrasensitive air particulate monitor instantly and continuously identifies virtually all known constituent elements in the periodic table and their relative concentrations. Since all these elements have well-characterized atomic energy levels, exciting the atoms enables the air samples to be easily identified. This inexpensive device, which can be used indoors or out, contains a miniature microwave plasma source that performs the "shaking up" of the elements. It is ideal for work sites that handle hazardous materials, such as beryllium.

"I've no doubt that this portable instrument will greatly reduce, or in some cases eliminate, the risk of worker exposure to hazards related to operating processes," said principal investigator Yixiang Duan of Los Alamos' Analytical Chemistry Sciences Group. "The monitor can detect almost all hazardous elements, although our project's initial focus was on creating an ultrasensitive monitor for detecting beryllium air particulates." Exposure of workers who are sensitized to beryllium can lead to chronic beryllium disease, which scars the lungs and can be fatal.

Researchers pump an airborne sample through a tube into the heart of the microwave plasma source. Argon and helium are most frequently used as plasma gases for analyzing metal and nonmetal elements. A fiber-optic cable alongside the plasma source detects the optical emissions from the elements and feeds that information to a palm-sized spectrometer, which converts the information into a graph. The graph shows each element's specific wavelengths and signal peaks on a laptop computer

Principal investigator Yixiang Duan works with the air monitor, analyzing a sample. The element's specific wavelengths and signal peaks are shown on graph on the laptop computer screen above the air monitor.

screen. The wavelengths identify the elements; the peak intensities reveal their concentrations.

Samples in solution are analyzed in the same way. The operator simply changes the initial air sampling pump to one suited for handling solution samples.

Steve Abeln, project leader for beryllium technology at Los Alamos, added "There are currently more than 100 cases of chronic beryllium disease within the DOE complex." Up til now, protecting workers has been difficult since exposure levels were always determined after the fact through laboratory analyses.

DOE recently lowered the beryllium exposure action limit to one-tenth of its former level, from 2 micrograms per cubic meter to 0.2 micrograms. The new portable monitor can reach a detection limit for beryllium air samples of 0.12 micrograms per cubic meter. In solution, the monitor possesses a beryllium detection limit as low as 9 trillionths of a gram per milliliter.

"The monitor is about ten times more sensitive for air particulate monitoring than laser-based techniques, which are the only field technologies currently available," said Duan. It's easier to use and very portable—the size of a milk crate and weighing about 55 pounds. The team currently is shrinking it further and making it even easier to use. PT

Nanotechnology and the Future

In the field of "nanotechnology," scientists and researchers dream of individually manipulating atoms and molecules to create materials on a minute scale with

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entirely new characteristics. Nanotechnology works on the scale of the nanometer—one ten millionth of a centimeter—or the width of five or six atoms laid side by side. Some of the current research includes a quantum dot device for the next-next-generation semiconductor; and carbon nanomolecular materials with new functions, such as buck-minsterfullerene (C60), nanotubes, and self-assembly monolayers.

According to a study conducted in the United States, global research and development investments in the nanotechnology field have skyrocketed over the past several years. In contrast to Europe and the United States, Japan's nanotechnology is characterized by an emphasis on nanodevices such as semiconductors, their production process, and nanoparticle materials. Research on a silicon nanocrystal single electron device (SED) is proceeding, led by corporations such as Hitachi, Toshiba, and NEC, who are working on a new memory device.

Nanotechnology in biological fields is being researched at Osaka University and at the Ministry of International Trade and Industry's (MITI) Atom Technology Project—where the use of scanning probe microscopy to analyze DNA base sequences down to the nanometer scale is being studied. The Atom Technology Project, established in 1992, brought together over 100 top researchers from a wide range of fields at Tsukuba's National Institute for Advanced Interdisciplinary Research (NAIR) to form the Joint Research Center for Atom Technology (JRCAT). Accomplishments during the first phase of the project include the creation of silicon nano structure, atomic level control of oxide films, and the convergence of computer-simulated experiments and theoretical predictions. Research is continuing into these and other related developments.

The free exchange of ideas between different organizations and disciplines will be an essential factor in nanotechnology's future development. Recently, the Center of Nanobiotechnology was established at Cornell University to combine silicon technology and biology—an experiment in opening up new nanotechnology territory. In Japan, the 15 national research centers under MITI are to be combined into one independent administrative body in April 2001. PT

Free Internet Access On the Go

Business travelers who rely on the Internet to communicate with their offices and customers are among the most frequent Internet users. Get2Net is a fast-growing operator of hundreds of public Internet access terminals that bring the Internet to the traveler. The Get2Net stations—strategically placed near airport gates, frequent-flyer clubs and restaurants—offer unlimited access to the Internet to check e-mail, confirm flight schedules, browse the Web, locate information on area events, get real-time information on their favorite stocks, or do research. Since it is based on advertising support, the services are offered to users free of charge.

The NetSet and NetStation, shown here, are popping up all over the country in places that travelers frequent. Its Internet service is offered to users free of charge.

The first units were installed in 1997 at Norfolk International Airport and are currently located in 75 percent of the country's busiest airports. New York area airports—JFK, Newark, and LaGuardia—have NetSets (stand-up Internet kiosks) or NetStations (private Internet sit-down phone booth-like cubicles). Concept bars and grills and restaurants have recently opened in Washington, D.C., St. Louis, and San Jose airports. Get2Net plans to install 1000 units in airport bars and restaurants operated by Host Marriott Services.

In addition to the airport Internet terminals, there are terminals at roadside travel plazas around the country. These terminals consist of specially "ruggedized" hard drives, monitors, and keyboards, all contained in tabletop models, stand-alone stations, or private booths.

Over 1000 terminals will be in place around the country by the end of the year, and there will be 6000 units by 2003. Possible public venues for these terminals, aside from airports, include bars and restaurants, hotels, convention centers, mega-book stores, coffee shops, and shopping malls.

As more and more business and leisure travelers become Internet-savvy, it is expected that sending e-mail will become as commonplace as making a phone call. Get2Net envisions that out-of-home Internet terminals will become widely accepted public communication tools, and just as commonplace as the phone booth. They see Internet terminals as multimedia pay phones, supporting e-mail, Internet surfing, voice conversations, and even video-conferencing. PT

"Eye" Am A Camera

A next-generation charge-coupled device (CCD) technology was recently introduced by Fuji Photo Film Co., Ltd. Differing from conventional CCDs with square photodiodes and pixel arrangements, Fujifilm's new Super CCD has octagonal-shaped photodiodes and pixels situated on 45-degree angles. This "honeycomb" pattern greatly improves the quality of digital images. The technology increases sensitivity, improves signal-to-noise ratio, and offers a much wider dynamic range—resulting in digital images with richer, true-to-life colors and better clarity.

The improved space efficiency for the photodiodes located in each pixel allows for larger pixels and higher resolutions. As a result, a Super CCD with 1.3 million pixels would reproduce the picture quality of a conventional CCD with 2 million pixels.

For example, the area of the photodiode in a 1/2-inch Super CCD with two million pixels is about 1.6 times as large as the area offered in the conventional CCD with the same number of pixels. The device's pixels also increases the image sensor's ability to capture more resolution in both the horizontal and vertical directions.

In addition, the Super CCD mirrors the optics of the human eye to understand collected information. In a way

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➤ Cars As Communications Centers

Get your latest stock market quote while driving down the highway. The ICES control panel and screen from the Ford concept vehicle, shown here, displays stock market figures—at the sound of your voice.

Available to consumers for the first time this summer, the automotive aftermarket version of Visteon's in-car computing system—ICES (Information, Communication, Entertainment, Safety and Security) allows drivers to optimize their traveling time. With the use of simple voice commands, ICES provides drivers with access to the Internet where they can check e-mail and obtain real-time information such as news, weather reports, and stock prices. ICES also provides access to a turn-by-turn navigation system.

ICES is activated by Visteon Voice Technology, which allows drivers to stay connected while keeping their eyes on the road and their hands on the wheel. It is hoped that this new technology will eliminate some National Highway Traffic Safety Administration concerns about cellular phone use being a growing factor in crashes. Built on Microsoft's Windows CE operating system and powered by an Intel Premium Processor, the in-car system was seen for the first time in a Ford Windstar TekSport concept car at CES in January.

"Visteon's ICES will radically change how time is spent in a vehicle," said David Pearce, Visteon's vice president for global aftermarket operations. "As cars and trucks become much more than basic transportation—a mobile office, an entertainment center, and an information source—consumers are seeking to have their vehicles become a natural extension of their lifestyles. Visteon's ICES does that by creating a seamless link between home, office, and car."

The system can also control a multitude of cockpit functions, including the trunk and fuel-door release; and it can control interior lights, outside mirrors, and steering-wheel height. PT

similar to the retina, which interprets color and light, it transforms optical signals into electrical impulses. The device also streamlines the process by which electrical charges are transmitted through the photodiodes, making high-speed continuous photography possible, thus offering high-quality, full-motion video output.

Digital cameras featuring this new technology are being developed, with products expected to be available this year. Down the road, Fujifilm's Super CCD technology can lead to new products such as ultra-compact digital cameras and a single product that can capture both megapixel still images and full-motion video with digital camcorder quality. PT

"Doctored-Up" Cotton

Researchers at Pacific Northwest National Laboratory, the U.S. Department of Agriculture, and Virginia Commonwealth University's Medical College of Virginia Hospitals are exploring innovative methods of altering cotton gauze to enhance the healing of chronic wounds. Approximately two million Americans, including diabetics and those confined to beds and wheelchairs, suffer from non-healing wounds.

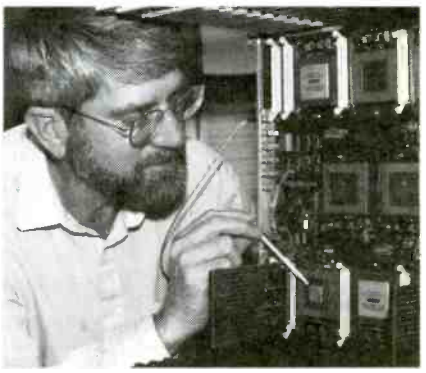
Studies show there's a link between chronic wounds and elevated levels of the enzyme elastase. This enzyme is known to degrade proteins such as fibronectic, which is required for tissue repair. This association has prompted research into altering cotton to remove elastase. The challenge is to do so without sacrificing the material's valuable properties, such as absorbency and air permeability. In one approach, researchers synthesized a peptide "recognition site" for elastase on the cotton surface that absorbs the degradative enzyme away from the wound.

The modified dressings are scheduled to enter clinical trials at Medical College of Virginia Hospitals this spring. PT

World's Fastest Encryptor

The world's fastest encryptor device has been developed at the Department of Energy's Sandia Laboratories. The device should soon be protecting data transmitted from supercomputers, workstations, telephones, and video terminals. It encodes data at more than 6.7-billion bits per second, ten times faster than any other known encryptor.

Designer Lyndon Pierson says the device "has both the security and bandwidth necessary for the protection of all types of digitized information—voice, audio, video, cell phone conversations, radio and television transmissions, banking and credit card information, and general purpose computer data—at speeds previously unimagined."



Lyndon Pierson points to the unclassified encryptor chip—the world's fastest encryption device—that his Sandia research team designed.

Consisting of 16 sets of 16,000 transistors on an integrated circuit chip, the encryptor is the size of a dime. Data, broken down into single bits of information in 64-bit units, are pipelined through the transistors. Then a computationally intense algorithm scrambles the information so that it becomes incomprehensible to anyone who does not have the cryptographic key. PT

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New Models with Newly Added Features!!

TOUCH DISPLAY MODULE

CTD1047 COLOR

10.4-inch color TFT

NEW

CTD5741 COLOR

5.7-inch color STN

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

NEW

μTD4141

5.7-inch monochrome

Development Support Tool

For Windows 98/95

$170 NEW

New Features

Personalized Color Pallets

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

Copying

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

Expanded Flash Memory

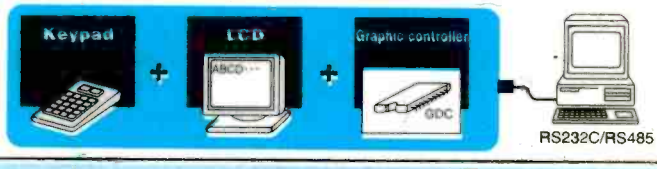
Image Manipulation

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

Screen-to-Screen Group Move

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

●System Setup Example



Specification / Model		μTD4141	CTD5741	CTD1047
Display	LCD	5.7-inch, monochrome	5.7-inch, color STN	10.7-inch, color TFT
	Resolution	320 × 240	320 × 240	640 × 480
	Maximum digits	40 columns × 30 lines	40 columns × 30 lines	80 columns × 60 lines
	Effective display area (mm)	116 × 87	116 × 87	211 × 158
Key matrix input		10 × 6	10 × 6	13 × 10 (640 × 480)
Key size (mm)		12 × 14	12 × 14	15 × 15
Power supply		5V DC 0.8A	5V DC 1A	5V DC 1.2A
Dimensions (mm)		W189 × D112 × H32	W189 × D112 × H32	W272 × D205 × H43
Standard price		**$635**	**$845**	**$1400**

※Escutcheons and cases available for all models.

※Standard prices shown in this table are changed without notice for rate of exchange.

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

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

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

INH International Hanbai Co., Ltd
22-30 Kanda-cho, Onomichi, Hiroshima, 722-0016, Japan

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Q & A

READERS' QUESTIONS, EDITORS' ANSWERS
CONDUCTED BY MICHAEL A. COVINGTON, N4TMI

Mystery Circuit

Q *A few years ago, I tried to build a field-strength meter using the circuit in Fig. 1. It did not detect the 46-MHz transmitter I was testing; instead, the LED appeared to fluctuate randomly in response to the proximity of my body, the position of a metal door 30 feet away, and even passing cars. The circuit worked with only a few of the 2N2222-compatible transistors that I tried, and it did not work when I transferred it to perfboard or powered it with a power supply.*

What was the circuit detecting, and does it have any hobbyist value?—R. H., Carson City, NV

A Welcome to the wild world of floating inputs! Much of the art of electronic engineering is devoted to keeping things like this from happening.

There's a lot of electrical noise in the world, ranging from static electricity (DC) to capacitively coupled AC from nearby power lines, noise spikes from motors, and radio-frequency signals. When you leave a high-impedance input unconnected, the noise is picked up.

Your circuit uses a Darlington connection (Fig. 2) to create a super-high-gain transistor with very high input impedance. If each transistor has a current gain (beta) of 50, then the beta of the whole thing is 50 × 50 × 50 × 50 = 6,250,000; and the input impedance is theoretically 6,250,000 × 220 ohms or more than 1000 megohms. In reality, it isn't that high because of leakage.

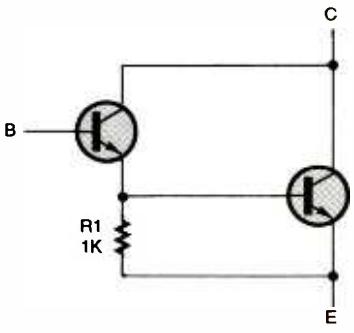

Fig. 2. A Darlington transistor behaves electrically like a two-transistor gain stage. The amplified collector current from the first transistor feeds the base input of the second transistor. The overall gain of the circuit is the gains of the two transistors multiplied together. For that reason, Darlington transistors have phenomenally high gain ratings.

In fact, the problem with the circuit is that any leakage in or around the first two transistors is also multiplied tremendously. That's probably why only a few of your transistors worked, and it's also why the circuit didn't survive being transferred to perfboard. On a really clean, alcohol-washed perfboard, in low-humidity conditions, it might have worked. Even then, it would probably still respond to temperature changes, light shining on the diode, or other incoming signals.

Figure 3 shows a simpler "mystery circuit" you may enjoy experimenting with. Touching the antenna or holding your hand near it will change the LED from red to green, or vice versa; you may also see it turn yellow or orange or even go off entirely. This circuit relies on the extremely high input impedance of CMOS integrated circuits. It also illustrates why you should never leave a CMOS input unconnected; electrical noise will cause very erratic operation. You'll get the most interesting results on dry days when there's a lot of static electricity around.

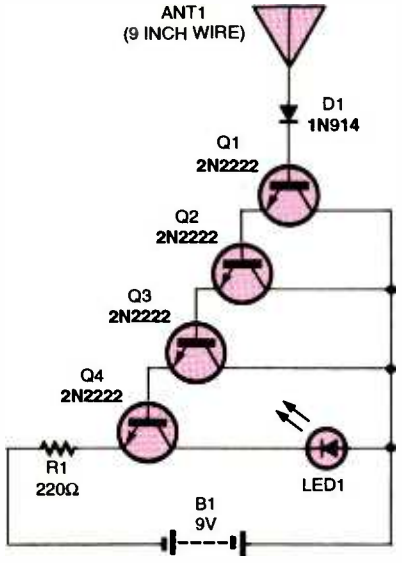

Fig. 1. While this circuit might seem to be a serviceable field-strength indicator, its floating input will pick up everything from passing cars and people to what might be interpreted as "other-worldly spirits!"

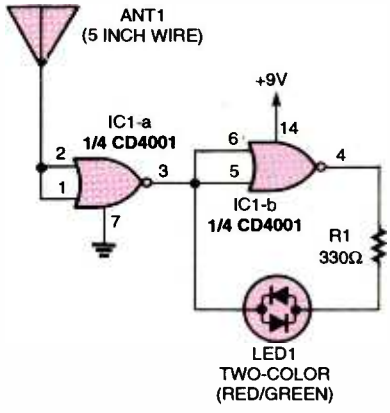

Fig. 3. Here's a simple circuit that demonstrates the effects of a high-impedance floating input. Any signal from body proximity to cosmic rays will cause LED1 to flicker and change color wildly.

Solid-State Relay Hangs

Q *I am trying to use a RadioShack 275-310 solid-state relay and cannot get it to switch a DC load properly. When I apply the control signal, the relay switches on; but then it won't switch off until I remove power from the load circuit. Why is this?—M. D., by e-mail*

A A real relay is a switch actuated by an electromagnet. A solid-state relay, however, is something quite different. Inside it is a Triac, or bi-directional thyristor, activated by light from an LED. This is a latching switch; once it's triggered, it conducts until the flow of current stops. (See Fig. 4.) With AC, this happens twice on every cycle; with

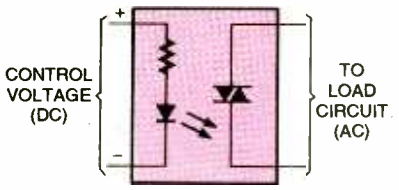

Fig. 4. Most solid-state relays are optically-triggered Triacs in a sealed case. An LED is positioned within the case to shine on the Triac. Since, like its cousin the silicon-controlled rectifier (SCR), the Triac will latch in the "on" state as long as any current is passing through it, its use is restricted to AC circuits unless you want the latching feature.

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DC, it doesn't happen until power is removed from the load circuit.

As you've surmised, solid-state relays are normally used with AC loads. You can use one with DC as long as you understand that it will latch. For some applications, such as alarms, latching is exactly what you want.

What's A 5M6 Resistor?

Q *What does it mean when the value of a resistor is given as 2k7, 5M6, or the like? I thought all resistors had numeric values.—M. D., by e-mail*

A You've run into a European notation in which the decimal point is replaced by the metric prefix (k for kilo, M for mega). Thus, 5M6 means 5.6 megohms, and 2k7 means 2.7 kilohms (2700 ohms). Likewise, 27k and 56M would mean 27 kilohms and 56 megohms, respectively. When the value is given in ohms, you'll often see an R in place of the decimal point. Thus, where Americans would write 4.7 ohms or 270 ohms, Europeans write 4R7 or 270R, respectively.

Another thing you'll see in European diagrams is nanofarads (nF), a unit of capacitance equal to 1000 picofarads. Thus, where we write 2700 pF or, equivalently, 0.0027 µF, Europeans write 2.7 nF or just 2.7n.

Intermittent TV

Q *I have a late-1980's model Zenith TV. The problem is that when I'm watching TV, the power sometimes goes out completely. After leaving the TV off for a period of time, I can turn it back on. Recently the intervals at which it will shut itself off have become much shorter. Can this be a power supply problem? Please give me some idea where to start looking. – B. S., Grand Rapids, MI*

A It could be a heat-related loose connection, either a plug loose in a socket or a bad solder joint. It could also be a power-supply or high-voltage problem, where something is on the verge of tripping a shutdown circuit and finally does so after it gets warmed up.

You might start by unplugging every internal connector and plugging it back in. **(Use high-voltage precautions, of course; there are potentially lethal voltages in a TV set.)** Also, check for solder joints that look bad and re-solder them. Unfortunately, a cold solder joint often looks exactly like a good one.

Another strategy is to try identifying the affected area of the chassis by blowing warm air on it (to make it fail) or by using cold air or freezing spray (to bring it back to life).

Check the service manual, too (available from *www.hwsams.com*; see sidebar, "How to Get Information About Electronics"). You can check voltages to try to identify something that is out of specification.

As long as the problem is infrequent, it will be hard to troubleshoot. The fact that it is occurring more often is actually good news; when it happens, you can measure what is going wrong.

By the way, have you made sure the plug isn't loose in the outlet and the power cord isn't loose where it connects to the TV?

Video Connector Question

Q *I have several Sony EVO210 VCRs that I would like to use with security cameras. The front "remote" is a 5-pin DIN connector similar, but not identical, to S-VHS. There is a sliding panel on the right side with a 24-pin rectangular male connector*

HOW TO GET INFORMATION ABOUT ELECTRONICS

On the Internet: See our Web site at *www.gernsback.com/poptronics* 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 http://www.hitex.com/chipdir/, or try addresses such as http://www.ti.com and http://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.repairfaq.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.

Copies of past articles: Copies of past articles in **Electronics Now, Popular Electronics** (post 1995 only) and **Poptronics** are available from our Claggk, Inc., Reprint Department, P.O Box 4099, Farmingdale, NY 11735; Tel: 516-293-3751.

Electronics Now 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, PO Box 549, Tooele, UT 84074.

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; (http://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.

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(with only 22 pins actually present). At the right rear is another flap concealing a 12-pin female DIN socket labeled "camera" (the keys make it appear to be octagonal).

How should I go about finding the correct connectors or pinout specifications? I've asked Sony; they're amazingly unhelpful with orphaned products. – Ross Goeres, Albuquerque, NM, goeres@ix.netcom.com

A The first step would probably be to renew your efforts to get a service manual from Sony. Double-check the model number; we could not find "EVO210" or "EV0210" (with a zero instead of O) in the database of Howard W. Sams (*www.hwsams.com*), nor on any Web page anywhere, and that's a bit suspicious. If this equipment was originally sold outside the United States, you'll need to contact Sony in that country.

We're publishing your e-mail address in the hope that a reader who has solved the same problem can help.

The Dark Side Of The Telephone

Q *Could you provide a circuit that would block my teen-age son from calling certain area codes, especially 900 numbers? I am in prison, and my wife is being billed hundreds of dollars per month because my son is calling 900 numbers without our permission. – M. B., Sayre, OK*

A Back when 900 numbers were new, I submitted comments to the FCC arguing that they should do away with them. My reasoning was that a person's account with the telephone company is not like a credit card; it is not as tightly controlled and was never intended for buying anything more than just telephone service. A stranger or casual visitor to your house can use your telephone; now that 900 numbers exist, that same casual visitor can charge thousands of dollars to your account. If credit cards worked that way, we'd consider them horribly insecure.

The circuit that you describe could be built; it would work by decoding the dialing tones and cutting off the line, or short-circuiting it temporarily, when "1-900" is detected at the beginning of a sequence. This would require a programmed microcontroller, plus a DTMF decoding chip. One such chip is the Mitel 8870; information about it is available at *www.mitelsemi.com*. The DTMF decoder identifies the individual digits, and the microcontroller keeps track of the sequence in which they are received.

However, your problem is not an electronic one. Anybody who would spend hundreds of dollars of your money against your wishes would also tamper with any circuit that you could build and install. If you really can't control your teen-aged son, you should seek the help of the legal system before he does further damage.

Your local telephone company can almost certainly block calls to 900 numbers. Notify them that your son does not have permission to use the telephone and that you will not pay for calls that he makes. If the telephone company can't help you, simply turn off telephone service to the house and get your wife a cell phone that she can keep in her possession at all times.

A MOSFET "Gotcha"

I was bitten by this one recently and thought I'd share it with everyone...

It's common practice to drive the gate of an IRF510 or IRF511 MOSFET with a 5-volt logic signal. I've even done that in circuits published in this column.

That's fine, as long as the IRF510 isn't carrying much current. Under heavy load, however, it will not turn fully "on" with a 5-volt gate voltage. The published threshold voltage, 4.0 volts maximum, is the voltage at which it starts to conduct. Experimentally, I measured 6 volts as the minimum to achieve the rated 0.6-ohm drain-to-source resistance.

There are logic-level MOSFETs, such as the IRL530 (with an L, not an F). They start to turn on fully around 2 volts and are fully on at 4 volts. Use them when you must switch high current with a logic-level signal.

Writing to Q&A

As always, we welcome your questions. The most interesting ones are answered in print. Please be sure to:

(1) include plenty of background information (we'll shorten your letter for publication);

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

(3) type your letter if possible, or write very neatly; and

(4) if you are asking about a circuit, include a complete diagram.

Questions can be sent to Q&A, **Poptronics** Magazine, 500 Bi-County Blvd., Farmingdale, NY 11735, or e-mailed to *q&a@gernsback.com*, but please do not expect an immediate reply in these pages (because of our backlog) and please don't send graphics files larger than 100K. Due to the volume of mail, we regret that we cannot give personal replies. P

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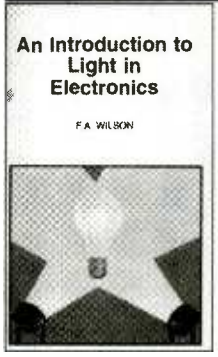
An Introduction to Light in Electronics



Taken for granted by us all perhaps, yet this book could not be read without it, light plays such an impressive role in daily life that we may be tempted to consider just how much we understand it. This book makes a good start into this fascinating and enlightening subject. It has been written with the general electronics enthusiast in mind.

To order Book #BP359 send $6.99 plus $3.00 for shipping in the U.S. and Canada only to Electronics Technology Today Inc., P.O. Box 240, Massapequa Park, NY 11762-0240. Payment in U.S. funds by U.S. bank check or International Money Order. Please allow 6-8 weeks for delivery. ET08

Practical PIC Microcontroller Projects

This book covers a wide range of PIC based projects, including such things as digitally controlled power supplies, transistor checkers, a simple capacitance meter, reaction tester, digital dice, digital locks, a stereo audio level meter, and MIDI pedals for use with electronic music systems. In most cases the circuits are very simple and they are easily constructed. Full component lists and software listings are provided. For more information about PICs we suggest you take a look at BP394 -- An Introduction to PIC Microcontrollers.

To order Book #BP444 send $7.99 plus $3.00 for shipping in the U.S. and Canada only to Electronics Technology Today Inc., P.O. Box 240, Massapequa Park, NY 11762-0240. Payment in U.S. funds by U.S. bank check or International Money Order. Please allow 6-8 weeks for delivery. ET10

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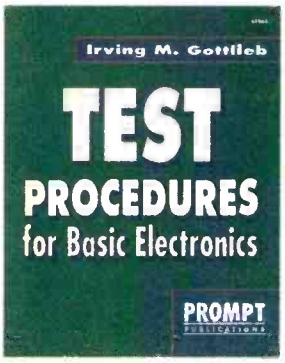

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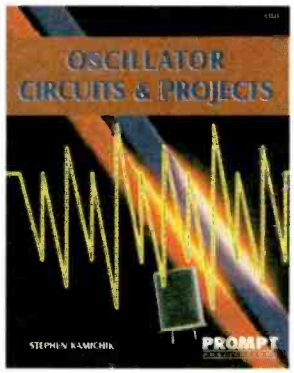

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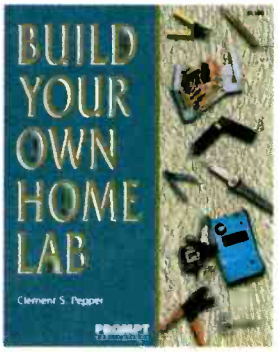

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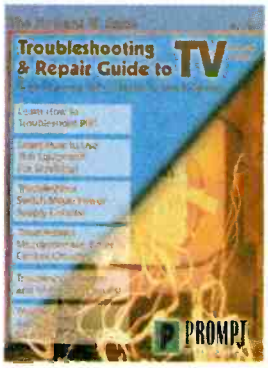

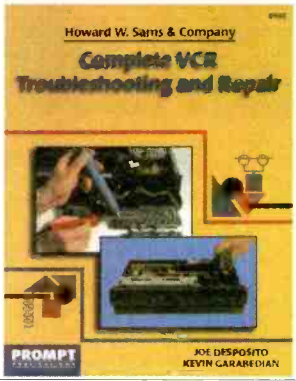

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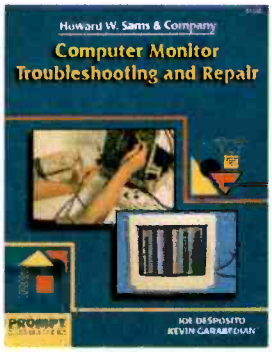

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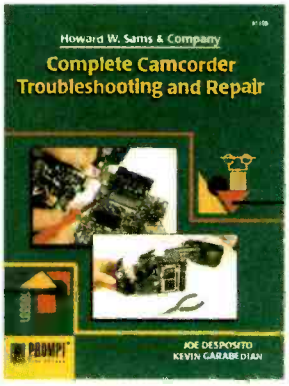

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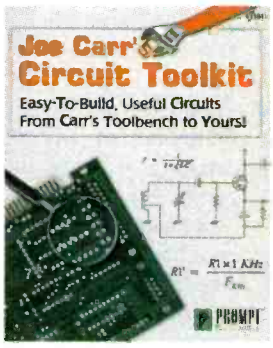

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VCR Cleanup Problems

This month we deal with the cure for many common VCR problems—the need for a proper cleaning, inspection and replacement of worn or tired rubber parts, and the cleaning of video heads. Performing video-head cleaning correctly is critical for the health of your video heads! See Fig. 1 for a diagram of the VCR tape transport or refer to a VCR repair manual while you read the following.

General Guide to VCR Cleaning and Rubber Parts Replacement

All the guideposts, wheels, and rubber parts of a VCR should be cleaned periodically: how often depends on usage. Of course, no one really does it unless something goes wrong. Don't try to clean the video heads until you learn the proper procedures; you can break them, and that will be a very expensive lesson. In most cases, they do not need attention.

Cotton swabs and alcohol can be used for everything *except* the video heads. Using 91% medicinal alcohol is OK, but pure isopropyl is better. Avoid rubbing alcohol, especially if it contains any additives. Just dry the rubber parts quickly to avoid leaving residue behind or damaging them further.

Cleaning might get your machine going well enough to get by until any replacement rubber parts arrive, and you can confirm your diagnosis.

Things to Clean

Capstan and Pinch Roller—These components collect a lot of crud, mostly oxide which flakes off old rental tapes. Use as many cotton swabs as necessary, which are wet but not dripping with alcohol, to remove all foreign matter from the capstan—the shiny shaft that pulls the tape through the VCR for Play and Record. Just don't get impatient and use something sharp—the crud will probably come off with the swabs or else with some help from a fingernail.

Clean the pinch roller, which presses against the capstan in Play, Record, and Search mode CUE and REVIEW, until no more black stuff comes off. Again, use as many swabs as necessary until the swabs remain clean.

If the pinch roller is still hard, shiny, or cracked, it will probably need replacement. Pinch rollers are available for about $6 from various parts suppliers. It is sometimes possible to put the pinch roller in an electric drill, drill press, or lathe, and carefully file off the hard, shiny, dried-out rubber surface layer. Do this only as a last resort—this fix is probably temporary at best. For a detailed, step-by-step procedure, see the link on my Web site to an archived *sci.electronics.repair* newsgroup posting.

Various Guideposts—These mechanisms include the roller guides—the white rollers on metal posts which are near the video head drum when in Play or Record mode—and should also be cleaned. When in FF or REW, or with no tape present, these guides move on tracks to a position toward the front of the VCR. Note that the roller guides with the white rollers and tilted metal posts will be fairly loose when in the unloaded position, but you should not be able to lift them off the tracks. When actually playing or recording a tape, they will be snug against the stoppers at the end of the tracks.

Idler Tire—The idler swings between reels and transfers motor power to reels. Clean it the same way until no more black stuff comes off. A dirty or worn idler tire is probably the single most common VCR problem.

If the idler tire appears cracked, glazed, or dried out, it will need to be replaced at a cost of about $.50 to $1. As a temporary measure, you can usually turn the tire inside out and replace it. The protected inner (now outer) surface will grip well enough to restore functionality until a replacement tire arrives, when you can verify the problem's.

The idler assembly includes a slip clutch. If it weakens, the idler may not have enough force to press on the reel-table edges, which are the surfaces on the reel tables that the idler contacts. These edges can be cleaned in the same way. If the clutch becomes too tight, there can be audio, video, or crinkled tape problems and/or excess wear of the idler tire. It is possible to obtain the entire idler assembly as a replacement part. They can also usually be disassembled and adjusted, if necessary.

Audio/Control and Full-Erase Heads—Cotton swabs and alcohol are fine for cleaning these heads and anything else that the tape contacts on its exciting journey through your machine

Rubber Belts—Access to some belts will probably require the removal of the bottom cover. On some models, you may need to unscrew circuit board(s) blocking access to either the top or bottom of the tape transport. Make notes of what went where—particularly different types of screws and routing of wires. After noting where each belt goes, remove them individually, if possible, and clean with alcohol and cotton swabs or lint-free cloth. Dry them quickly to avoid degrading the rubber from contact with the alcohol.

If a belt is trapped by some assembly and not easy to remove, use the swab on the belt and/or pulley in place. However, if it is stretched, flabby, or damaged, you will need to figure out how to free it. Any belt that appears loose or flabby or does not return instantly to its relaxed size when stretched by 25% or so will need to be replaced and may be the cause of your problems. Belts cost

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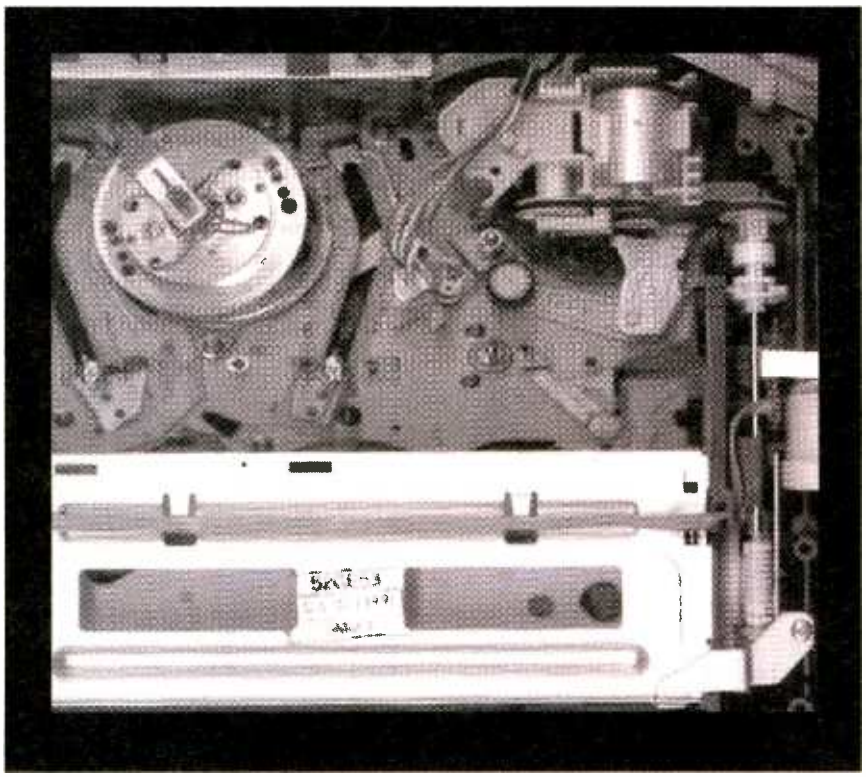

Fig. 1. A typical VHS VCR tape transport mechanism.

between $.30 and $2; complete replacement belt kits are often available by model number, with prices from $3 to $12. Meanwhile, the belts will function better once they are cleaned—maybe just enough to get by until your replacements arrive.

Video Heads—**READ CAREFULLY.** Improper cleaning can ruin the expensive video heads. **Do Not** attempt to clean the video heads without reading and following the procedure described in detail below. And don't clean them if there are no problems with video noise/lack of video or with the HiFi audio

Lubricating a VCR

The most important thing is not to add any oil or grease unless you are absolutely sure it is needed. Most parts in a VCR are lubricated at the factory and do not need any further lubrication over their lifetime. Too much lubrication is worse than too little. It is easy to add a drop of oil, but difficult and time-consuming to restore a VCR that has taken a swim.

Never, *ever*, use WD40 in a VCR! WD40 is not a good lubricant despite the claims on the label. Legend has it that the WD stands for Water Displacer, which is one of the functions of WD40 when used to coat tools. WD40 is much too thin to do any good as a general lubricant and will quickly collect dirt and dry up. It is also quite flammable and a pretty good solvent; there is no telling what will be affected by it

A light machine oil like electric-motor or sewing-machine oil should be used for gear or wheel shafts. Plastic safe grease like silicone grease or "Molylube" is suitable for gear teeth, cams, and the roller guide tracks.

Unless the VCR was not properly lubricated at the factory, which is quite possible, the only areas that might need lubrication are the roller guide tracks—clean and grease them. Sometimes, you will find a dry capstan, motor, lever, or gear shaft; but this is less likely.

Need for Manual or Automatic Video Head Cleaning

When should you clean a video head? Only when symptoms point to a problem with the head. Periodic cleaning is not necessary and may cause excessive wear if done with a head-cleaning tape, especially the dry kind, which may be excessively abrasive. Frequent cleaning by hand, while not damaging, still represents a slight risk since you never can tell when you might do something you will regret!

VCRs should be cleaned periodically, but video heads usually do not need periodic cleaning as the spinning heads perform a self-cleaning function. "If it ain't broke, don't fix it."

I do not see any advantage in buying a VCR that claims to have automatic video-head cleaning. The automatic head cleaner is a foam roller that contacts the rotating heads for a couple of seconds when the tape is loaded. In my opinion, this is worse than useless as any crud collected by this foam may just be redeposited on the heads during the next cleaning cycle. So, if your VCR has this *feature* and you experience symptoms of dirty video heads after each tape, remove the feature and performance will improve.

The only ones to benefit from an automatic head cleaner are the manufacturers of the VCR as it increases their profit margins!

As noted below, there is a slight risk that at some point automatic head cleaners may actually destroy the video heads—no doubt timed to be one day after your warranty runs out. In addition, they do nothing to clean those portions of the VCR that really may need periodic maintenance like the rubber parts, A/C head, and tape guides, discussed above

Video Head-Cleaning Technique

Caution: Read the following in its entirely to avoid an expensive lesson.

As noted, improper cleaning can destroy the video heads. The head chips are very fragile and just rubbing them in the wrong direction can break the chips off, requiring replacement of the entire upper cylinder assembly—one of the most expensive parts in your VCR! **Never** use an up-and-down motion to clean the heads.

The best method to use is manual cleaning, using the proper head-cleaning sticks, but that means you need to take the cover off your VCR. If you prefer not to do this, try a commercial wet cleaning tape, but there is a slight risk involved. The material used in some of these may have an excessively coarse fiber structure that can catch a video head and break it off. I have not seen this happen, nor could I recommend a specific brand as there is no way of knowing what their current product uses. I do not recommend the dry type at all, as these are almost always much more abrasive and may cause premature wear of your video heads especially if used regularly. When using the wet-type cleaning tapes, follow the directions and—very impor-

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tant—wait long enough for everything to dry out or else you will have a tangled mess inside your VCR.

Since regular video-head cleaning should not be needed, I do not recommend the regular use of a cleaning tape. If you do need to clean your video heads frequently, the video heads may be worn, the backtension may be set too high, or you may be playing old or dirty (literally) rental tapes.

When you do clean video heads by hand, use the head-cleaning sticks. They are covered by chamois and are the safest. **Do Not Use Cotton Swabs**, which can catch on the ferrite cores and either cause damage or leave fibers stuck in the heads. It's OK to use swabs for cleaning the other parts, like the rollers and audio/control head, as I described above, but not *on* video heads.

To use the cleaning stick, moisten it with head cleaner or alcohol. Pure isopropyl is best; however, the 91% medicinal variety works as long as you dry everything pretty quickly. Don't flood it, as it will take a long time to dry. You also take the slight risk that any water in the alcohol will sit on surfaces and cause rust; don't take the chance.

Gently hold the flat portion of the chamois against the upper cylinder where it is joined to the lower (non-rotating) cylinder. Rotate the upper cylinder by hand so that the heads brush up against the moist chamois. **Once again, do not move the head-cleaning stick up and down**; you could break the fragile ferrite of the heads, and that costs big bucks. Side-to-side motion is the safest as long as you are gentle.

I know people who use a piece of moistened typing paper, a business card, Mr. Coffee filter paper—or even their Mark-1 thumb for video-head cleaning. I do not recommend these for general service procedure; use chamois first!

I suppose the only real requirement to prevent damage is that the material should have a fine enough structure and should not have any fibers that can get stuck in the heads. So, the short list of acceptable materials is quite long—some more effective than others. My concern for a general recommendation is that people's interpretation of these requirements can vary quite a lot. If a novice comes to me and asks what to use, I will say cleaning sticks. Once they understand the characteristics of the heads and their mounting, they are free to use whatever works. Depending on how dirty the heads are, a couple of passes may be enough. Let everything dry out for at least a half hour. You may need to repeat this for stubborn clogs. However, one pass will often do it.

As noted, under NO circumstances should you be going up and down, even though you might think this would work better given that the head gaps are vertical (or nearly so). The head gaps are solidly filled with a material of similar hardness to the ferrite. Stuff can't get trapped in the gap—only on the surface, above or below, and inside the winding area. Look at a head chip close up under a microscope, some time.

In addition, inspect and clean the drum itself staying safely away from the video-head chips. The five fine grooves in the drum help control the air bearing that the tape rides on and help to stabilize tape motion. These should be clear of dirt and tape oxide. (**Do not** use anything sharp—the moistened head-cleaning sticks will work.)

Next time, we will deal with the more common VCR problems. Until then, check out *www.repairfaq.org*. I welcome comments (via e-mail only please) of all types and will reply promptly to requests for information. P

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This updated electronics reference gives readers the electronics information they need—and only the electronics information they need. It comes in a handy portable format that has a quick look-up layout. Key charts, equations, and data tables make it easy to find information.

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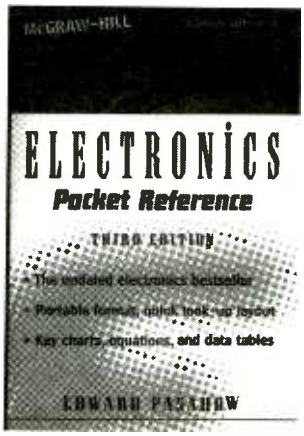

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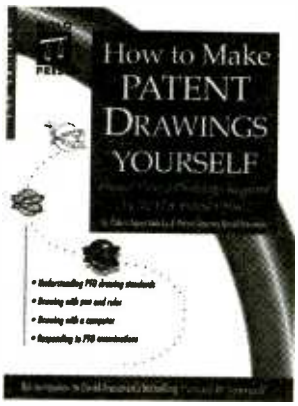

This second edition includes the latest changes in the patent rules, which affect several parts of the patent applica-

(Continued on page PR-10)

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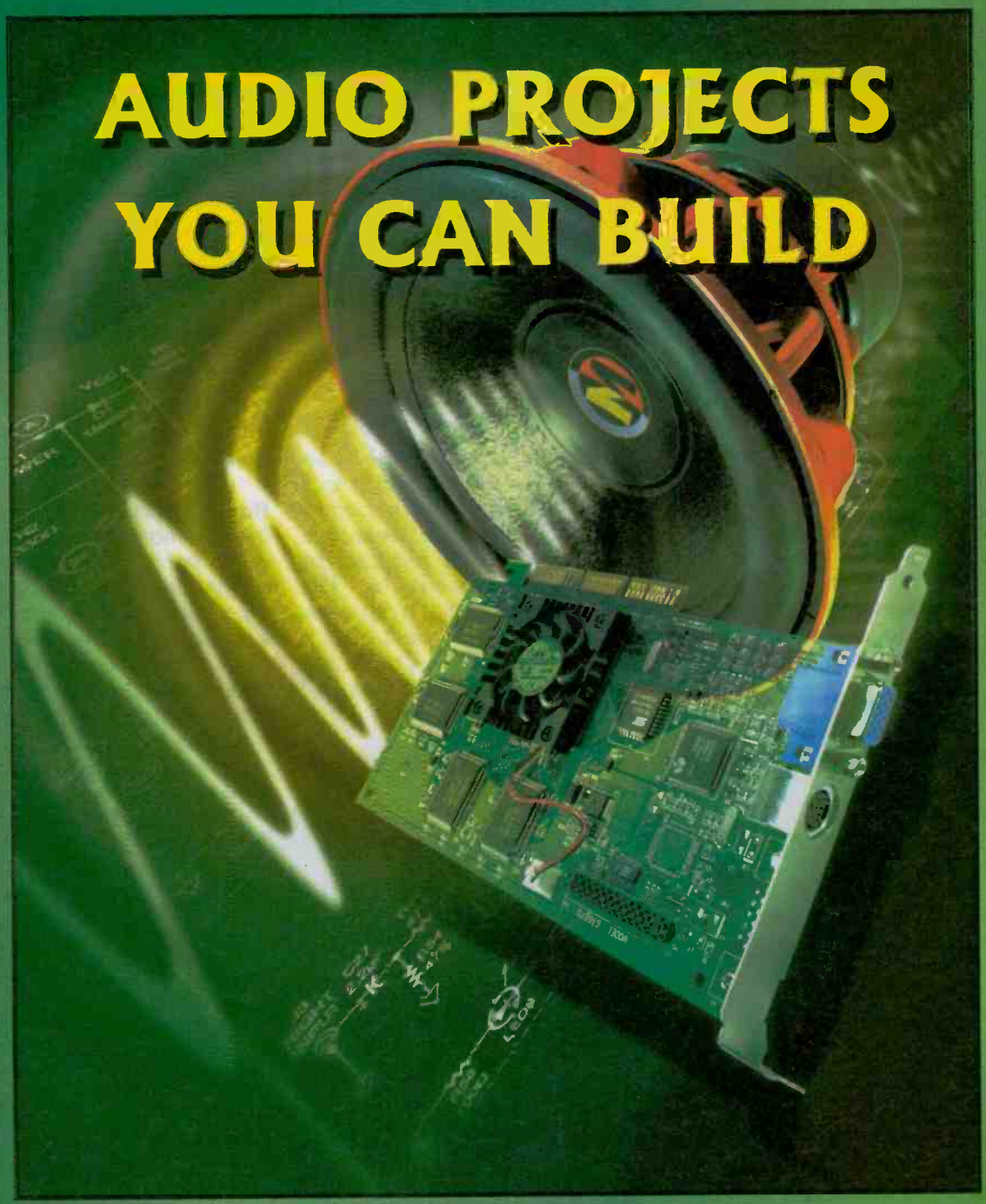

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Audio Signal Generator

GARY McCLELLAN

Tired of "making do" with generic audio oscillators when adjusting or troubleshooting audio gear? Use one that's fine-tuned for just that use!

If you work with audio equipment on a daily or occasional basis, sooner or later you'll have to do some troubleshooting or aligning, or make some adjustment to your gear. Perhaps you have a small home-recording studio or repair shop for electronic-musical instruments. One item that's probably on the "wish list" of everyone in the audio field is an audio oscillator that can be used on the bench to troubleshoot musical instruments and in the studio to set levels in professional sound systems. It has to be small and easy to operate by busy people who don't have time to read manuals or learn software commands. The *Audio Signal Generator* presented here fulfills that wish. Several units have already found their way onto workbenches and into studios since it's development, and the design has been proven successful.

Unlike generic audio oscillators, this unit has been optimized for audio applications. For example, the unit offers balanced and unbalanced outputs for professional- and consumer-equipment testing. Line- or microphone-output levels are selectable at the flip of a switch. Level setting is made easier by using a volume control in place of the traditional linear control found on commercial generators. Knob "twiddling" is reduced by presetting the frequency to 1 kHz, the most widely used value in audio testing.

You'll also be pleased to know that this circuit handily outperforms most service-grade audio generators. For example, the prototype produced a rock-stable 992 Hz, 2.5-volt sinewave output. Total harmonic distortion was 0.028%. The balanced-line outputs on the XLR-compatible output were matched to within 1% at full output—amazing performance from a few cheap parts wired in a simple circuit!

How It Works. As you can see from the schematic diagram in Fig. 1, the Audio Signal Generator is a simple, straightforward device. It is based on a quad op-amp and two voltage regulators. The op-amp serves as a classic Wein-bridge oscillator and a balanced-line driver. The voltage regulators provide stable power for the op-amp.

Op-amp IC1-a is connected as a 1-kHz Wein bridge. The op-amp is configured for a gain of 4, which is adjustable with R3. The frequency is determined by the RC time constant of the C1/R1 and R2/C2 pairs. Those resistor-capacitor combinations must be equal in value for the oscillator to work.

An unusual design feature of the oscillator is the inclusion of an incandescent lamp, I1. We're using the thermal properties of I1's filament to stabilize the output voltage of the oscillator. When a filament is cold, it has a very low resistance. That resistance rises as the filament heats up. When used as a light source, a lamp acts as a short circuit when first turned on. As it heats and starts to glow, the rising

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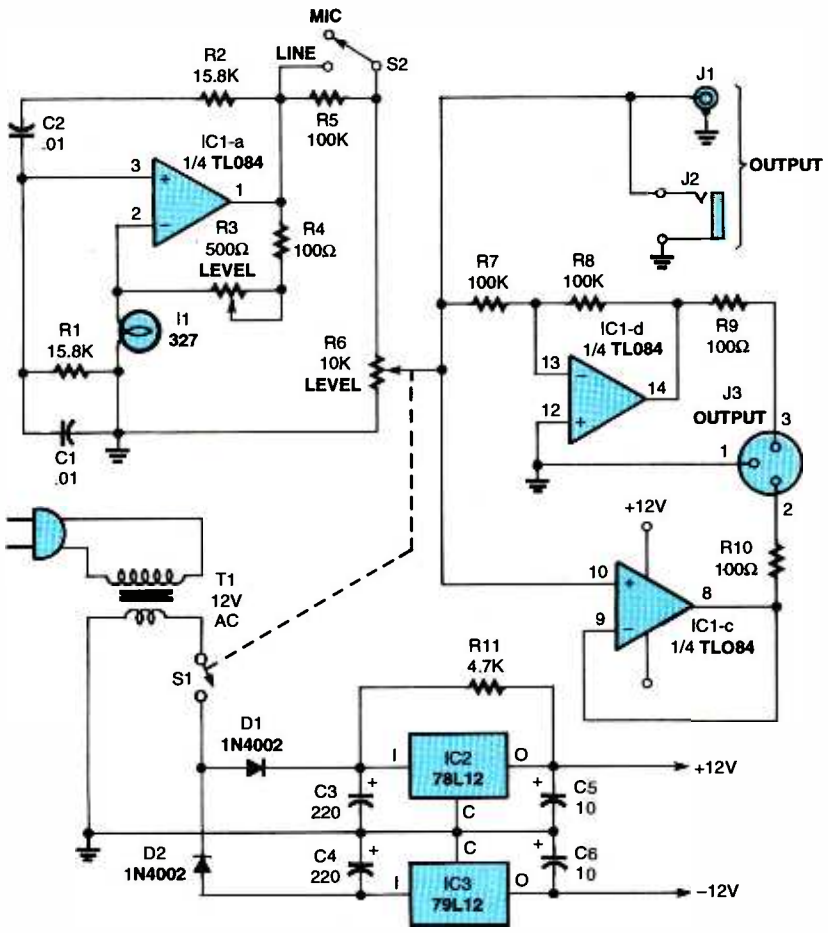

Fig. 1. The Audio Signal Generator is a basic circuit that has amazing performance given its parts count. The output level of the oscillator is controlled by a novel use for an incandescent lamp. As the voltage rises, the resistance of the bulb's filament drops, lowering the voltage. That feedback circuit is extremely stable.

resistance reduces the current flow until an equilibrium is reached. In our oscillator circuit, the resistance increases when the output voltage rises, reducing feedback, and returning the output voltage to a preset level. Likewise, if the output voltage drops, the lamp resistance decreases, increasing feedback, and returning the output to a preset level. Be aware that lamp I1 does not light in normal operation; if it does, there is a serious problem with op-amp IC1!

In fact, that "safety" feature was used in the past in some model train and slotcar setups. An automobile headlight was wired in series with the track. As long as everything was OK, the lamp remained out. That's because although a fair amount of current could be drawn through the lamp, the voltage drop across it was very small due to the extremely low resistance of the filament. As soon as something jumped the track and caused a short circuit, the lamp saw the total voltage drop from the transformer and lit up. Not only did it present a load to the transformer to prevent catastrophic burn out, it lit up the room to alert everyone to the nature of the problem.

The output of IC1-a drives a simple selectable attenuator and an output-level control. The attenuator consists of R5 and S2. With S2 closed, R5 is shorted, effectively removing it from the circuit. The output signal from IC1-a can therefore continue through the circuit at line level. Placing S2 in the "MIC" position removes the short across R5. The resistor then reduces the output voltage to microphone-friendly levels. Potentiometer R6 adjusts the output level. In order to make level setting easier, a volume-type control with a logarithmic taper is used for R6 to match the sensitivity of the human ear. The output from R6 connects to J1 and J2 for standard unbalanced outputs, as well as the input of the balanced-line-driver circuit.

Op-amp IC1-d inverts the unbalanced audio output from R6. The inverted output goes to pin 3 of J2. Unity gain is set by R7 and R8. Resistor R9 protects the op-amp from short circuits, and it minimizes the possibility of oscillation when the unit is connected to a long cable.

Op-amp IC1-c buffers the unbalanced audio output from R6. The non-inverted output goes to pin 2 of J2. Resistor R10 serves the same purpose as R9.

The power supply uses a conventional half-wave rectifier and three-terminal voltage regulators to develop +12- and −12-volts DC. Resistor R11 was included to insure that IC2 starts up each time power is applied. During the development of this project, it was discovered that IC2's output voltage would sometimes read −0.8 volt after power up. The problem was that IC3 starts up sooner than IC2, forcing it to shut down. Of the several possible cures for the problem, R13 proved to be the simplest and most effective solution. Incidentally, R13 does not affect power-supply regulation at the expense of reliable startup.

Construction. Obviously, before building the Audio Signal Generator, you need to obtain the parts. Here are some thoughts and suggestions on that subject.

The cabinet that was used in the prototype was an LMB CR-632 "Crown Royal" unit that measures 2⅛ inches high, 3½ inches wide, and 6¼ inches long. It is available from any LMB distributor such as Mouser Electronics or Digi-Key Corporation. Feel free to use any other cabinet; the only important considerations are that it is large enough to hold all of the components and that it is made of metal to prevent hum pickup.

If you want, you can build the circuit on a piece of perfboard using standard construction techniques. However, a neater and more pro-

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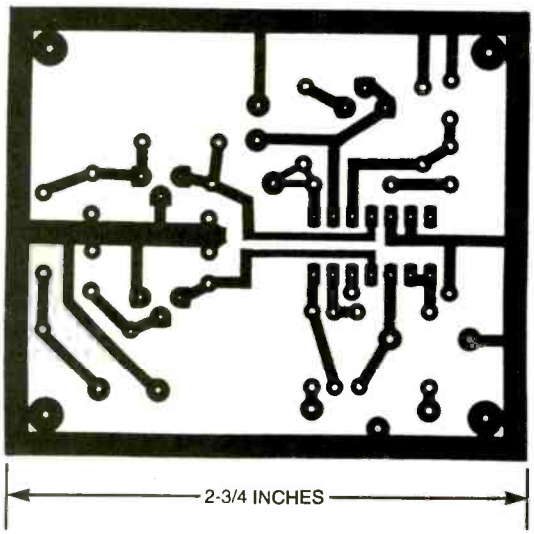

Fig. 2. The Audio Signal Generator is simple enough to fit on a single-sided PC board.

fessional-looking project results from using a printed-circuit board with the added advantage of reducing wiring errors. If you want to use that construction method, a foil pattern has been provided in Fig. 2. If you prefer perfboard construction, try to obtain a Fiberglas board; it is far more durable than those inexpensive phenolic "experimenter" boards.

The incandescent lamp is available from most electronic distributors, such as Mouser Electronics. Since it is designed for aircraft service, most aircraft-supply houses also stock it. When you buy it, get several; they are rather fragile. Do not use a substitute for this lamp; it was much less shock- and vibration-sensitive than all others tried in this application.

The remaining components will probably be found in your "junk box" or purchased from distributors.

If you fabricate a PC board from the foil pattern or use a perfboard, be sure to drill the four mounting holes in the corners.

If you are going the PC-board route, use the parts-placement diagram in Fig. 3 as a guide for component location. Double-check the resistor values and the polarities of the electrolytic capacitors before soldering them. All of the semiconductors are polarized, so install them carefully. Applying power to an incorrectly-installed semiconductor will most probably destroy it instantly. Since IC2 and IC3 have a slightly different pinout with respect to each other, note the case orientation shown in Fig. 3. Better yet, check the manufacturer's data sheet first.

It's a good idea to use a socket for IC1. Since that component is CMOS-based, it is susceptible to electrostatic discharge. With a socket, IC1 doesn't have to be installed until the board is built and wired into the case; the less it is handled, the less chance of damaging it. Remember, static-discharge damage can show up any time from immediately to two years later. Protecting the part now will help avoid grief and frustration later.

Lamp I1 is installed by carefully soldering pieces of leftover resistor lead to the base and tip of the bulb. The resulting "PC-mount" bulb is then inserted into the board and quickly soldered in place. You might want to use a heatsink to help keep the solder connections on the lamp from melting while soldering the other ends of the leads to the PC board. Don't forget to install the jumper; it runs from pin 12 of IC1 to a nearby ground pad.

When you are done, check your work for errors and correct them. It is best to do that after taking a short break or at the start of your next work session. Set the board aside.

Prepare the case by marking and drilling appropriate holes for the controls: J1–J3, R6, S1, and S2. The following description gives measurements for the author's prototype case and control layout. Refer to the photographs if you'd like to use a similar design.

Place a strip of masking tape over the front surface and mark a

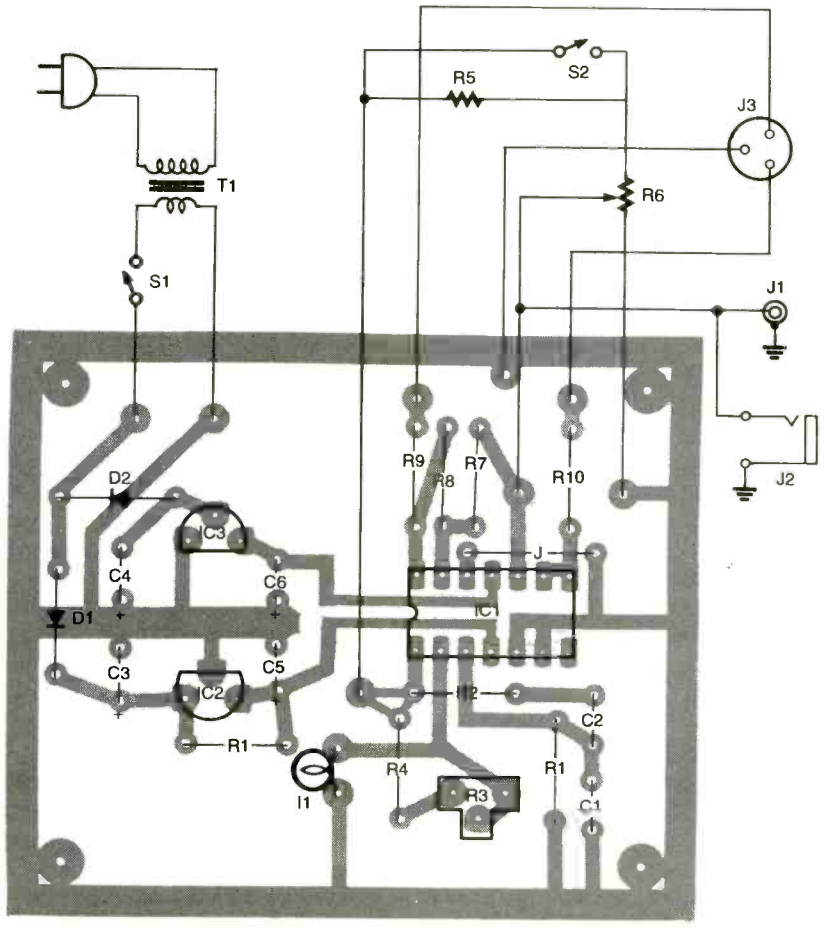

Fig. 3. The wiring of the external components, jacks, and controls for the Audio Signal Generator can get a bit tricky; double-check your work carefully.

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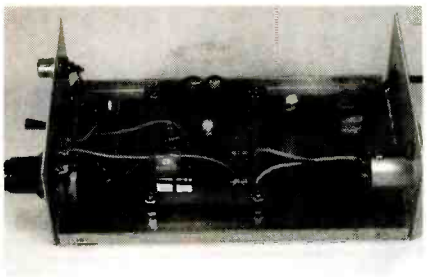

The Audio Signal Generator fits neatly in a small case. Carefully planning the wiring results in a professional-looking project.

horizontal centerline. Then mark hole locations fl inch from each edge for J1, J2, and R6. Switch S2 goes in the center. Drill the holes and deburr them. A similar piece of tape with a centerline goes on the back of the case. Mark two hole locations for the power cord and J3. The hole for the power cord should be large enough for a 1/8-inch grommet. Deburr those holes, also. Note that J3 needs two additional holes for mounting screws.

As an alternative, you may use an appropriate jack for power, especially if the wall transformer that you'll be using has a plug on the end of its wire. We'll assume that you're going to wire the transformer directly; any modifications in that respect will be up to you.

Using the PC board as a guide, mark the locations of the four mounting holes. The board should be about 1fi inches from the front panel. Mark an additional hole about one inch from the rear panel for a power-cable clamp. Set the PC board aside before you drill and deburr the holes. Remove the tape and wash the cabinet thoroughly.

For a professional-looking unit, label the various jacks and controls with dry-transfer or press-on letters. One type of label product that works well is the *Audio and Experimenters* set from Russell Industries. Similar letter sets are available from electronics distributors, office-supply stores, and graphics-supply houses. Spray the cabinet with several light coats of clear-lacquer spray paint and allow it to dry overnight.

When the case is dry, begin mounting the components to it. Push the grommet into the rear panel hole and install J3 with appropriate hardware. Install four threaded spacers that will support the PC board. Mount J1 and J2 on the front panel. Be sure to sand the inside of the cabinet around the holes for a good ground connection. Finish up by installing R6 and its knob and S2.

On the PC board, attach 3-inch lengths of hookup wire to the locations that will connect to S2 and R6. For J3 and S1, use 4-inch lengths. Pass the wire from T1 through the rear-panel grommet, and connect one lead to the other power-input pad.

Install the PC board to the threaded spacers with screws. Solder R5 across S2 and connect the appropriate 3-inch wires to S2 and R6. Additional jumper wires will be needed to connect the "hot" side of J1 and J2 to the wiper of R6, as well as between R6 and S2. Don't forget a ground wire between J1 and J2. That wire should also connect to the ground side of R6 (opposite S2).

Connect the unattached wire from T1 to S1; the 4-inch wire connected to the power-input pad of the PC board goes to the other side of S1. Use a nylon cable clamp to secure the power cable to the cabinet in the hole that was drilled previously. Finally, connect the three remaining 4-inch wires to J3. When you're done, compare your work against the parts-placement diagram in Fig. 3. If everything looks good, you're ready to test the completed Audio Signal Generator.

Testing, Adjustment, and Operation. A few simple tests are needed before using the Audio Signal Generator. Plug in T1 and clip the negative lead of a voltmeter to the cabinet. Turn the unit on and set the output level for zero. Check for the following power supply voltages: On IC1, pin 4 must read 12 volts within 0.5 volt, while pin 11 must read −12 volts at the same tolerance. The DC-offset voltages on pins 2 and 3 of J3 should not exceed 20 mV; if they do, try replacing IC1.

To adjust R3 for the best balance between level and distortion, connect an oscilloscope to J1 and set R6 fully clockwise. If you don't see a

(Continued on page PR-10)

PARTS LIST FOR THE AUDIO SIGNAL GENERATOR

SEMICONDUCTORS

IC1—TL084 quad op-amp, integrated circuit
IC2—78L12 fixed 12-volt regulator, integrated circuit
IC3—79L12 fixed 12-volt regulator, integrated circuit
D1, D2—1N4002 silicon-rectifier diode

RESISTORS

(All resistors are 1/4-watt, 1%, metal-film units, unless otherwise noted.)
R1, R2—15,800-ohm
R3—500-ohm potentiometer, PC-mount
R4—100-ohm
R5—100,000-ohm
R6—10,000-ohm panel-mount audio-taper potentiometer with integral single-pole, single-throw switch (RadioShack 271-1721 and 271-1740 or similar)
R7, R8—100,000-ohm
R9, R10—100-ohm
R11—4700-ohm, 1/4-watt, 5%, carbon-film

CAPACITORS

C1, C2—0.01-µF, 50-WVDC, polyester
C3, C4—220-µF, 25-WVDC, electrolytic
C5, C6—10-µF, 16-WVDC, electrolytic

ADDITIONAL PARTS AND MATERIALS

I1—No. 327 pilot lamp (Mouser Electronics 606-CM327 or similar)
J1—Chassis-mount RCA jack (Mouser Electronics 161-2052 or similar)
J2—Chassis-mount 1/4-inch phone jack (Mouser Electronics 16PJ022 or similar)
J3—Male XLR chassis-mount connector (Mouser Electronics 174-7143 or similar)
S1—Single-pole, single-throw switch (part of R6)
S2—Single-pole, single-throw toggle switch
T1—12-volt AC, 400 mA wall transformer (Digi-Key T611-ND or similar) IC socket, case, knob for R6, 1/8-inch rubber grommet, nylon cable clamp, wire, hardware, etc.

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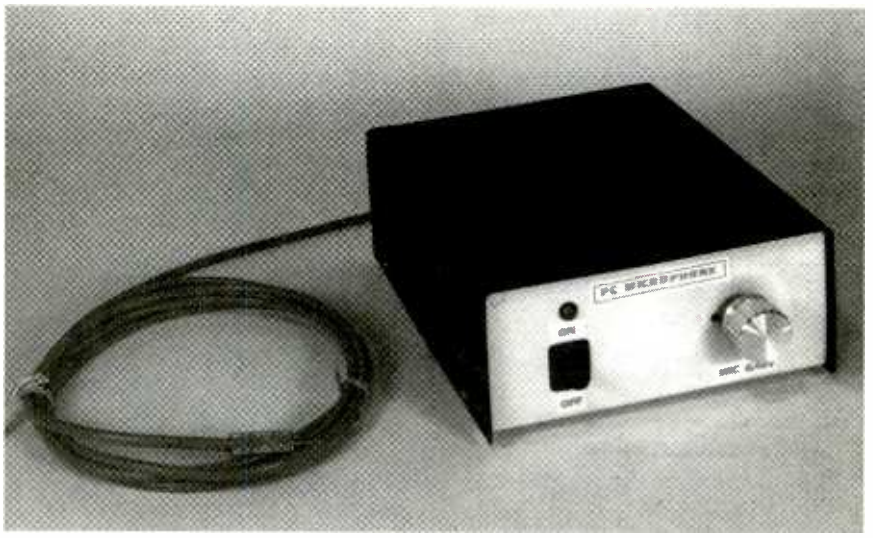
PC Microphone Swapper

You've got a top-of-the-line sound card and professional-quality sound-editing software to match—so why use that cheap microphone? Hook up a high-end microphone to your system, and you'll be amazed at what your computer can do!

ROBERT OLDS

Soon after I bought a multimedia computer, I began to realize that my options were limited in terms of what type of microphone can be used. Be honest—would you really choose a microphone that looks like a plastic drumstick if you had a choice? Karaoke sessions just aren't the same with it. I wasn't satisfied with the microphone's sound performance either. I found that it was too unidirectional and prone to "popping" noise. What is needed, therefore, is a way to use a professional-quality microphone when the situation warrants it. Face it—wouldn't you (like me) want to use a microphone that meets your expectations for appearance, feel, pickup pattern, and frequency response? If you would like the ability to swap your computer's microphone for another type, then the *PC Microphone Swapper* is the answer to your prayers.



The typical computer microphone is an electrostatic microphone, sometimes called a condenser or capacitor microphone. If that's the next microphone you'd like for your computer, then all you need to do is plug it into your computer's sound card and you're done. Chances are, though, that the microphone you choose will be a dynamic microphone because they are common and rugged. Crystal and ceramic microphones are less common than dynamic microphones but available. Whatever the microphone type (except carbon microphones, which are essentially obsolete anyway), if it's not an electrostatic one, you'll need the PC Microphone Swapper. It is designed to connect a non-electrostatic microphone to your computer's sound-card.

Part of the problem with using different types of microphones with a sound card is the direct-current bias voltage present at your sound card's microphone input. While an electrostatic microphone requires that bias voltage, only a carbon microphone can be used as a substitute; all others are incompatible. The PC Microphone Swapper isolates that DC voltage from the microphone plugged into it. Furthermore, the circuit has a high-input impedance and is capable of providing signal gain so that a variety of microphones can be successfully used with your computer.

As wonderful as those features sound, the PC Microphone Swapper's best feature is that it is a simple, easy-to-build circuit. In spite of its high-end performance, it can be built on a piece of perfboard or an etched PC board. The PC Microphone Swapper should serve you well for all but the most critical low-noise applications.

Circuit Operation. The schematic diagram for the PC Microphone

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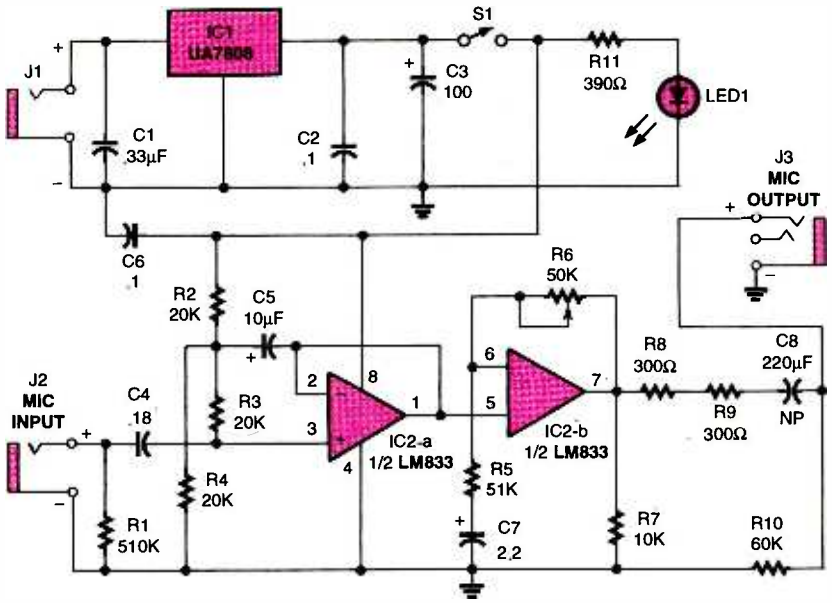

Fig. 1. The PC Microphone Swapper converts and amplifies the signal from a professional studio-quality microphone for direct connection to the microphone input of a sound card.

Swapper is shown in Fig. 1; refer to it during the following discussion.

The circuit is built around IC2, an LM833 low-noise dual op-amp designed for audio applications. The first op-amp (IC2-a) functions as a bootstrapped impedance buffer. The LM833 is internally compensated for all closed-loop gains so you can directly short the output to the inverting input without concern for instability. Resistors R2, R3, and R4 were conservatively chosen to provide ample bias current to the op-amp circuitry.

The op-amp input is designed to have an input resistance of 510,000 ohms as set by R1. That value can be seen as a versatile input value. For practical reasons, I do not recommend that R1 be either over 1 megohm or less than the impedance of the microphone to be used. If you change R1, you should recalculate an appropriate value for C4 using the following capacitive reactance formula

$$C=10/(6.28f_CX_C)$$

where X_C=R1 (in ohms) and f_C=20 Hz; C4 will be in Farads. That formula deviates from the traditional capacitance reactance formula by a factor of ten as part of a conservative design effort.

For example, if you want to use a 600-ohm-impedance microphone only, set R1 to 600 ohms to match the microphone output impedance for the maximum power transfer between the microphone and the input circuit. It's debatable whether there is a definite advantage to doing this since the circuit functions acceptably as is. At any rate, let's continue with our example. The capacitive reactance calculation becomes:

$$C4=10/(6.28 \times 20\ Hz \times 600\ ohms)=1.33\times10^{-4}F$$

or 133 µF. In practice, the nearest standard capacitance value that's equal to or higher than 133 µF should be used; a 220-µF capacitor will do. Incidentally, if you do make a substitution and have to use a polarized device, put the positive end towards IC2.

The second op-amp (IC2-b) is set as a typical non-inverting AC amplifier designed for single-supply operation with a signal gain of 2. It can be debated whether an amplifier stage is necessary here since the computer software allows for volume and gain adjustments. Regardless, I consider it worthwhile to include the additional circuitry. Keep in mind that we're working with low-level audio signals in a computer—one of the noisiest environments in terms of electrical interference known to man. Any boost to the signal level will help mask any noise pickup. Parts-wise, it's not a huge additional investment, and it broadens the usefulness of this project with various combinations of sound cards and microphones. From a practical point of view, I don't recommend providing for a gain over 2 because of the risk of overdriving the sound-card input, and subsequent distortion.

The output of IC2-b is loaded by R7 to keep the output referenced to circuit ground. Without R7, the output would have a tendency to drift based upon the charge of output

PARTS LIST FOR THE PC MICROPHONE SWAPPER

SEMICONDUCTORS

IC1—uA7808 fixed 8-volt regulator, integrated circuit
IC2—LM833 dual op-amp, integrated circuit
LED1—Light-emitting diode, green, T-1¾ size

RESISTORS

(All resistors are ½-watt, 5% units, unless otherwise noted.)
R1—510,000-ohm
R2–R4—20,000-ohm
R5—51,000-ohm
R6—50,000-ohm potentiometer, linear taper
R7—10,000-ohm
R8, R9—300-ohm
R10—60,000-ohm
R11—390-ohm

CAPACITORS

C1—0.33-µF, ceramic-disc
C2, C6—0.1-µF, ceramic-disc
C3—100-µF, 16-WVDC, electrolytic
C4—0.18-µF, ceramic-disc
C5—10-µF, 16-WVDC, electrolytic
C7—2.2-µF, 16-WVDC, electrolytic
C8—220-µF, 16-WVDC, non-polarized electrolytic

ADDITIONAL PARTS AND MATERIALS

J1—Co-axial power jack, panel-mount
J2—Phone jack, ¼-inch, mono
J3—Phone jack, ¼-inch, stereo
S1—Single-pole, single-throw toggle switch
12-volt DC, 50-mA wall-mount transformer, shielded audio cable, wire, case, knob for R6, hardware, etc.

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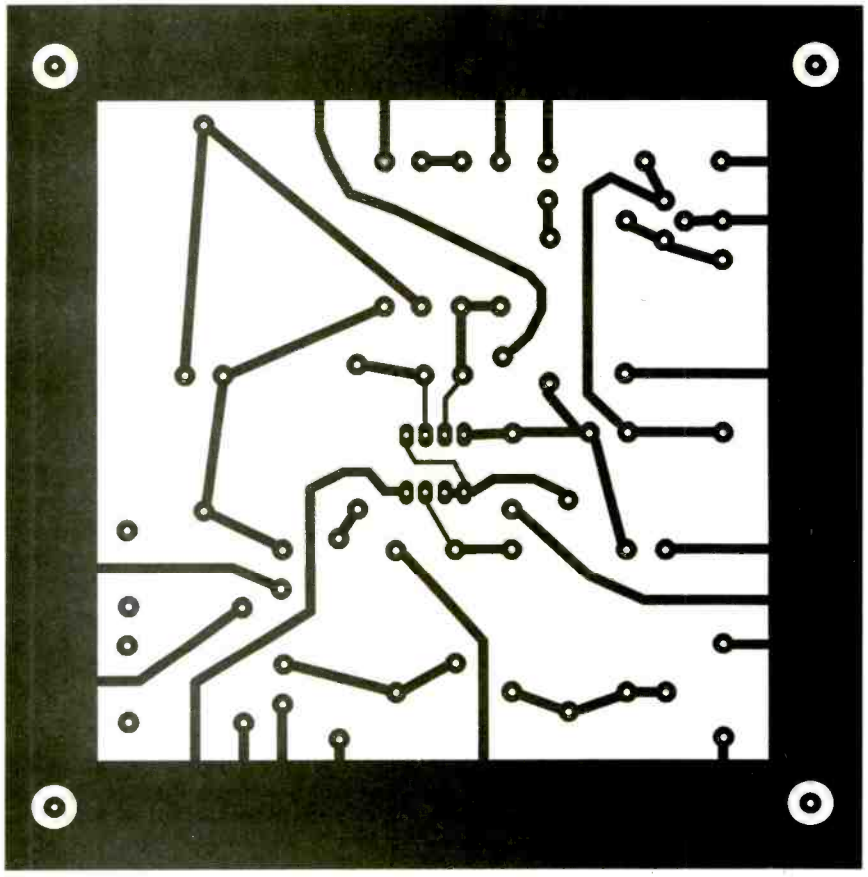

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Fig. 2. While the PC Microphone Swapper can be built on a piece of perfboard, a PC board yields a more professional-looking project. In addition, wiring errors are eliminated.

capacitor C8. The output impedance is about 600 ohms, which is set by the series combination of R8 and R9 in parallel with R10. That impedance value matches the typical computer-microphone impedance. Resistor R10 helps discharge C8. In addition, R10 keeps the output from floating because of its firm ground connection.

An important consideration in designing the circuit is keeping both the bias voltages within the op-amp stages and any external DC voltages from changing those biases. Capacitors C4, C5, C7, and C8 fill that dual function; their chosen values provide a low-frequency cutoff of around 20 Hz. Note that C8 is a non-polarized capacitor; the polarity across C8 will likely change each time the circuit is turned on or off.

Any audio circuit that is powered from an AC source needs good filtering on the power-supply inputs; the PC Microphone Swapper is no exception. It is standard practice to place a capacitor of 0.1 F or so at the IC power pin (or pins for a dual-polarity supply design). Capacitors C1, C2, and C6 provide high-frequency filtering as well as making sure that the power-supply connection will not be highly reactive. Capacitor C3 provides another level of power-supply filtering in addition to complementing C6's high-frequency filtering by shunting lower frequencies.

A 12-volt DC wall-mounted power supply feeds the PC Microphone Swapper through J1. Voltage regulation is handled by IC1; reducing the supply to 8 volts keeps power-line hum and noise at an unobtrusive level. Although a 9-volt regulator will probably work as well, the slightly lower voltage ensures that any variations in the input-voltage level (including ripple) will be sufficient for IC1. Resistor R11 limits current through LED1 for "power on" indication.

Note the unusual location of S1. Positioning the switch *after* IC1 reduces the annoying (and possibly destructive) "pop" sound caused by capacitors charging or discharging. Even with that additional design feature, you can still hear some "pop" noise when the PC Microphone Swapper is turned on or off. A good idea would be to mute the microphone source using the volume control software in your computer (the preferred method), or at least turn the speaker volume all the way down before turning the PC Microphone Swapper on or off.

Circuit Construction. The original prototype for the PC Microphone Swapper was built on a piece of perfboard using standard construction techniques; that method of construction will work just fine. However, using a printed-circuit board is preferable for aesthetics, ease of assembly, and reduced wiring errors. Whichever method you choose, the following paragraphs will provide helpful construction information. If you choose to etch your own PC board, a foil pattern has been provided in Fig. 2.

If you are using the foil pattern to etch your own board, follow the parts-placement diagram shown in Fig. 3 for component location. Although it's not essential, I would suggest that you assemble the parts in size order from smallest to largest; the repeated strain that can be placed on the leads of the larger, heavier components while handling the board will be reduced that way. Using a socket for IC2 is also a good idea instead of soldering it directly to the board; troubleshooting and experimenting with different pin-compatible op-amps becomes easier.

A suggested order for installing the components is as follows:

IC socket
Resistors
Capacitors
IC1

As you are installing the components, double-check that the values are correct for the item that you are installing. When you install the capacitors and semiconductors,

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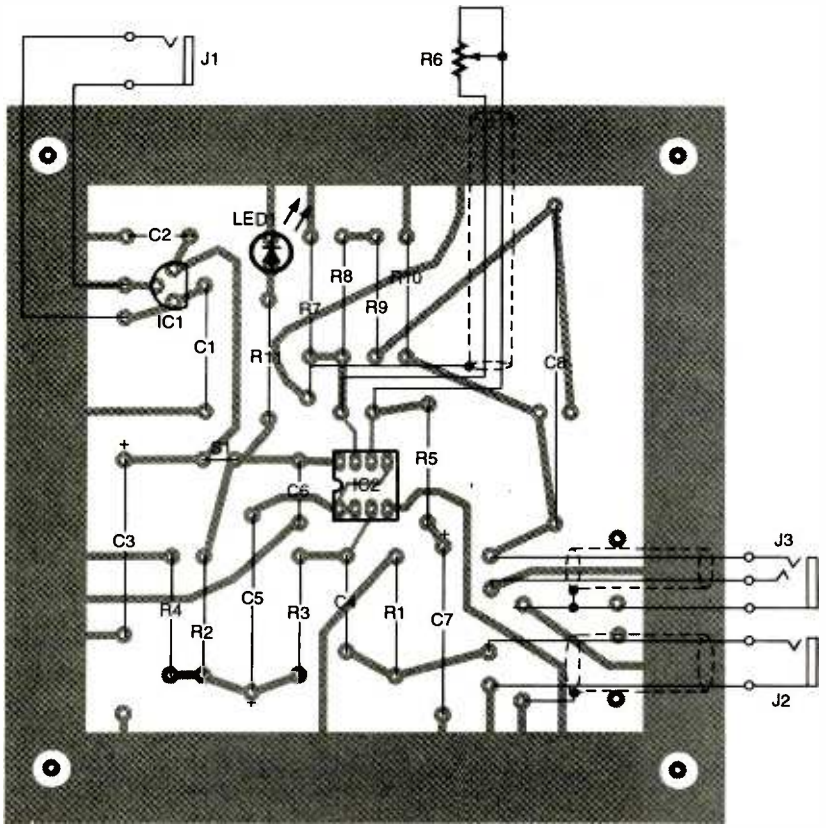

Fig. 3. When installing the PC Microphone Swapper components in the PC board, start with the smaller items first. Large capacitors, such as C3 and C8, might break off if their leads are bent and stressed too much during assembly and handling. Note that the PC board layout is designed for either an axial- or a radial-mount version of C8.

note that some capacitors and all semiconductors are polarized; installing them backwards will damage them the first time that power is applied to the circuit. Electrolytic capacitors tend to rupture and explode while semiconductors will pop and smoke. To paraphrase the old engineering joke, electronics run on internal smoke—they won't work if it leaks out!

The value of R11 was chosen to match the specified component for LED1: a 15-mA current at a 2.2-volt voltage drop and an 8-volt supply. If you wish to use a different color or type of LED, you can recalculate the value of R11 with:

$$R11=(8-V_f)/I_f$$

You might find that the specified value of R11 is conservative enough to work with any T-1¾ LED.

Capacitor C8 is a non-polarized device; it can be installed in either direction. The PC board has been laid out to accommodate either an axial- or radial-leaded device. Simply use the appropriate holes for whichever style you were able to locate.

Current requirements for the PC Microphone Swapper are very low, so you won't need to use a heatsink on IC1.

Once the PC board is finished, inspect your work one more time for any errors such as wrong or missing parts, backwards components, poor or unsoldered joints, or solder splashes that might bridge two adjacent conductors.

The PC Microphone Swapper can be mounted in any suitable case. A metal one is recommended to act as a "Faraday cage" shield in order to minimize any hum or noise that the unit might pick up from other equipment. The arrangement of the major components that was used in the prototype is shown in Fig. 4. Drill appropriate holes for the external controls and jacks; feel free to place the jacks and switches any way you prefer.

Note that the PC board connection for R6 has only two holes. Jumper the wiper terminal on the potentiometer to one of the outer terminals; treat that connection as a single terminal. You might want to connect the wiper to the outer terminal that measure zero ohms when R6 is turned all the way counter-clockwise (to the left). That way, IC2-b will have unity gain (no amplification) with R6 turned "all the way down." A twisted-pair wire is suggested to make the electrical connection between the PC board and R6.

The typical computer sound card expects a ⅛-inch stereo phone plug to be connected to its input. You have two options for J3. As shown, a ⅛-inch stereo jack is used; a simple stereo patch cord connects the PC Microphone Swapper to the computer. On my prototype, I had available a length of shielded audio cable; it was hard-wired to the PC board in place of J3. The other end of the cable had a ⅛-inch stereo phone plug attached to it. If you decide to go that route, be sure to use a tight grommet or strain relief where the cable passes through the case. For those that decide to use a jack, a twisted-pair wire will do fine for the connection between J3 and the PC board.

Use a ¼-inch mono phone jack for J2. Shielded two-conductor microphone or audio cable should be used to make the connection from J2 to the PC board; twisted-pair wire won't provide adequate shielding. Noise considerations dictate that the shield on any shielded cable be connected to one ground point only. The PC board has a ground pad for just that purpose. Additionally, there are "tie-down" pads for securing the cable to the PC board by wrapping and twisting a bare wire around the cable; that forms a strain relief for the cable.

Power is supplied through J1. You can use any type of connector that you have available as long as a mating plug is available for the wall transformer. If, for example, the wall transformer that you'll be using to power the PC Microphone Swapper has a standard coaxial power plug on it, use a companion coaxial power jack of the same size. Before wiring J1 to the PC board, plug the transformer in and check

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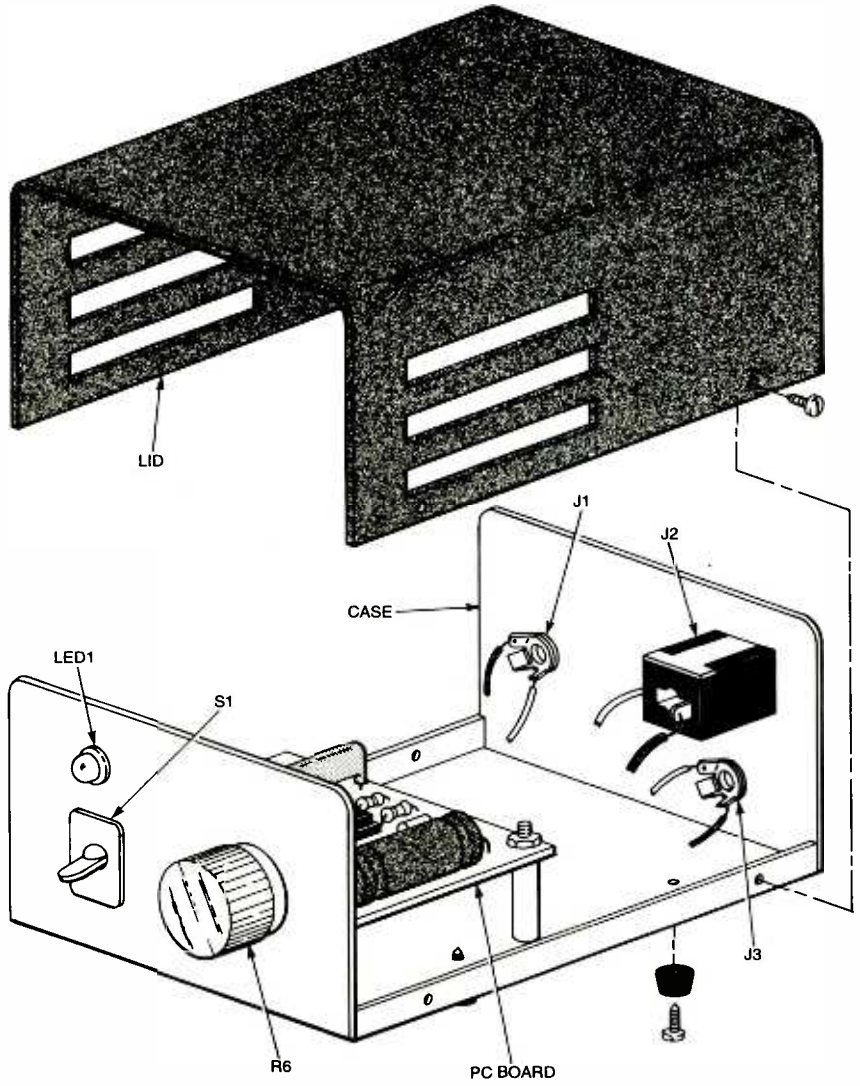

Fig. 4. The completed PC Microphone Swapper drops easily into any suitable metal case—a professional-looking finish to a professional-sounding project!

the voltage polarity; there is no real standard as to whether the positive voltage is on the inner or outer contact.

Pay attention to polarity when wiring LED1. In addition to a flat spot on the case, one lead is shorter than the other to help identify the two leads. The short lead is the *cathode*, which connects to circuit ground.

The case should also be connected to circuit ground. Jacks J1-J3 might already have established that connection, but it is always better to err on the safe side. That ground connection will reduce the effect of stray capacitance on the circuit.

Testing and Use. Once again, check the completed circuit for any construction errors like solder bridges and proper placement and orientation of all components. Fix any problems that you see. Before testing the PC Microphone Swapper, verify that your computer works with the original microphone. Record your voice; you don't have to save this recording. Doing that simple step can save you the aggravation of advanced troubleshooting when all you needed to do was unmute the microphone input on your computer's volume-control software.

Mute the microphone input and connect J3 of the PC Microphone Swapper to the microphone input of your sound card. Plug in the wall transformer to J1 and connect a suitable microphone to J2. Set R6 to unity gain (lowest setting), turn on the PC Microphone Swapper, and unmute the microphone input. Hopefully you can now enjoy yourself with your latest successfully-completed project. If necessary, adjust R6 to compensate for low microphone-signal levels.

If the circuit does not function at this point, turn off and unplug the circuit. Recheck all connections as well as the component identities, placements, orientations, and polarities very carefully. Are IC1 and IC2 installed the right way around? Are you using the correct ICs? Did you forget to connect something? If things look all right, use a voltmeter to verify that IC1 is delivering an 8-volt output. The bias on IC2-a should be 4 volts; you should see power across pins 8 and 4. Study the schematic diagram again. The PC Microphone Swapper is a simple circuit; the trick is to isolate the problem based upon your observations and correct or replace the defective element.

Once you have the PC Microphone Swapper up and running, you can try experimenting with the circuit. For example, feel free to wire IC2-b as a non-inverting unity gain buffer. To do that, leave out R6, R5, and C7. Put a jumper wire across the PC-board connections for R6

Once you start using the PC Microphone Swapper, you'll be amazed what your sound card and computer is capable of in terms of high-fidelity sound recording and reproduction. It will have you wondering why you ever tolerated the less-than-stellar sound quality of the mass-produced microphone that originally came with your sound card. P

9 out of 10 mice prefer the Consumer Information Catalog online. Catch it at **www.pueblo.gsa.gov.**

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AUDIO CABLE TESTER

Got a problem with your microphone or audio gear? This handy tester will confirm (or eliminate) the possibility that your cable is the culprit.

GARY McCLELLAN

Have you ever set up a sound system that didn't work and discovered the hard way that the problem was caused by a bad cable? Perhaps you've wasted time troubleshooting an amplifier or console only to learn that the fault was an intermittent cable. If you've been a victim of situations like those, then the *Audio Cable Tester* is a project for you!

The Audio Cable Tester checks the most common audio cables with XLR, phone, and RCA connectors. Cables with same-gender XLR connectors or with less-common connectors can be tested with simple adapters that can be bought or built. The Audio Cable Tester is simple, easy to build, and very easy to use. It can save you hours of wasted effort and protect your nerves from the aggravations caused by bad cables. But be aware that once people see how handy your unit is, they might ask you to build them one!

How It Works. As you can see from the schematic diagram in Fig. 1, the Audio Cable Tester is a simple "low-tech" device. It is nothing more than a continuity tester that has been adapted to check audio cables.

Pushing switches S1, S2, or S3 applies 9 volts from battery B1 to the "SEND" group of jacks (J1, J2, and J3). A cable connected to one of the "SEND" jacks and plugged into one of the "RECEIVE" jacks (J4, J5, and J6) provides a current path. As a result, an LED lights each time a

switch is pressed to indicate continuity through the cable wiring. The particular LED that lights depends on which switch was pressed and whether the cable being tested has a functioning wire. For example, if you are testing a simple audio wire with RCA plugs, it would be connected to J3 and J6. Pressing S3 will test the shield and will light LED1 if it is good. Likewise, S2 will test the center conductor; LED2 indicates a good connection. Obviously, pressing S1 won't do anything because that particular type of cable doesn't have a third conductor in it.

The test current is about 7 mA, which is enough to display high-resistance connections as a dim indication on the LEDs. That problem is common with well-used audio cables, and the cure is to cut off the worn connectors and replace them.

The test for each switch is uniform for each connector type. Switch S1 checks for continuity through the ground lead of the test cable. That corresponds to pin 1 on the XLR connectors, the sleeve on the phone jacks, and the shield connection on the RCA jacks. Switch S2 checks for continuity through the positive (+) signal lead of the cable. This corresponds to pin 2 on the XLR connectors, the tip on the phone jacks, and the center connection on the RCA jacks. Finally, S3 checks for continuity through the negative (-) signal lead of the cable. This corresponds to pin 3 on the XLR connectors and the ring connection on the phone jacks.

Note that each set of jacks are wired in parallel according to industry practice.

Building the Audio Cable Tester. The Audio Cable Tester is simple enough to be built just by mounting the components in a suitable case and wiring them together. Most, if not all, of the parts are probably in your "junk-box" collection. However, there are some important considerations about the case.

The author's prototype was a plastic case that measured 4 inches wide, 5 1/4 inches long, and 1 3/4 inches high. You may use any other size case, provided that it is made of plastic and is at least 1 1/2 inches high. Plastic is necessary because the jack ground connections must be insulated from each other. The height requirement comes from J4; at least 1 1/4 inches of space is needed behind the panel.

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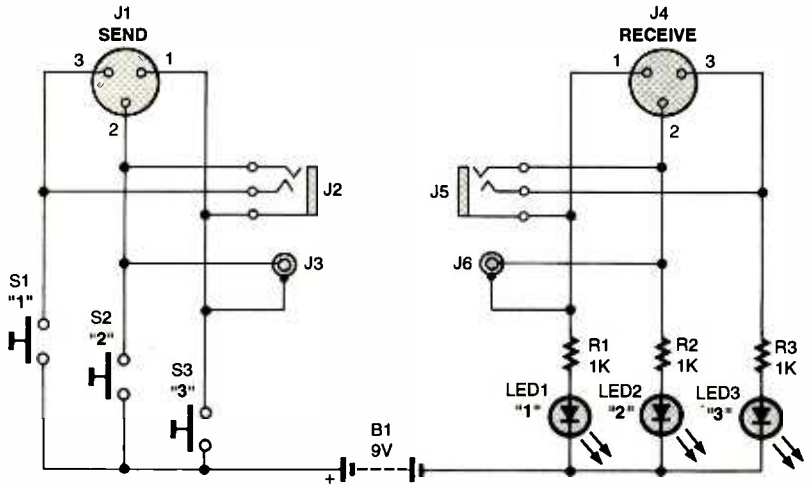


Fig. 1. The Audio Cable Tester is a simple continuity tester that can work with many different types of audio cables. With the appropriate adapters, almost any oddball type of connector can be accommodated.

PARTS LIST FOR THE AUDIO CABLE TESTER

B1—9-volt alkaline battery
J1—Male XLR connector (Mouser 568-NC3MX or similar)
J2, J5—Stereo phone jack (RadioShack 274-312 or similar)
J3, J6—Chassis-mount RCA jack (Mouser 161-2052 or similar)
J4—Female XLR connector (Mouser 568-NC3FX or similar)
LED1–LED3—Light-emitting diode, red, T-1fl size
R1–R3—1000-ohm, 1/4-watt, 5% carbon-film resistor
S1–S3—Single-pole, single-throw, momentary-contact pushbutton switch (RadioShack 275-1547or similar)
Battery connector, battery holder, case, LED holders, wire, hardware, etc.

If you need to buy a case, you might consider LMB 407 (the author's choice), LMB 503, or Bud PBS-11325 cabinets. The last two cases feature a built-in battery compartment, which is especially desirable for this project. You can get them at any LMB or Bud distributor, such as Mouser Electronics.

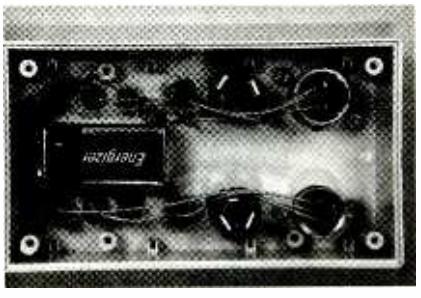
Once you have the parts, it is time to get busy. Clear a space on your workbench and begin with the cabinet.

Refer to the photographs for the component layout on the cabinet lid. Place strips of masking tape over the front surface and draw lines 5/8-inch apart along the edges of the lid, then mark hole locations for the six jacks. On the lower left side of the lid, mark hole locations for the three switches. On the lower right side, mark hole locations for the three LEDs. Drill and file the holes to size, and then deburr them. Don't forget to drill the mounting holes for jacks J1 and J4. Remove the tape from the cabinet and wash it thoroughly.

Label the jacks, switches, and LEDs with suitable press-on letters or any other method you choose. Letter sets are available from electronics distributors, office-supply stores, and graphics-supply houses. Spray the cabinet with a light coat of clear lacquer spray. Allow five minutes for the coating to dry and then spray a second light coat. Let it dry overnight.

Once the case is dry, you're ready to mount the components. Mount jacks J1 through J6 using the supplied hardware. In the case of the XLR jacks, 4-40 screws and nuts will do nicely. Snap the LED holders into their holes and push an LED into each holder from behind the panel. If the LED or holder fits loosely in the panel, secure it in place with a dab of silicon sealer.

Now it's time to wire the unit. Pay close attention to the polarity of the LEDs when wiring them; the short lead and flat spot on the case indicates the cathode connection, which goes to the negative terminal of B1. It's a good idea to use a heat sink or pliers on each LED lead while soldering. LEDs are susceptible to heat damage, and excessive heat causes them to lose most of their brightness.



The Audio Cable Tester is simple and straightforward enough to be built by simply mounting the components to the case and hardwiring them directly. Note that the resistor leads are covered with insulating "spaghetti" tubing to prevent shorts within the unit. You might want to use a case with a battery compartment rather than gluing the battery directly to the case as the author did here.

Inspect your work for any miswiring or other construction errors. With B1 temporarily connected, you're ready to test the latest addition to your repair bench.

Checkout and Operation. Before using the Audio Cable Tester, perform the following tests. Connect a known-good balanced-line cable to J1 and J4. As you press S1, S2, and S3 in sequence, LED1, LED2, and LED3 must light in sequence. That indicates continuity through the pin 1 (ground), pin 2 (positive signal), and pin 3 (negative signal) wiring.

Repeat the process with a stereo phone cable connected to J2 and J5. Pressing the switches as above should yield the same results. This time, LED1 tests the ground (ring), LED2—the tip, and LED3—the sleeve connections. If you don't have a stereo cable, you can use a mono cable instead. In that case, pressing S1 will light LED1 and LED3 together due to the 2-conductor plug shorting the ring and sleeve connections on the jacks; S2 will light LED2 in the expected manner.

Finally, connect an RCA cable to J3 and J6. Switch S1 will light LED1 through the cable's shield, and S2 will send current through the center conductor to LED2; S3 and LED3 are not used to test that type of cable.

If you encounter problems, check

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the wiring. If an LED doesn't light, it might be wired backwards or heat damaged. If the wrong LED lights when you push a switch, check the jack connections.

Once the Audio Cable Tester passes those tests, it is ready for use. Close up the cabinet and secure the rear half with the screws that came with it. If your cabinet has a battery compartment, disconnect the battery, route the connector through the compartment, close the cabinet, and reinstall the battery. If your case doesn't have a battery compartment, you can use a holder clip or other method of your choosing. Note that in my prototype, I simply glued the battery to the inside of the case with silicone adhesive. While that method will make it a bit of a chore to replace the battery when the time comes, you won't have to worry about the battery rattling around due to rough handling of the unit or being bounced around in a tool box. Testing cables is a very quick operation that draws very little current; the battery will most likely need replacing every 3-5 years.

The Audio Cable Tester is easy to use. Simply follow the testing procedure outlined above: connect the cable to the suitable jacks, push the switches, and observe the LEDs. If you don't get the indications described above, the cable is defective.

Here are some suggestions that will help you get the most out of your new Audio Cable Tester. Check for intermittent cables by pressing a switch and wiggling the cable where it enters a connector. Repeat the process for the other connector. If an LED flickers while you wiggle the cable, cut that end off the cable and replace the connector. Don't forget that you can check cables with different connectors, like an RCA-to-phone adapter; just plug them in and test in the usual manner. Balanced-line cables with same-gender XLR connectors on each end can be checked by obtaining a gender-changing adapter. If you have cables with mini-phone plugs to test, use a stereo mini-phone-to-phone-plug adapter. P

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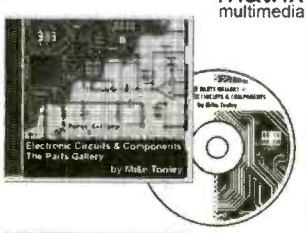

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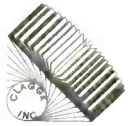

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Pen Scanner/Translator

A few months ago we introduced the C Pen 200—a pen-like scanner that makes it possible to capture data from printed documents while on the go. Now C Technologies AB has improved an already great product by adding language translation to its *C Pen 600* ($300 MSRP).

The language dictionary feature allows you to select individual words in a specific foreign language and translate them, with full definitions. While it won't translate phrases, it is a great way to get the gist of printed matter you come across when traveling. You pick the dictionary language you want to ship with the device—others are available online for a modest fee. Choose from Spanish, French, Italian, German, and Swedish dictionaries; each contains the full *Oxford Edition* text of English and the chosen language. That's 150,000 words!

Like its predecessor, the C Pen 600 can read up to 100 characters per second, storing them as editable text. With its built-in 6MB of memory, the Pen allows you to store up to 2000 pages of text (less depending on how much memory you fill with language-translation dictionaries). All text can be transferred via infrared to your computer or IR-equipped Palm OS device.

Imagine—all this and it only weighs 3 ounces!

C Technologies AB, Ideon Research Park, Scheelevagen 15, SE-223 70 LUND, Sweden; *www.cpen.com.*

CIRCLE 90 ON FREE INFORMATION CARD

Web in the Kitchen

Can't get enough of the Internet? Want to bring it to a room that all family members spend time in? CMi Worldwide has come up with a way to stay wired in the kitchen ... without coffee. Dubbed the *iCEBOX* (Information Communication Entertainment Box), it's expected to rival the microwave in popularity when it hits the streets this summer for around $499.

Like the "nuke 'n' eat" oven, the iCEBOX makes daily tasks more efficient. Anyone in the house can send e-mail, read online news, or even check in with stock investments over breakfast and maybe keep up with ebay auctions before dinner.

Most interesting is the convergence nature of the device. The countertop box also lets you watch cable television and play audio or video CDs. Add a video camera, and you can even use the screen to keep an eye on any room in the house, turning the iCEBOX into a security system or baby monitor.

To earn its appliance status, the iCEBOX is expected to be easy-to-use and ready to go right out of the box. Included will be a washable, grease- and shock-proof wireless keyboard, as well as a remote to take advantage of those typing-free tasks. Time around the table may never be spent the same way again.

CMi Worldwide, 600 Stewart Street, Suite 700, Seattle, WA 98101; 800-897-8554; *www.cmiworldwide.com.*

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3.34-Megapixel Camera

Want to take digital imaging to the next level? Resolution approaching that of film is finally available for less than the four-figure mark. Boasting 3.34 megapixels, Nikon's *Coolpix 990* ($999) may just put one-hour photo shops out of business. The new CCD inside the camera provides true, non-interpolated 2048 × 1536 images. While they might not hold up well when blown up to 8 by 10 prints, images from the camera will look out of this world when printed in standard 3 by 5 format.

Using the camera is a pleasure, as it requires only two seconds to ready itself between full-resolution shots. Lowering the resolution will let you capture up to 30 frames per second for a total of 80 shots (using CompactFlash memory cards). Rounding off the real-camera feel is a 3X zoom lens.

Nikon Inc., 1300 Walt Whitman Road, Melville, NY 11747; 800-52-NIKON; *www.nikonusa.com.*

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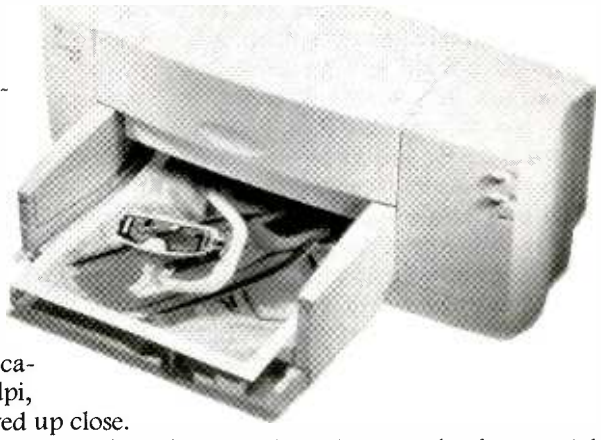
Budget Photo Printing



Digital cameras, scanners—it's easier and more affordable than ever to get a color image into your computer. But what then? Not everyone can invest a grand or two in a photo-quality printer, and taking a disk somewhere to make prints is just as annoying as using film again. That's why Hewlett-Packard (HP) has released the high-quality, ultra-affordable *DeskJet 842C* ($149).

Thanks to HP's award-winning color-layering technology—PhotoREt II—the new DeskJet can blend tiny drops of ink to produce a broad range of realistic colors. Photos, invitations, and just about any other color project will come to life, especially on coated paper designed for color applications. The resolution when printing photos is 600 × 1200 dpi, though the output looks more like twice that, even when viewed up close.

When using the printer for standard black text pages, users will be pleased with its laser-like speeds of up to eight pages per minute. Depending on their ink coverage, color pages can come out in up to five pages per minute.

Hewlett-Packard Company, 3000 Hanover Street, Palo Alto, CA 94304; 800-752-0900; *www.hp.com.*

CIRCLE 93 ON FREE INFORMATION CARD

Gaming with Viper II

Unless you're a teen, chances are that finding time to play computer games is tough. If and when you do grab a moment, though, make the most of it. See every bit of detail programmers put in; enjoy every animation with fluid presentation. In short, swap that old video card with a hot one like S3's *Diamond Viper II* ($199, MSRP).

Powering the new card is the Savage 2000 processor, which controls a 128-bit graphics system. Thanks to the card's 32MB of memory and single-pass Quad-Texture engine, multi-textured games will not only look great, but will refresh on the screen quickly as well. And speaking of speed, the card can handle up to an AGP 4X system for enhanced video throughput; though it can make the best of the more common 2X AGP port.

In addition to making the most of games, the Viper II enables users to enjoy high-resolution displays of up to 2048 × 1536. Further, those with DVD-ROM drives will appreciate the card's built-in hardware acceleration. Both on a monitor and a TV (there's a video-out port), movies and games on the new media will sparkle.

S3 Inc., Diamond Multimedia, 2841 Mission College Boulevard, Santa Clara, CA 95054; 408-588-8000; *www.diamondmm.com.*

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TED NEEDLEMAN

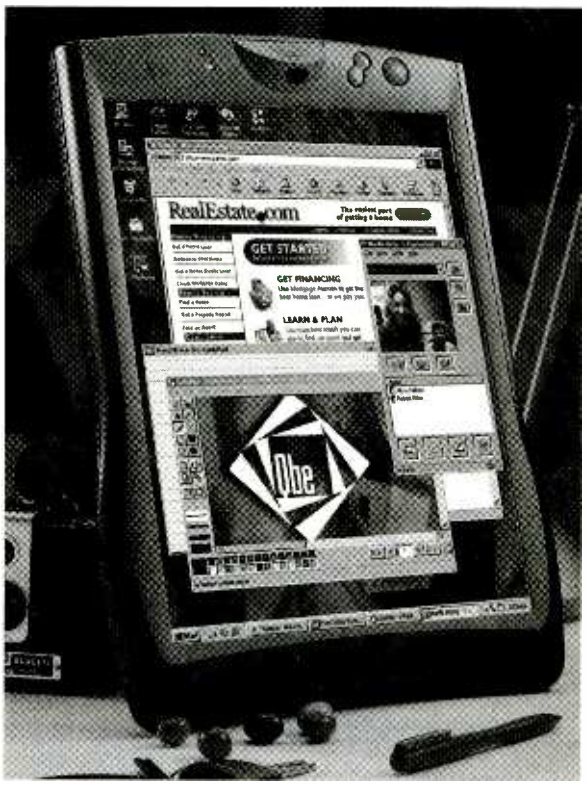
Aqcess Qbe Personal Computing Tablet

For a while, about five or six years ago, pen-based PCs were the hottest thing in the industry. Then, except for specialized versions like the pad your UPS driver carries, they pretty much vanished from the public eye.

Or have they? For the most part, pen-based PCs have just shrunk in size. The wildly popular Palm Pilot and its Palm OS kin are considered PDAs (personal digital assistants), rather than true general-purpose PCs. But that's largely because of the limited nature of applications that come bundled with them. As for the Palm OS, there are tons of programs available for it that make you wonder if machines running it aren't really PCs.

Now those who compute via stylus just might have a larger form factor to consider again: the *Qbe Personal Computing Tablet* from Aqcess Technologies. This neat device makes us think of those science-fiction movies where an ordinary-sized object gets exposed to a chemical or nuclear radiation and grows to gigantic proportions—sort of like an "Attack of the 50-foot Palm Pilot!" The Qbe isn't really that large, only 14 × 10 inches and 1.5 inches thick, but at first glance it sure does look a lot like a Palm Pilot on steroids.

Inside, however, the Qbe is more like a fairly conventional PC than a Palm OS device. Our pre-production unit was powered by an Intel Celeron running at 433 MHz, and Aqcess intends to offer a variety of CPUs. The motherboard uses standard Intel 440BX core logic and can accommodate 512MB of RAM, though our review unit had a much more modest (and affordable) 64MB. The hard disk in our review unit was a 6.4GB Ultra ATA/33 model. Audio is provided by an ESS Technology FM synthesis chipset and video by a SIM (Silcon in Motion) AGP video chipset with 8MB of RAM. A 24X CD-ROM was included; though expect a DVD drive as an option soon. The net result of this configuration is a unit that operates likes a similarly configured desktop.



NOW FOR THE INNOVATION

As its photo might indicate to you, the Qbe has some unique features that make it so much more than just another PC. While the unit's 13.3-inch active-matrix TFT LCD color screen is very similar to the type you'll find on many laptops, it differs in two important respects. First, its display content can be electronically rotated 90 degrees, so that what you see is taller than it is wide (unlike a standard PC screen, where the opposite is true). The result is a screen setup that permits the display of pretty much a full page in the right aspect ratio. You know, kind of like a tablet.

The second major difference is that the screen is covered with a transparent capacitive touch layer. This Touch Pen overlay operates with a tethered pen or even by double tapping it with your fingertip. We were impressed with the system's handwriting recognition—provided by ParaGraph's *PenOffice*—which, unlike that of the Palm Pilot, does not require you to learn a special alphabet of characters. You can write in print or even cursive! You'd be amazed by the accuracy.

A standard USB keyboard comes with the Qbe, and a PS/2 mouse port

(Continued on page 46)

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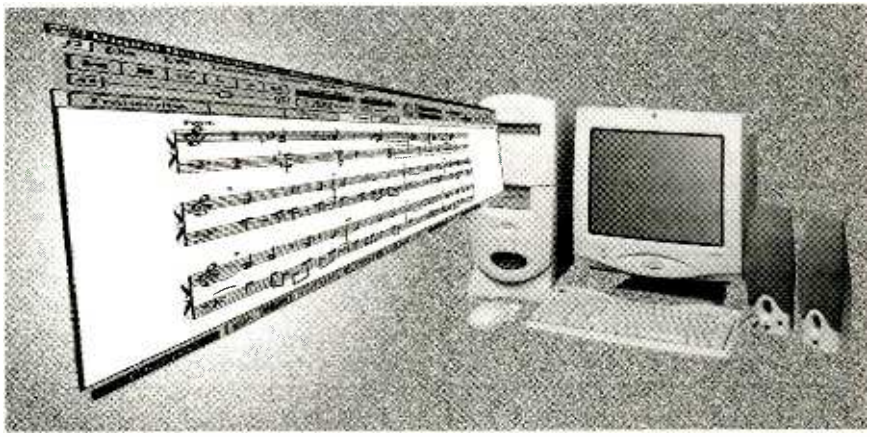
Making Music on a PC

KONSTANTINOS KARAGIANNIS

From soundtracks for multimedia projects to the next top 40 hit, your computer can make recording CD-quality music a cinch. Check out these software products that will have even non-musicians grooving to their own tunes.



You've no doubt experienced music in some form on your PC. Most games released from the past decade on, for instance, have had some kind of soundtrack built into them. And when it comes to more popular music, few computer users haven't put at least one audio CD into their machine's CD drive to check out the quality of the system's speakers. Now, with MP3s gaining in popularity, some even use their PCs as their only music player.

But did you ever give thought to using your computer to *make* music?

You should, or you'll risk missing out on a major source of enjoyment and maybe even productivity (if you're an aspiring or professional musician, that is). The hardware in a modern, multimedia PC offers so many different recording and tone-creating opportunities. All it takes is the right software to unleash these capabilities ... hence, this article.

We've rounded up programs that fall into three categories. The first type is what we call "fun" software, because it's designed to allow anyone—that's right even those of you who never took a single music lesson—to play around with melodies, rhythms and sounds to create original tunes. Next, we gathered up some applications that let you work with or simulate instrument sounds, most likely for the purpose of recording. And that will bring us to our last category: software designed to let you record multiple tracks of audio and mix them just like you would in a real studio.

Because most Windows and Mac OS computers come with CD-quality sound cards, we didn't feel the need to expand the scope of this article to encompass hardware. However, if you think your system's audio card may not be up to the task of one of the programs here that you're interested in here, consider upgrading to the suggestion we give in this month's *Peak Computing* (see page 42).

So, without further delay, let's get right to the goodies themselves.

Fun for All. Here's a great way to introduce yourself to the world of PC audio creation, without a major investment in either time or money. As for the former, you needn't have put in a single minute at an instrument, and you won't have to put in too many of them figuring out how to get started with the following packages. As for money, well, the low prices in this section will speak for themselves.

First up in our fun category is *GrooveMaker* ($59, ESP) from Cakewalk (the makers of a very popular recording program, *Pro Audio 9*, which we'll be getting to later on). *GrooveMaker* is a loop-based, mixing app for creating electronic dance music on both Mac and Windows PCs. If you like modern dance music genres like Techno, Trance, Dub, Jungle, House, Drum 'n' Bass, or Progressive, you'll be playing around with this program

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Enter the world of modern electronic music genres with Techno eJay. *No music knowledge required here—just pick the samples of drums and instruments you like and hear your tune come to life.*

for pulse-raising hours.

In keeping with its neo-musical influence, *GrooveMaker* has a futuristic interface that lets you mix sounds without any virtual turntables (after all, how 20th Century turntables are, even when only onscreen). Using tools that resemble the controls of an *X-Files* alien vessel, you can mix unique, professional sample loops in real time, without interrupting the groove that is being played.

We were impressed with the wide variety of instrument samples, including bass, drums, percussion, synthesizers, pads, vocals, and effects. Opt for the *GrooveMaker MAX* version for an extra $20, and you'll get two additional CD loop libraries (though the basic library is pretty diverse).

Because the programmers at Cakewalk know you might want to actually use some of your grooves, they made it possible to export *GrooveMaker* projects to their other products (including *Pro Audio 9*). Further, you can bring sounds *in* to *GrooveMaker*, as it allows for WAV and AIFF imports. With all these features and its great sound, the program is an addictive joy.

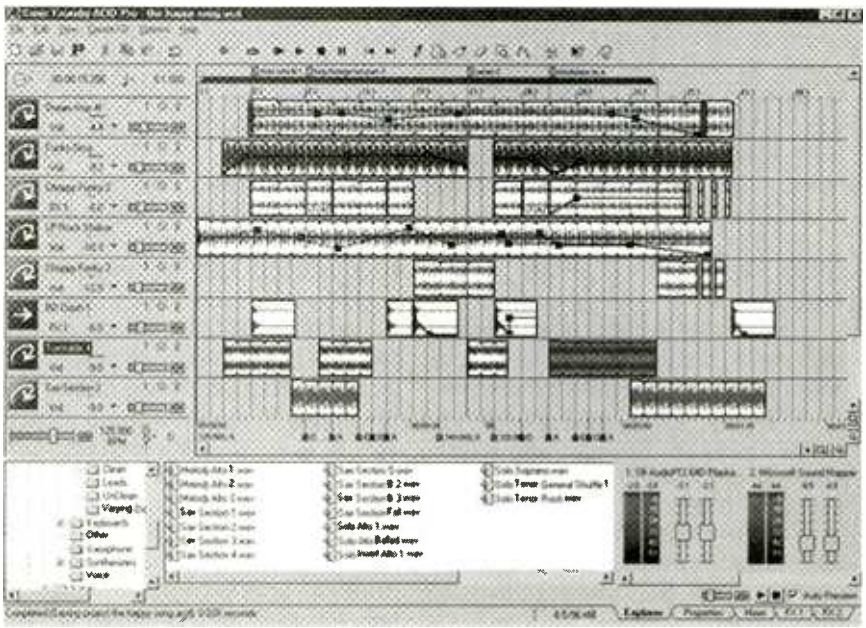
A similar program from Voyetra Turtle Beach is *Techno eJay* ($49). This title also recognizes the fun of mixing Techno, Electronica, Drum 'n' Bass, Trance, and Acid Jazz club music, and lets you become a creator in these new genres of expression.

On the CD-ROM are 3000 professionally recorded samples that you can select to arrange in a 16-track mixer environment. While it may not look as "space-age" as that of *GrooveMaker*, *Techno eJay*'s interface has the added benefit of preparing those new to computer music for the interfaces of professional recording programs. Lay down sounds in side-by-side tracks and watch your multi-layered music grow.

Choosing sounds is easy. Just decide which category to start with by choosing from Loop, Drum, Bass, Guitar, Sequence, Layer, Rap, Voice, or Effect. Then select from the samples in each of these categories. Double-clicking on a sample lets you hear it; dragging the sample onto a track lets you use it. That's it—your work's in progress. Like *GrooveMaker*, the *eJay* also lets you import samples (just WAV, though). Adding effects like Echo, Distortion, or Robotize will make your mix even more interesting.

Once you've got some tracks down, you can use the Hyper Generator II to edit or create finished patterns. When your song is complete, you can save it as a WAV file and play it any time you like.

Sampled and Synthesized. If you're considering taking your music to the next step, you likely will want to be able to work with high-quality sounds in a more customizable environment. The two programs we look at here make it possible to mold sounds into samples that can be used by themselves or imported into pro recording apps (which we'll get to in the next section).



With ACID PRO 2.0, *you can adjust individual track settings of samples and loops, thereby creating unique sounds ready for use in recording projects.*

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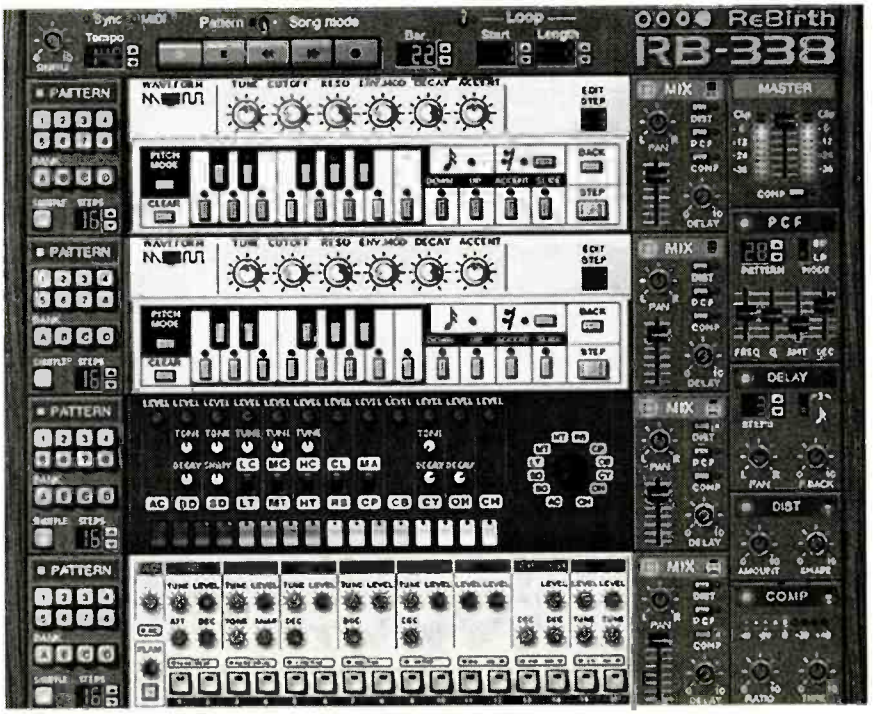
While a bit pricey, they do replace a lot of hardware that would cost even more.

Relying on pure sampling technology, Sonic Foundry's *ACID PRO 2.0* ($399) is a loop-based app for musicians and media professionals who demand flexibility and pro quality from their audio tools. Fortunately, great sound doesn't come with irritating complexity in this case. *ACID PRO 2.0* is surprisingly simple to learn and use.

To get started, you can peruse the multi-genre library of over 400 professionally recorded loops (for those who don't know, these are short clips of one or more instruments playing a pattern, such as a four-measure drum and bass line). Mix and match them as you please—the program will make sure they match tempos—and add to your heart's content to the unlimited available tracks. Each of the latter has its own Volume, Stereo Pan, and Effects settings, so you can fine-tune every bit of your project's sonic range.

Once you've mastered working with loops, you can eventually graduate to creating your own samples.



It looks like synth modules from the 80s and, fortunately, ReBirth RB-338 *sounds just like them, too. Create tracks that will breathe "old" life into new music.*

One of the nicest surprises in the package is the inclusion of Sonic Foundry's *Sound Forge XP 4.5*. This award-winning audio editor lets you edit loops for use with other software, synchronize audio to video files, and develop streaming media for the Net. You can also convert sound files into a wide variety of file formats WAV, WMA, MP3, AIF, and RM. For WAV outputs, the app even lets you save tracks, one at a time, to a CD-R (all serious musicians should get one of these drives—trust us).

Because of all these products' audio nature, it's impossible to do them justice in a paper review. *ACID PRO 2.0*'s loops drive the frustration of this fact home for us. You've got to hear them to appreciate them. Fortunately, Sound Forge and most other vendors mentioned in this article have downloadable sound samples.

If you'd like to experiment with where electronic music began—synthesis—consider the brilliant *ReBirth RB-338 v2.0.1* ($179; $69, upgrade) from Propellerhead Software. As the company claims, this is truly the stuff that "techno dreams are made of." Ask anyone involved in making electronic music and he or she may tell you that the sounds of the legendary TB-303, TR-808, and TR-909 synth/drum modules were among the best ever created. Unfortunately, these boxes went out of production in the mid 80s, making finding them a difficult task (not to mention expensive, as no one wants to part with them for less than a small fortune).

Rather than try to simulate the noises from these modules—a process which has failed in the past, we might add—Propellerhead programmers decided to reverse engineer each section of circuitry in the devices and simulate this hardware in software. The result is a stunningly accurate virtual reproduction of the synths. Even the onscreen interface looks exactly like the boxes, with virtual clusters of knobs and blinking LEDs.

In addition to being able to play around with simulated analog bassline synths and drum machines, you can use *ReBirth* to add digital delay, quad-input distortion, compression, analog filtering emulation, and PCF (Pattern Controlled Filter). The sound is incredible coming from any 16-bit card. Check out some of the sam-

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For the ultimate in high-end home recording, Cakewalk's Pro Audio 9 *(left) is difficult to beat, packing in every feature imaginable. However, those looking for quality on a budget can't go wrong with the impressive Voyetra offering:* Digital Orchestrator Pro *(right).*

ple MP3s at the Propellerhead site to see what we mean.

CD-Quality Recording. Now's the time to apply all that music savvy to a worthwhile goal. With the following two packages, you'll be able to record multi-track, CD-quality songs. The files can be used to make a killer demo on either tape or CD (again, thanks to CD-R drives), or can be compressed to the popular MP3 format (more on this in *Net Watch*—see page 44). There is a bit of a learning curve associated with these recording apps, but, as you'll see, you can learn while you record with either of them.

Imagine ... instead of having a giant mixer, dozens of cables, and digital recording decks, you can have complete control of dozens if not hundreds of tracks right on your monitor. Just input one track at a time, then play it back to record a different part along with it in real time (sound cards with multiple inputs will let you record a band simultaneously, but these are costly devices).

The industry king in this category of recording apps is Cakewalk's *Pro Audio 9* ($399, ESP; $79 upgrade for registered users). With a decent sound card, this package turns your computer into a complete multitrack, digital recording studio capable of turning out ready-to-press music. This latest version includes unprecedented support for working with guitars and lets you encode finished creations to MP3 format.

We really love the *Pro Audio 9* interface. With only a few minutes of orientation, it began to feel just like the "real thing." Actually, it's better, as you can work with each track in a way tape never allowed, cutting and pasting selections at will (forget about performing the same song part repeatedly). Each track can be cleaned up, too, whether it's MIDI or digital audio. You can use Quantize to adjust MIDI performances automatically into perfection; more impressive is how you can delete the silent spots between sloppy digital or live audio notes and use *Pro Audio 9* to correct the tempo of these isolated notes. Now everyone can play like a master.

If you have a wave-compatible sound card, your options are even more varied. The new WavePipe Technology delivers instantaneous control of mixing, muting, soloing, recording, and effect changing. No more latency like older products had. Adjust an onscreen dial and hear the results on the fly.

What can we say? This program makes recording so easy that studios may start losing customers on a regular basis. The power you get right out of the box makes *Cakewalk Pro Audio 9* worth its price.

However, some of you might want a more affordable intro to the world of digital recording. It's good to know that you can still create quality results without spending too much. Voyetra Turtle Beach offers *Digital Orchestrator Pro* for half the price of *Pro Audio 9* in a boxed form. But guess what? You can save even more by downloading the program, turning *Digital Orchestrator Pro* into a $99 recording dream come true.

Like its pricier competitor, *Digital Orchestrator Pro* lets you work with both MIDI and digital audio, mixing the two into finished, CD-ready songs. Though you can't quite clean up the performances on digital tracks like you could with *Pro Audio 9*, the MIDI quantizing is still there, and you could always cut and paste those perfect analog recordings you make even once. Further, Step Record mode allows you to enter one note at a time in non-real-time, if you're really having difficulty with a particular passage. Pitch Shift Transform lets you add harmonies effortlessly, too.

As much as we liked the Cakewalk interface, Voyetra's is even easier to get started with (especially if you've played around with *Techno eJay*). The toolbar is intuitive and quite navigable. Other onscreen features are wonderfully labeled, too, such as the Metronome Window, which allows you to name each drum or instrument, rather than relying on cryptic MIDI numbers for, say, the bass drum and snare.

When you're done with a tune, a little touching up on the 10-Band Graphic EQ will do wonders. You can then output it to WAV for CD burning or perhaps conversion to another format with another stand-alone product (like an MP3 encoder, for example).

Both of these pro recording tools are great in their own way. While Cakewalk's will likely remain the one of choice by the majority of pros for its more complete feature set, not everyone has an unlimited budget for home recording, ensuring that Voyetra's quality offering will be around a long time. Either product will have you creating music you never thought possible from home. P

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Budget Project and Computer Books

☐ **BP317–Practical Electronic Timing $6.99.** Time measurement projects are among the most constructed gadgets by hobbyists. This book provides the theory and backs it with a wide range of practical construction projects. Each project has how-it-works theory and how to check it for correct operation.

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

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

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SELINA KYLE

A Studio-Quality Sound Card

After last month's upgrade, some of you might be seeing a whole new world of computer video. This time around we'll be focusing on the circuitry in your PC that provides sound, thereby fulfilling the aural half of multimedia (as well as tying in with this issue's theme).

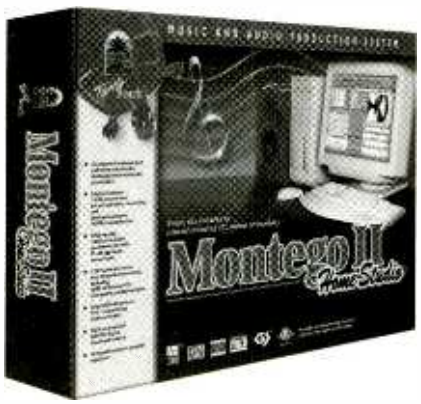
And we won't be presenting just any audio circuitry, either. Following up the Voodoo3 AGP TV, we thought we'd go all the way with a sound card that grants your PC recording-studio-quality I/O. It's designed to meet the needs of musicians who want to capture crisp signals from instruments and microphones or audiophiles who simply want *everything*—games, music, you name it—to sound great on their computers.

This is why our card of choice is the Turtle Beach *Montego II Home Studio* ($299). More than just a card to plug speakers into, the Montego II is a dual-board device that will fully exploit the digital-audio capabilities lurking in your computer.

FOR RECORDING AND MORE

Sound cards work with two different types of audio: digital and MIDI. The first one is the type you hear on CDs or in MP3 files: digital audio (DA), which is the encoded version of acoustic waveforms (all analog in nature). The second of these is the Musical Instrument Digital Interface (MIDI), which allows notes and instrument settings to be stored as tiny files of numbers. Each type of audio requires its own hardware to be created or recreated.

For digital audio recording, an analog-to-digital converter (ADC) is necessary. Conversely, to play back the DA there has to be a digital-to-analog converter (DAC) present, which can turn strings of binary zeros and ones back into audio. While CDs use 16-bit sample sizes in such conversions, the ADC and DAC in the Montego II use 18-bit sampling. This means that each time the analog waveform is sampled (44,100 times a second, to be precise), the Montego II's circuitry will capture samples that are 18 bits in size. More data captured results in a more accurate reproduction of audio. Add the fact that the converters have a >97dB signal-to-noise ratio, and you see what makes this card so special.



Whether you're recording music or playing it back, the Montego II Home Studio will provide added realism to your sonic experience. Say goodbye to humdrum audio forever.

As for MIDI, quality playback depends on what a piece of hardware uses to recreate instrument sounds. Remember, MIDI is just a mathematical representation of which notes should be played by which instrument (or "voice"), as well as when these notes should be intoned. To make this information sound realistic, a device has to be able to invoke decent simulations of real-world instruments or, better still, actual samples of them. The Montego II uses impressive versions of both of these technologies, featuring 64 sample voices, 256 realistic synthesized voices, and 64 downloadable sounds (letting you choose the samples you want). In other words, *every* type of MIDI recreation is found in this one card!

EXPANDED I/O

Before we talk about how to install the Montego II, we should draw attention to its physical form factor. In case you missed it in the intro, a reference was made to the device being "dual-board." This means you will need two open spots on the back of your system. However, you will only need one open PCI *slot*. The two boards connect together and plug into that one slot. Owners of older systems with a useless ISA slot adjacent to a PCI one should be happy about this. Simply make use of the case knockout in front of the ISA bus by putting in the Digital I/O Board.

What does this extra card do? As its name implies, the Digital I/O Board allows for expanded input and output. While the main Montego II card has the Stereo Line In, Mic, Stereo Line Out, and MIDI connectors you'd expect to find on any sound card, the I/O Board adds RCA and S/PDIF inputs and outputs. These two types of digital ports let you work with DAT (dig-

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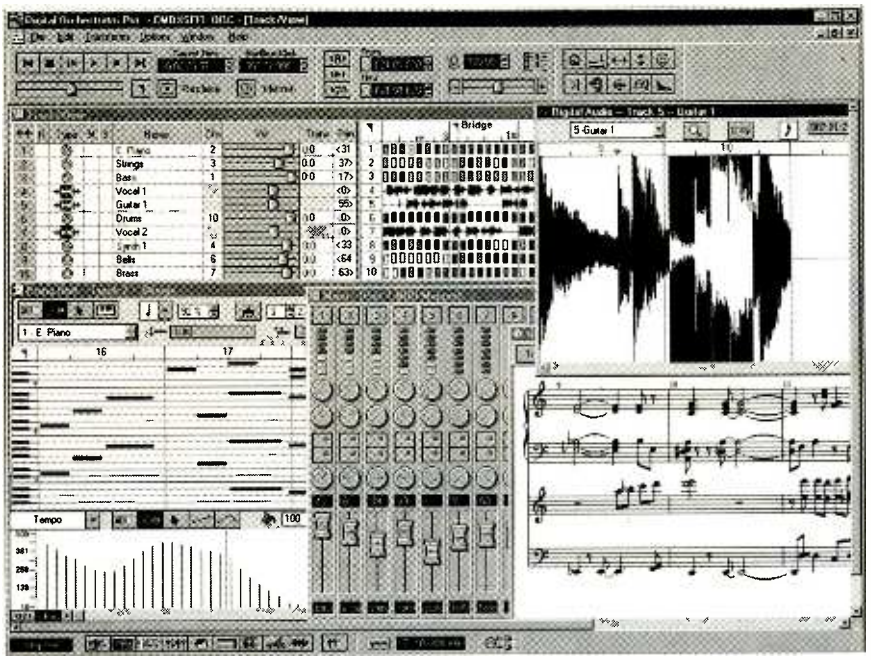

To unleash the recording capabilities of the Montego II, experiment with the bundled Digital Orchestrator Pro. *The software alone retails for two-thirds the price of the card, but you get it free!*

ital audio tape) decks, digital mixers, and other pro gear. There's even another Stereo Line Out, in case you want to create a dual-monitoring setup.

FROM OLD TO NEW

The first step in installing the new card is to remove or disable your machine's old audio circuitry. This means first "telling" Windows that you don't want it to look for the audio card or chipset. This is as simple as going into Control Panel/System and clicking the Device Manager. Scroll down to "Sound, video, and game controllers" and highlight each entry related to your sound card. Click on "Remove" at the bottom of the dialog box, and you're ready to exit Windows and power down.

What comes next depends on what type of setup you have. If you have a PCI sound card installed, you can just replace it with the Montego II, assuming there's a free adjacent slot. If there isn't, you can always move another card over a slot to make room. If your machine has an ISA sound card currently, you may want to position the Digitial I/O Board in that opening and

(Continued on page PR-7)

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NET WATCH

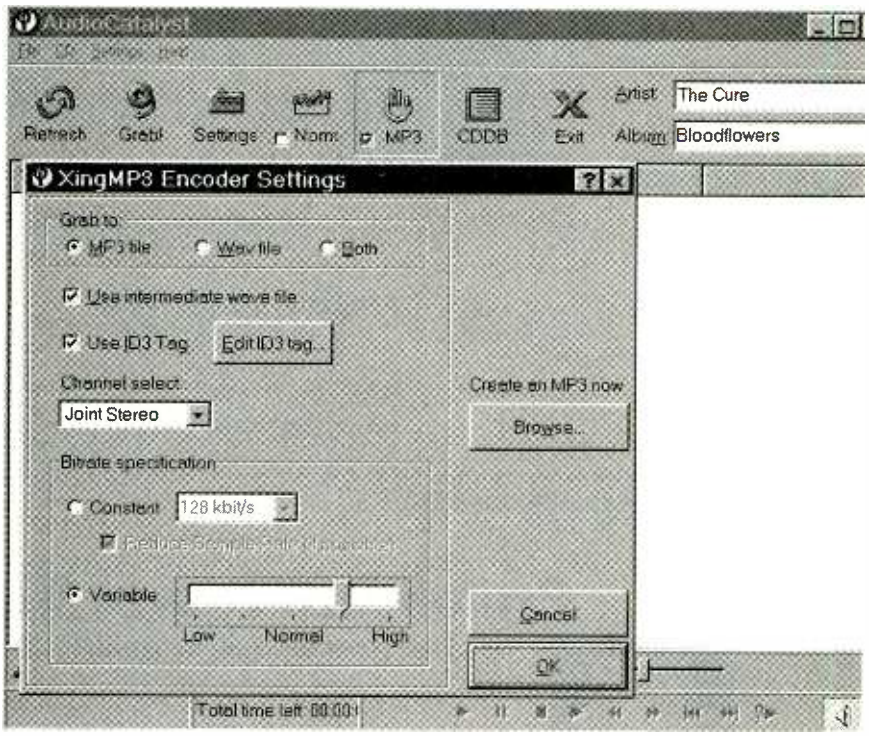
KONSTANTINOS KARAGIANNIS

MP3 SECRETS, PART I

It's amazing how far MP3 has come in the Internet world. We first covered the audio-compression format in this column back in the February 1997 issue of *Popular Electronics*, and while we knew it would be big we had no idea it would become a Net revolution. Remember when everyone was being bombarded by online pornography? This may change, as "MP3" has replaced "sex" as the most searched-for term on the Web.

For those of you who don't know, MP3 is short for MPEG Layer-3 audio. The format compresses audio by canceling out frequencies that the human ear can't hear (as well as a few bordering on both ends of our hearing range) and by combining certain other similar frequencies. While a typical CD-quality song in uncompressed WAV format takes up about 12MB a minute, an MP3 version of it can fit in approximately 1MB a minute. This makes it not only easier to store a lot of high-quality music on your hard drive, but faster to download it, too ... hence MP3's popularity online.

Considering the subject matter of this month's issue, we decided to revisit the subject of compressed audio. What you're about to read are a few MP3 secrets that will greatly improve your enjoyment of the format. Ranging from how to get the best sound quality in your files to how to best play them back, some real gems of MP3 are described here.



For fast ripping of music from CDs, AudioCatalyst *is tough to beat. Be sure to use its VBR features for best quality. The setting shown here, between Normal and High, is an average rate of 160 Kbps.*

VBR IS THE KEY

Making a high-quality MP3 is easy, if you know what to do. The trick is to get the most out of every MB of your MP3's resulting file size. We'll let you in on how to do just that—it turns out there's a setting involved in the encoding process that can make your music sound *so* much better.

First, to make an MP3 you have to use an encoder program like Xing *AudioCatalyst* or MusicMatch *Jukebox 4.5* (see "Hot Sites"). These programs can "rip" or take music directly from a CD or can work with Windows WAV files. Either way, the encoder takes the digital audio and compresses it. Assuming it's a CD-quality file, the data will have a 44.1-kHz sample rate (i.e. the number of times a second the original analog waveform was sampled to make a digital file). As this rate is a standard, we won't concern ourselves with it.

Next, you have to consider whether the audio is stereo or mono. Encoding in mono saves a lot of space, but who wants to listen to mono music? Again, this setting is standard—stereo all the way for music.

Now we get to the setting that you can change, and the one that can have a great impact on the sound quality and file size of your MP3. We're talking here about *bit rate*, or the amount of data contained in one second of real-time MP3 content. You can visualize an MP3 file as a factory assembly line with stacks of pies moving down it. The higher the stacks, the greater the amount of aroma that passes a given point every second; the higher the stacks, the better the quality of the smell. Change scent to sound and we can continue our analogy. Most files you'll find on the Net are encoded at 128 Kbps, which means that during each second of playback 128,000 bits

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MusicMatch's Jukebox 4.5 *does more than just create MP3s. It also gives you a way to organize them and convert them between formats.*

of data are being decoded. The more data decoded each second, the more realistic-sounding the result.

To get even better-sounding files, MP3 aficionados started encoding music at 160 or 192 Kbps. While these settings sound more "present," louder and clearer, and more like their original source material, they are also much larger. A 192 Kbps file, for instance, is 50 percent larger than the de facto 128-Kbps variety.

How can you get better quality without all the bloat? Three letters: VBR.

Variable Bit Rate is a recent encoding scheme that lets the program judge just how much data is required at each moment to provide accurate representation. For instance, a soft intro with maybe a single instrument might only need 96 Kbps to sound CD-like. But two seconds later, a whole orchestra might blast into the tune, requiring about 160 Kbps to do justice to the dynamics. The great thing about VBR is you set the average bit rate, and the encoder goes up and down from that baseline to do a realistic job. Unlike CBR, or Constant Bit Rate, there's no wasting of data on quiet segments and no loss of data during busy ones. With VBR you can get the best results possible during every musical passage.

We find that 160 Kbps as a VBR average produces really wonderful-sounding files. But if you're tight on storage space, consider using 128 Kbps VBR instead of 128 Kbps CBR. The VBR scheme will allow for really dense passages to encode at about 144 or 160 Kbps and will drop to 96 or 112 Kbps or so whenever it can to save space.

PLAYBACK TIPS

Once you have a great-sounding file, how can you enjoy it most? A major criticism leveled at MP3 by audiophiles is that, barring expensive living-room digital-audio players, you'll most often be listening through a com-

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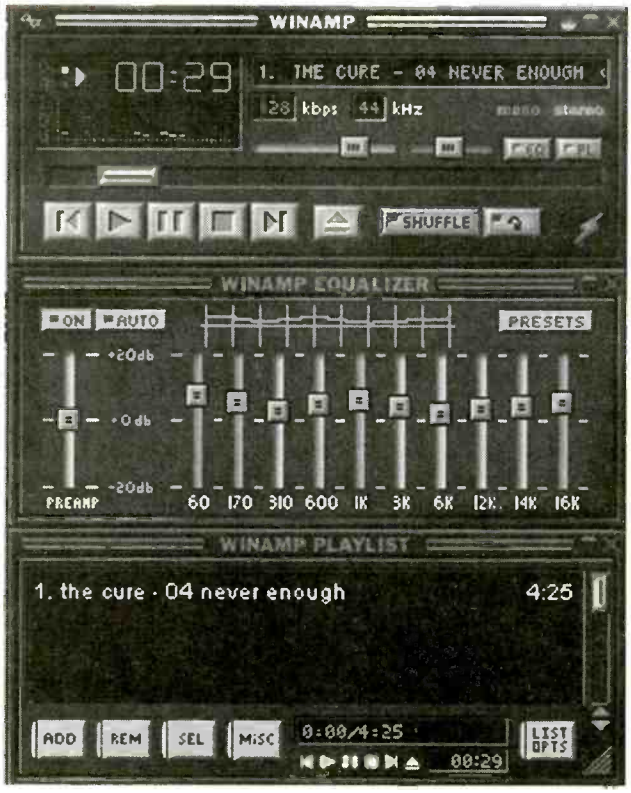

Winamp *is without a doubt the best way to play MP3s on a computer. Even though it's a free program, it has some great features, including EQ that can greatly enhance your listening enjoyment, if used properly.*

puter system. Yes, PC speakers have gotten pretty decent in quality, with subwoofers greatly reducing the "tinniness" of the audio. However, many systems still leave a lot to be desired.

What's the best way to listen to MP3 on a computer? Whether you have a subwoofer or not, do not allow your music to lose any more frequencies! Remember that Layer-3 encoding does chop off some lows and highs. Use some equalization to make up for this.

For starters, see if your PC's sound card and drivers allow for some hardware EQ. Double-click on the little yellow speaker icon located to the right of your Windows 95 or 98 Start Taskbar (this area is called the System Tray). A Volume Control mixer window will appear. Under the Options menu, click on Advanced Properties. If the latter is grayed out, then you can't use sound-card EQ. Further, even if it's not gray-ed, you still might not be able to proceed. Once you've clicked on Advanced Properties, a button will appear under one or a couple of the mixer sliders. Should one appear under Volume, click the button. You may be pleased to find Bass and Treble sliders that will let you greatly enhance the sound of your MP3s. If they're not there, though, don't worry. You have an-other shot at EQ.

What MP3 player software are you using? Hopefully not Windows *Media Player*. As nice as the app is, it doesn't do justice to the MP3 format. You should be running Nullsoft's *Winamp*. This free program allows for the use of various audio plug-ins and is an all-around stable choice for playback. Best of all, it has a ten-band graphic equalizer! Just be careful not to go too crazy on adjusting the slider. To avoid distortion and maximize the benefits of *Winamp*'s EQ, only vary from the baseline setting of each band by about 40 percent. In other words, if there was an imaginary +1 to 10 above and −1 to 10 scale below each slider's base setting, you should only move a slider up or down to plus or minus four, or so.

The enclosed shot of *Winamp* shows the author's personal favorite EQ setting for music, if you're curious.

YET TO COME

Next month, we'll be focusing on some little-known ways to acquire MP3 files from the Internet. Trust us, you won't want to miss the next installment of this column!

Until then, if you have any questions or comments, feel free to contact me via snail-mail at *Net Watch*, **Poptronics**, 500 Bi-County Blvd., Farmingdale, NY 11735, or e-mail at *netwatch@gernsback.com*. P

HOT SITES

AudioCatalyst
www.xingtech.com/mp3/audiocatalyst

Jukebox 4.5
www.musicmatch.com

Winamp
www.winamp.com

SYSTEM DESIGN

(continued from page 36)

SYSTEM SPECIFICATIONS

Model: Aqcess Qbe
Price (as configured): $3495
Vendor: Aqcess Technologies, Inc., 3611 S. Harbor Blvd., Santa Ana, CA 92704; 888-240-2823; *www.qbenet.com*
CPU: 433-MHz Intel Celeron
Memory: 64MB PC100 RAM, expandable to 512MB
Storage: 6.4GB Ultra ATA/33 hard disk, no floppy disk
ROM Drive: 24X CD
Video: 13.3-inch active matrix TFT display with capacitance TouchPen overlay, SIM AGP video chipset with 8MB RAM
Audio: ESS Technologies Maestro wavetable audio chipset
Size: 14 × 10 × 1.5 inches (HWD)
Weight: 5.9 pounds
Battery: Lithium-Ion, 2–4 hours life on a charge
Ports: USB, IEEE-1394
Expansion: Via Porticle port replicator
Other: Windows 98

CIRCLE 120 ON FREE INFORMATION CARD

is included should you wish to use a standard mouse. Also included is an IEEE-1394 port.

For the Qbe's price tag it's a good thing the device also comes with some attractive extras. A small CCD video camera is in the case, as are a modem and Ethernet adapter, and even a card reader for swiping credit cards. In case you'd rather avoid pen entry, L&H *Voice Express* speech recognition is included.

We loved it, but keep in mind that the Qbe really isn't the right solution for everyone. It's somewhat expensive, and the lack of a floppy disk drive will stop some users in their tracks. But then, it really isn't trying to be an all-around PC. You can buy a laptop with the same 13.3-inch LCD screen and even more features for $1,000 less than the cost of the Qbe. However, just try using the laptop while, say, walking around a warehouse to take inventory.

Such true Pen-based computing applications are what the Qbe is intended for. Filling out forms, accessing databases, even wirelessly surfing the Web on the go—all these applications are perfect for the Qbe. Oh, and if you *really* hate typing and are somewhat old-fashioned, you just might enjoy writing under a tree with the tablet PC on your knee and stylus in hand. P

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COMPUTER BITS

TED NEEDLEMAN

Converting LPs to CDs

I'm not going to discuss my age—it's just a touch too depressing to think about. But I will admit to having a rather large collection of records that no one in the family has listened to in quite a while. For those of you from a slightly younger generation, records were the first popular plastic ("vinyl") audio recording media, before CDs, cassette tape, or (horrors!) 8-Track tape. I used to have a rather serviceable, if not particularly high-end audio system set up in the family room. However, as we needed space for videogame consoles and home-theater stuff, first the large floor speakers were removed, and then the turntable needed to go.

With the returning popularity of 60s and 70s music in movies and advertisements, my kids are getting tired of hearing me say, "I've got that on a record." Of course I do, but with the stereo system in pieces, all I can show them is a 12-inch piece of black vinyl and the cover lines.

Recently, after years of prodding by my better half, I decided to transfer about 100 or so of my albums onto CDs. Considering that most of the more than half-dozen PCs in this house have CD-R or CD-RW drives, this was probably a project that I should have undertaken previously. But, as they say, better late than never.

THE BEST LAID PLANS....

Burning an audio CD is not really a big deal. All of the current popular software applications that come with CD-R and CD-RW drives provide the capability of creating a CD disc with the music stored in a format that can be read by not only CD-ROM drives in a computer, but CD players and changers, as well. Many software packages are adding the capability of burning files in the new MP3 compressed audio format; though at the present time, these files can't be played on a standard audio CD drive.

These buttons on the Carrera turntable let you program the tracks to play.

The hard part of this project, however, turned out to be getting the audio off the vinyl record, and into a usable format on the PC's hard disk. Most CD-burning software requires that the individual audio tracks be stored as WAV files. This WAV format is the commonest uncompressed audio format used by the Windows operating system. When the software actually creates the CD, it will perform the conversion of the WAV file into an audio file that can be played on any CD player.

Dusting off the old turntable, I pulled out a small set of RadioShack bookshelf speakers I had stored and connected my trusty Kenwood KR-2090 receiver. Once all the dust was carefully cleaned off, hooking everything together took about 10 minutes. The speakers and turntable connect exactly as if you were going to listen to a record. To connect the receiver to the PC's sound card, a patch cord is necessary. This cord has a stereo mini-plug on one end, and two RCA plugs on the other. You can purchase one of these cords for a few dollars at many audio stores or RadioShack. I had one that came with the upgrade of Adaptec's *Easy CD Creator 4.0* I recently bought. Make sure that you plug this into the "Line-In" connector on your PC's sound card.

For the target system, I decided to use my new review system: the Compaq Presario 5868. This PC features a 600-MHz Athlon CPU from AMD, 128MB of RAM, a giant 20GB hard disk, and a 4X CD-RW drive. This system is fast, powerful, and has plenty of room to store WAV files before I burn them onto an audio CD. Most sound cards, including the SoundBlaster PCI128 card that the Presario incorporates, include a record utility. Basically, this utility lets you set the input mode (mono or stereo) and the sampling rate at which you want to record the input. For recording at CD quality, you want to set this at 44.1 kHz. This eats up disk space fast, but it's a necessary setting.

With everything hooked up, I started the recorder utility, keyed the turntable for the first track on one of my wife's favorite *101 Strings* albums, and started recording. So far, so good. Then things started to take a left turn. In the middle of track 2, I started hearing loud cracking noises. These weren't the slight dust pops that often happen when playing vinyl records. I had cleaned the record before starting, and these were much too loud to be cleaned up by the software utilities that most CD-R burning software provides. As it turned out, the phono inputs on the Kenwood receiver had started to give up the ghost. The other inputs and

The SA-155 amplifier from Radio Shack is small, but it will let you easily hook up several audio sources.

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A slide switch on the SA-155's rear panel lets you choose between a magnetic or ceramic phono cartridge input.

radio parts of the receiver worked fine, but one of the components in the phono-input amp section was fast going bad.

Unfortunately, I'm a lot better at troubleshooting PC problems than I am at trying to fix a 20-year-old receiver. But this situation left me with a serious problem. My turntable, an older Carrera linear-drive model, was operating just fine. And for this particular type of task, the Carrera was perfect, as it has a set of buttons that you can use to program what track or tracks to play. An optical sensor locates the start of each track, moves the tone arm to the correct place, and lowers it to play the track. When the arm hits an area of blank vinyl, the sensor raises the arm and moves it either onto the next programmed track, or back to the home position. I didn't want to have to try to find a new turntable. But none of the other stereo equipment I had in the house had an input for a magnetic phono cartridge. Understandably, these inputs have fallen out of favor over the years. And, without the boost in amplitude and the correct equalization, the high-quality magnetic cartridge in the turntable was useless.

The last time I looked, which admittedly was many years ago, all of the major electronics chains carried inexpensive phono preamps for about ten bucks. A quick search uncovered the fact that these seemed to have dried up years ago. Resigned to having to spend some money, I found that RadioShack, among other vendors, still offered relatively inexpensive turntables. For about a hundred bucks you can get one with a built-in phono preamp, so it can be used on the auxiliary input of most standard receivers and amplifiers.

Once I got to RadioShack, however, I received some interesting news. The first was that although it no longer carries the standalone phono preamp in its retail catalog, my local RadioShack could order it from a special-order catalog and have it in about a week. The price had gone up to around $30, but it was still available if I wanted it.

Not really wanting to wait, however, I let the manager of the store show me a $60 Optimus SA-155 Integrated Stereo Amplifier. This tiny amp puts out only a few watts of power, but that is sufficient to drive my small bookshelf speakers to an uncomfortable loudness. Best of all, however, it has a set of phono inputs with a switch on the rear panel that provides magnetic phono boost and equalization. Plunking down my 60 bucks, and rushing home, I was quickly back in business.

BRING IT ON HOME, NOW

Once I got the Optimus SA-155 hooked up, the rest of the project went as smooth as silk. In actuality, I didn't have to record each track as a WAV file—the CD recording software that's included and pre-installed on the Presario 5868 can directly accept an audio input from the sound card, without the intermediate WAV step. Called *just!burn*, from CeQuadrat, the program may be hard to come by as the company was purchased by Adaptec last summer. Adaptec produces its own very popular *Easy CD Creator*, so it's unlikely that *just!burn* will continue for much longer as a standalone product. That's unfortunate—while I like *Easy CD Creator* a lot, and just upgraded to *Version 4.0*, there are a number of *just!burn*'s features that really appeal to me.

CeQuadrat's just!audio *presents you with a recording console so you can record direct to your hard disk from the audio source.*

When you launch *just!burn*, you are presented with a splash menu that lets you choose just!data, for creating data CD-Rs or CD-RWs, just!backup, for automatically backing up your hard disk onto CD-R/RWs, or just!audio, for making audio CDs. Toggling the just!audio screen brings up the recording console, which has VU meters and an elapsed time counter. Also there are controls to de-click the recorded audio and set the volume to maximum (when you have a recording that was recorded at a very low level). There's even a trim button, in case you've recorded too much "dead" time. Once the tracks are recorded onto your hard disk, you can add titles, label the CD, and prepare to burn it.

Non-Presario owners may find *just!burn* included with a number of CD-RW drives. If you don't get a copy, however, don't be too disappointed. *CD Spin Doctor*, the audio CD utility that's included with Adaptec's *Easy CD Creator*, also lets you record directly from an audio source, including LPs, cassettes, or another audio CD.

Next time, we'll burn the CD, and add the finishing touches. As always, your comments are welcomed. E-mail me at *tneedleman@aol.com*. P

VENDOR INFORMATION

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JOHN IOVINE

Telepresence

This month, we will build a simple ROV (Remote-Operated Vehicle) that will be upgraded to become a telepresence robot. What is telepresence? Telepresence is a way to project an operator's presence to a remote location through a device that also feeds back, with high-fidelity, one or more senses to the human operator.

A near-perfect system would make users feel as if they were at the scene and operating from inside the robot. A perfect system would require a humanoid robot that could accurately follow human movement, gestures, locomotion, and balance while providing visual, thermal, tactile, and force reflection over its entire exoskeleton to the human operator. The illusion created in a perfect system is that the operator has merged with the robotic system.

State of the Art

Current telepresence systems fall short of that goal. In most cases, the remote system is a vehicle similar to the one that we will build. However, even rudimentary telepresence systems are extremely valuable. There are a many systems that are in commercial use. The first systems that come to mind are underwater ROVs.

Underwater ROV systems range in complexity from simple one-eye (camera) vehicles to stereoscopic vision systems with robotic arms and cargo holds. Underwater ROV systems are used for exploration and excavation in locations that are impossible or very difficult to get to because of size or maneuverability restrictions (caves or sunken ships) or seabed "hot spots" where underwater volcanos are literally boiling the ocean around them.

While it is technically feasible to send a person to those locations, it can be quite dangerous and expensive—the mission of the unit now becomes one of life support for the crew instead of meeting the objectives of exploration or excavation.

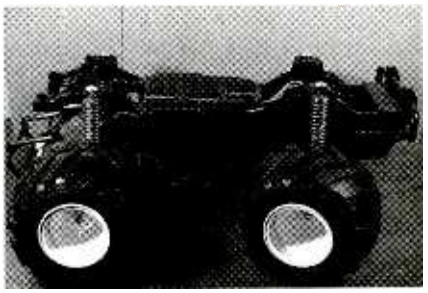

Fig. 1. Any suitable radio-controlled car can be converted into a telepresence robot. This particular chassis comes from RadioShack.

Likewise, there are many applications for ground-based ROV systems that are called into use when the situation is hazardous to human life:

Grabbing and disposing of explosive materials

Fire-fighting situations

Cleaning up toxic waste and pollution sites

Cleaning up nuclear reactors and nuclear wastes

Police departments have ROVs that can withstand small munition fire for entering a criminal's hideout. Some units are equipped with two-way communication gear. That comes in handy in a hostage-negotiation situation when other means of communication are not available.

Airborne ROVs include remotely-operated drones that are used for military targeting and surveillance. That technology has filtered into commercial applications. For instance, airborne helicopter ROVs are used in the motion-picture industry to shoot aerial footage at a fraction of the cost of shooting the same scene using conventional aircraft and crew. Putting an ROV in a risky situation can result in some thrilling footage of, say, an exploding building or a collapsing bridge. One need look no further than the occasional news item stating that some member of a film crew was badly hurt or killed while filming to appreciate the advantages of aerial drones in such situations.

Enter Virtual Reality

As ROV systems evolve, they will utilize more "virtual reality" interfaces and develop into true telepresence systems. The technology will probably include head-mounted displays, stereoscopic vision, and tactile and force feedback (areas to explore if you're looking for stuff to experiment with!).

Pathfinder and Sojourner

NASA has sent a slew of robotic explorers into space. We have received breathtaking photographs from their travels. Recently, the Mars Pathfinder mission and Sojourner vehicle received a lot of press. On the surface, it might appear as if Sojourner is an ROV. It's close—pilots on Earth do drive the craft around, but what it is missing to make it a true ROV is real-time interactivity.

Signals from Mars take about 20 minutes to arrive on Earth. That time lag makes it impossible to really "drive" the vehicle on Mars. One could drive the

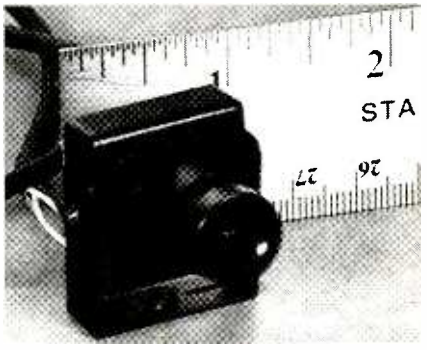

Fig. 2. Miniature charge-coupled-display cameras come in a variety of shapes, sizes, and options. This one has a glass lens for better image quality.

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rover off a cliff and destroy it before anyone on Earth could react, much less give a command to turn or stop the vehicle. So the pilots drive the Sojourner vehicle in short spurts. Twenty minutes later, the unit receives the command to move a few feet. Another 20 minutes (for a round-trip total of about 40 minutes), the pilots back on Earth finally get to see what the Sojourner did. They can then analyze and chart the next leg of their path from new information gathered. Because of the time lag, small trips take a long time to navigate.

The benefit to the extensive charting information gathered from Sojourner is that it may be used to create a near-perfect model of its Mars landing site here on Earth.

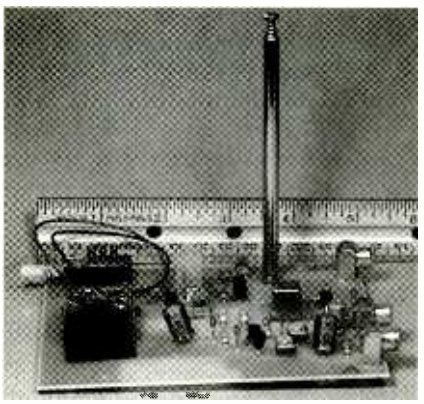

Fig. 3. A television transmitter sends the video back to the operator without the need for a cable. A kit like this one can send video and audio up to about 100 feet.

Lunacorp

Lunacorp is a private company that's attempting to open up space travel to Earth-bound people via telepresence. They plan to have a rover on the moon in 2003. The rover will have high-resolution cameras that will provide a real time, 360-degree view of the moon's surface as the rover travels.

The images will be radioed to Earth where specially-constructed rooms will reconstruct the images into a 360-degree view from the rover for small audiences—very much the "ultimate DisneyWorld attraction." Other equipment will include higher-resolution VR simulators that will tilt and rumble, allowing people to feel the moon terrain as if they were riding on top of the rover. A few selected people will actually be able to drive the Moon rover. All of the information will be recorded so subsequent rides can be given long after the rover becomes inoperable. For more information, you can visit Lunacorp on the Web at *www.lunacorp.com.*

TABLE 1

Lens Size	Field of View
3.7 MM	90 degrees
4.0 MM	76 degrees
6.0 MM	60 degrees
12 MM	46 degrees

A Vehicle Of Our Own

Now that I've gotten you excited about the possibilities of ROVs, it's time to put one together to "experiment" with. Remember, it's not necessarily the "price of the toy" but the "coolness" factor that it embodies.

We'll start by choosing a suitable radio-controlled (R/C) vehicle as a platform. The criteria for the vehicle follow:

Proportional Steering

Adjustable Speed Control (slow speed needed—a proportional throttle is optional)

Large enough to carry additional equipment (CCD camera, video transmitter, etc.)

Rechargeable Battery Pack

The vehicle that I chose is shown in Fig. 1. Your choice should take into consideration issues such as price and availability.

CCD Camera

The charge-coupled-display (CCD) camera that you choose must be able to run from a battery-based power supply, typically 9–12 volts. Some black-and-white cameras come equipped with infrared LEDs for night work or other dark conditions. Unless you are planning to run a stealth ROV, the diodes just add to the current consumption of the camera and should be avoided.

There are two main choices in cameras nowadays: color or black-and-white. Color adds a wonderful dimension to the system, but color cameras cost much more than black-and-white units. If the ROV is going to be subjected to a harsh or dangerous environment (more about that later), you might want to run preliminary testing using cheap equipment before investing in a color system.

Miniature CCD cameras are available from any number of vendors. What you want to look for when comparing CCD cameras is the size of the CCD element. Better quality cameras have a 1/3-inch-square CCD element. Less expensive cameras use smaller elements—around 1/4 inch. The 1/3-inch CCDs will have a higher number of horizontal scan lines, providing a higher-quality image.

The next option to look for is the lens. Many cameras are sold with a pinhole lens. Pinhole lens will work quite well, but remember that pinhole lens are used primarily in stealth applications where the exposed opening for the lens is minimized to keep the camera well hidden. A better choice for picture quality are CCD cameras that use a standard glass lens. The size of the lens determines the field of view (FOV) of the camera, which will vary from manufacturer to manufacturer. Table 1 provides an approximate FOV for a few common lens sizes.

We want the camera's output signal to match whatever transmitter and television receiver we'll be using. For me, NTSC is the way to go. Depending on your country and the equipment you can get, you might have to find PAL or SECAM substitutes. Luckily, I've found that most CCD cameras have an NTSC output.

If the camera comes equipped with a microphone, that's a plus in terms of the overall telepresence experience; we can transmit the audio along with the video.

The camera that I chose is shown in Fig. 2. This microminature CCD camera is approximately 1-inch square, has a built-in microphone, is mounted on an adjustable Y-yoke, and has output leads for video and sound and an input jack for power. I liked it so much that I made it

Fig. 4. A higher-powered video transmitter such as the Ramsey unit pictured here can send signals a far as 1/2 mile. Check your local regulations concerning the maximum power allowed for unlicensed transmitters. Note that this unit transmits on Cable Channel 59; you'll need a television that can pick up that frequency as it is not within the standard broadcast frequencies.

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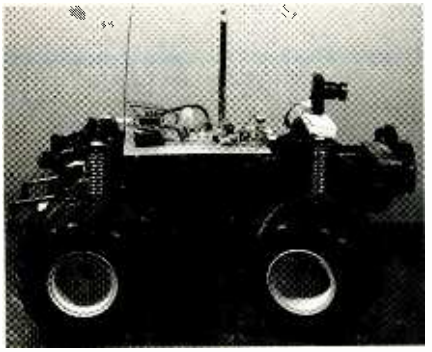

Fig. 5. A completed ROV ready to explore dangerous or inaccessible places.

available through my company, Images; see the sidebar for more details.

TV Transmitter Kit

There are a number of vendors supplying TV transmitter kits, one of which is shown in Fig. 3. Those kits can transmit video and audio signals from your camera to a nearby TV receiver. The kits are tuned to an unused TV channel (between channels 3-6) in your area. The kit that I built complies with FCC regulations concerning unlicensed transmitters; it can broadcast up to about 100 feet. Anything more powerful than that requires the appropriate license. Licensed "ham" radio operators are probably familiar with what their particular license allows.

Television transmissions by amateur-radio operators is called, appropriately enough, amateur television, or ATV for short. Ramsey Electronics sells a tiny, flea-weight ATV transmitter called the Cube 3000; it can be seen in Fig. 4. While that ATV transmitter is sold assembled, you still need to solder a few wires to the unit for power, antenna, and video input. This tiny transmitter is quoted as being able to transmit up to 1/2 mile using high-quality TV antennas. Although the range is much greater than an unlicensed transmitter, so is the cost; I found that the Ramsey unit is four times more expensive than the kit in Fig. 3.

TV Receiver

A portable TV receives the video and audio signals from whatever transmitter you choose. Obviously, you'll have to tune your TV to the frequency that you're using for the link. (Cable Channel 59, which is just below UHF channel 14, is the link for the Ramsey Cube, for example.) Many portable-TV sets, liquid-crystal-display TVs like the Sony Watchman, and automobile televisions are able to tune to the Ramsey frequency.

Connect the video and audio signal from the CCD camera to your transmitter. Tune in the signal using the TV receiver according to the instructions included with each kit. Once it's tuned, power down the camera and transmitter and install them on the R/C vehicle.

Mounting the Camera

Mount the CCD camera near the front of the R/C car. Position the camera so that it won't be hit if the car bumps into something. You can easily mount the camera using a piece of hook-and-loop material; one part on the camera and the mating part on the R/C car. Using a temporary mount lets you change the camera position or exchange cameras.

Position the TV or ATV transmitter behind the camera using some form of temporary mounting system. My completed unit is shown in Fig. 5.

Components

To build the Telepresence ROV, you'll need to find the following items:

Radio-controlled vehicle
CCD Camera
TV Transmitter Kit or ATV transmitter
Tunable TV receiver

To get you started in your search, here are some suggested suppliers that carry some or all of the above-listed items:

Images Company
39 Seneca Loop
Staten Island, NY 10314
718-698-8305
www.imagesco.com

Jameco Electronics
1355 Shoreway Rd.
Belmont, CA 94002
650-592-8097
www.jameco.com

JDR Microdevices
1850 S. 10 St.
San Jose, CA 95112
800-538-5000
www.jdr.com

RadioShack
(Check your local store)
800-THE-SHACK
www.radioshack.com

Ramsey Electronics
793 Canning Pkwy.
Victor, NY 14564
800-446-2295
www.ramseyelectronics.com

Driving the ROV

Once everything is in position, you can drive the car remotely. Driving will take some getting used to. A single camera doesn't provide depth perception or clues, so you will find yourself bumping into things. That's one reason to go slow. In addition, if the car is too fast, you won't be able to react quickly enough to avoid any obstacles.

Also, keep in mind that the turning radius of a typical R/C car is limited by the servo motor that operates the steering linkage. Servo motors typically rotate a total of 90 degrees, or about 45 degrees in either direction.

Going Further

Now that you've tried our introduction to ROV systems, you've probably seen there are many ways to enhance the system. Let me mention some obvious (or not-so-obvious) ones:

Replace the standard R/C car transmitter with a four-channel R/C system. Use two channels to control the car in the usual way. The two additional channels are hooked up to additional servos for motion control of other items such as a robotic arm and gripper. You could also attach the camera to one of the additional servos for sweeping your "vision" left and right. With a gimbal mount, the camera could be moved up and down as well.

By adding another radio link similar to the video link that we discussed, the ROV can send back data about its environment. Examples of that include vibration sensors to gauge the terrain, a digital compass to determine the direction that it's pointing in, and tilt sensors to determine the grade angle that the ROV is on.

Further Still: Sea and Air

The same ROV technology can be used to explore underwater and aeronautic environments. For underwater work, I would use a tethered system to

(Continued on page 56)

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GORDON McCOMB

Using "Not Quite C" to Program LEGO Mindstorms

The LEGO Mindstorms Robotic Invention System (RIS) has become a watershed for hobby robotics. Mindstorms allows both adults and kids to experiment with robotics, but without the usual requirements of constructing a frame and body and soldering electronic circuits. It's a quick and simple introduction to robotics, and especially to the programming behind building robots.

Yet the robots you can build with Mindstorms go far beyond simple automated toys. There is a surprising amount of power under the yellow plastic of the Mindstorms robot module. However, much of this power is not easily recognizable in the simplified graphical programming environment that comes on the Mindstorms CD-ROM, for whatever technical reasons. Fortunately, the full potential of the Mindstorms robotics system can be tapped by using alternative programming environments. In this column, I'll discuss "Not Quite C" (NQC), one of the more popular alternative programming languages for Mindstorms.

But before we begin our journey into more advanced Mindstorms programming, let's take a short break and look into the system, including what's inside the brick-shaped module that makes up the core of the Mindstorms RIS.

Inside the Mindstorms

The LEGO Mindstorms Robotics Invention System consists of three major parts. First of these is the RCX (*R*obotic *C*ommand *Ex*plorer) controller. The RCX is otherwise known as a "brick" or "programmable brick." The term comes from robotics researchers at Massachusetts Institute of Technology, who were the original developers of the concept behind the RCX. You can attach to the RCX a collection of motors and sensors to build a mobile automaton. As the RCX uses standard LEGO "bumps," you can attach regular LEGO parts to it.

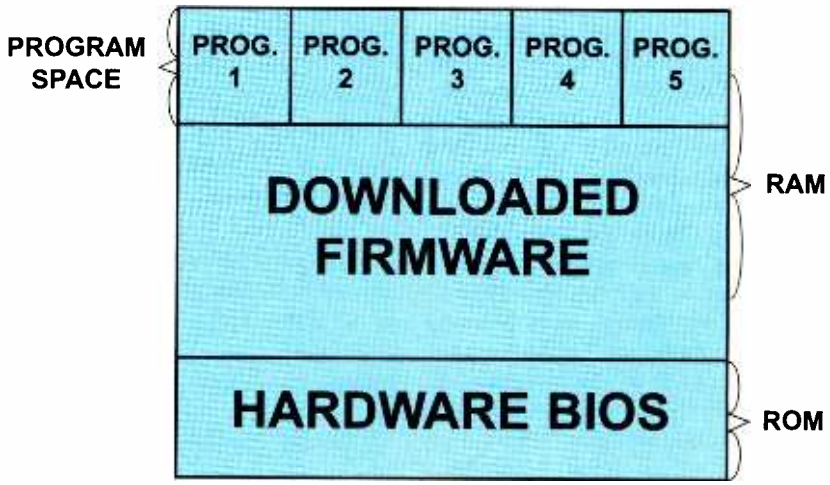

Fig. 1. The Mindstorms RCX uses a hardware BIOS in ROM, along with firmware and program data in RAM. Note how only five programs can be stored at a time.

The second major part is the Mindstorms programming environment, which allows you to create and store programs on a personal computer, and download them into the RCX. The RCX itself has no programming capability. While Mindstorms programming environment is the standard method of writing programs for the RCX, it is not the only way.

The third major part of the RIS is a two-way transmission "tower" for communicating between the personal computer and the RCX. The tower uses modulated infrared (IR) light, rather than radio signals, so that two or more RCX units can be programmed in the same room (the power output of the IR tower can be adjusted to avoid interference).

The LEGO Mindstorms RCX contains a Hitachi H8/3292 microcontroller. The H8 supports several memory types, including both ROM (read-only memory) and RAM (random-access memory). It also comes with its own built-in timers—three to be exact, though the RCX splits one of them to create a total of four—as well as eight 10-bit analog-to-digital converters. In all, it is a highly capable chip, which is one reason why the RCX can pack so many features in such a small package.

Figure 1 shows several different "layers" of program instruction used in the RCX. At the bottom is a form of hardware BIOS (basic input/output system). This hardware level is a permanent part of the H8 processor; and it provides for very low-level functionality, including downloading of programs. The hardware BIOS is stored in 16KB of ROM and cannot be changed or erased.

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The firmware layer contains what could be considered the RCX's operating system. This operating system can be periodically updated. In fact, when you first install the Mindstorms system on your computer, part of the setup process involves downloading the firmware from a file on your computer's hard disk and into the RCX. Whenever LEGO releases updates for the RCX on the Web, you need merely to return to the setup portion of the Mindstorms program and download the new version of the firmware.

Finally, the data layer contains the actual programs that you run on the RCX. Data programs are stored in RAM; the batteries in the RCX keep a small amount of power applied to the memory so that your programs remain, even when the RCX is turned off.

Both the firmware and the data are stored in 32KB of RAM. Since it is RAM, the data in it can not only be replaced but erased (including accidentally). The RCX can store up to five programs in RAM; there is enough RAM capacity for the firmware and five programs of about 1.2KB each. (Data is stored in a 6KB region; the rest of the RAM is allocated to the firmware, which currently consumes about 21KB). Compared to what you'll find in your desktop computer, that's not very much storage space. However, the RCX needs relatively little space to run its programs. Once you've downloaded a program into each of the five program "slots," you will have to overwrite one of the old programs in order to download a new one.

Using NQC to Program the RCX

At last count, there were over a dozen programming alternatives for the LEGO Mindstorms RCX. One of the first, and still one of the most popular, is the aforementioned NQC—a standalone, text-based programming environment for the RCX.

LISTING 1

```
#define LIGHT     SENSOR_1
#define MOTOR     OUT_A+OUT_C

task main()
{
   SetPower(MOTOR, 7);
   SetDirection (MOTOR, OUT_REV);
   SetSensorType(LIGHT,
SENSOR_TYPE_LIGHT);
   while(true) {
         if(LIGHT > 60)
               On(MOTOR);
         else
               Off(MOTOR);
   }
}
```

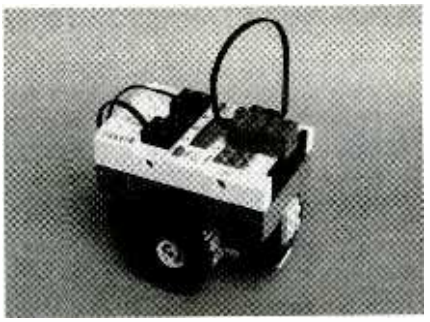

Fig. 2. Here's the basic rover robot equipped for the sample NQC program in Listing 1. It's equipped with two drive motors and a light sensor.

NQC is a freely distributed program available online at *www.enteract.com/~dbaum/nqc*. Versions of NQC are available for Windows 95/98, Mac OS, and Linux operating systems. Fetch the version you want, but note that the following steps assume you're using a Windows-based PC. See the documentation that comes with NQC if you are using a different computer.

Creating a NQC Program

As its name suggests, Not Quite C uses a C-language syntax for programming. For those unfamiliar with C, the syntax can look a little bit daunting. However, with just a bit of study, you'll find NQC is not difficult to master.

You may use any text editor to prepare your NQC file. Under Windows, for example, you can use the *Notepad* program. Your NQC program files should be stored in the same directory as the NQC.EXE program itself. Below is a simple NQC program that does an amazing amount of computational work. When run on an RCX with two motors attached to the outputs A and C, along with a light sensor connected to Input 1 and pointing forward, the RCX will seek out any bright light in the room. Aim a flashlight at the light sensor, for example, and the robot will come toward the light.

Figure 2 shows the prototypical RCX "rover" robot, set up for the example programs in this column.

Your First NCQ Program

Type in the short program shown in Listing 1. To try it out, save it as "photophile.nqc" (the robot programmed with it will, after all, be a lover of light). Be watchful of typographical errors, and do not omit any of the brace characters. We'll delve more into parts of NQC syntax throughout this month's column, but for now keep in mind that, as with most C-based languages, capitalization is important. For example, *while* is correct, but not *While*.

Let's take a closer look at the parts of the program.

```
#define LIGHT  SENSOR_1
#define MOTOR OUT_A+OUT_C
```

These two statements define constants (unchanging variables) used elsewhere in the program. Constants are defined using the *#define* keyword, followed by the name of the constant, and finally the value of the constant. Note that the value of the constants—LIGHT and MOTOR—are themselves constants. In this case, the constants SENSOR_1, OUT_A, and OUT_B are built-in constants, with values already defined by NQC. You use their own constants to make working with the RCX even easier. See Table 1 for a list of the most commonly used built-in constants.

You will note that the MOTOR constant refers to two outputs, both A and C (OUT_A+OUT_C). In this way, you can operate both motors together. This makes it a little easier to command the robot to go forward or backward.

```
task main()
{
```

Each NQC program can have up to ten tasks. Each task can be run simultaneously. The task that is run when you press the RUN button on the RCX is called *main*. You can give your own name to other tasks you add in your program, but *main* always

LISTING 2

```
#define LIGHT     SENSOR_1
#define MOTOR     OUT_A+OUT_C

task main()
{
   SetPower(MOTOR, 7);
   SetDirection (MOTOR, OUT_REV);
   SetSensorType(BUTTON, SENSOR_
   TYPE_LIGHT);
   while(true) {
         if(LIGHT > 60)
               On(MOTOR);
         else
               Off(MOTOR);
   }
}
```


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TABLE 1—NQC STANDARD CONSTANTS

CONSTANT NAME	FUNCTION	EQUIVALENT VALUE
SetSensor		
SENSOR_1	Input 1	0
SENSOR_2	Input 2	1
SENSOR_3	Input 3	2
SetSensorMode		
SENSOR_MODE_RAW	Raw value from sensor (0 to 1023)	hex 0x00
SENSOR_MODE_BOOL	Return Boolean (0 or 1) value	hex 0x20
SENSOR_MODE_EDGE	Count number of rising/falling edges	hex 0x40
SENSOR_MODE_PULSE	Count number of pulses	hex 0x60
SENSOR_MODE_PERCENT	Show value as percentage	hex 0x80
SENSOR_MODE_CELSIUS	Temperature sensor Celsius reading	hex 0xa0
SENSOR_MODE_FAHRENHEIT	Temperature sensor Fahrenheit reading	hex 0xc0
SENSOR_MODE_ROTATION	Rotation encoder	hex 0xe0
SENSOR_TYPE_TOUCH	Pushbutton switch	1
SENSOR_TYPE_TEMPERATURE	Temperature sensor	2
SENSOR_TYPE_LIGHT	Powered light detector	3
SENSOR_TYPE_ROTATION	Rotation encoder	4
Outputs		
OUT_A	Select motor A	1 << 0
OUT_B	Select motor B	1 << 1
OUT_C	Select motor C	1 << 2
Output Modes		
OUT_FLOAT	Let motors coast	0
OUT_OFF	Stop motors	hex 0x40
OUT_ON	Run motors	hex 0x80
Output Directions		
OUT_REV	Motors in reverse	0
OUT_TOGGLE	Motors change direction	0x40
OUT_FWD	Motors forward	0x80
Output power levels		
OUT_LOW	Motors at low speed	0
OUT_HALF	Motors at medium speed	3
OUT_FULL	Motors at full speed	7
Sounds for PlaySound		
SOUND_CLICK	Short beep	0
SOUND_DOUBLE_BEEP	Two beeps	1
SOUND_DOWN	Tone scale down	2
SOUND_UP	Tone scale up	3
SOUND_LOW_BEEP	"Error" beep	4

refers to the initial task that the RCX automatically runs.

Note the open-brace that follows the *task* main() statement. In NQC, like in C, multiple program statements are defined in *blocks*, or *compound statements*. For each *{* character there will always be a *}* character, indicating the end of the block. You will use blocks in *if*, *while*, and other programming statements.

```
SetPower(MOTOR, 7);
SetDirection (MOTOR, OUT_REV);
```

The *SetPower* statement sets the power to the motors. The 7 means full power; use 1 for low power or other values in between. *SetDirection* sets the direction of the outputs, reverse in this case. This will make the robot move toward the light (assuming the robot is constructed in the way shown in Fig. 2).

```
SetSensorType(LIGHT,
SENSOR_TYPE_LIGHT);
```

A single light sensor, connected to Input 1, is used for the robot. The *SetSensorType* statement sets the input—specified here as LIGHT—to accept a powered light sensor. This sensor is part of the standard equipment that comes with the Mindstorms RIS.

```
while(true) {
if(LIGHT > 60)
```


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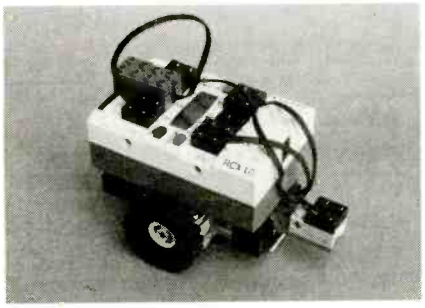

Fig. 3. You can add a touch sensor to the rover to enable it to determine when it has bumped into an object.

```
On(MOTOR);
else
Off(MOTOR);
}
```

The main body of the program is a *while* loop. This loop repeats the body of the program until you depress the RUN button on the RCX a second time or turn off the power to the RCX. The important part of the program is the *if* statement, which in "human terms" means:

"if the output of the light sensor is greater than 60, turn the motors on; otherwise turn the motors off"

Light sensors on the RCX return a value of 0 to 100, with 0 being darkness, and 100 being fairly bright light. The value of 60 was selected as a kind of threshold: if operated in dim room light, pointing a flashlight at the sensor will cause the motors to run. Turning the flashlight off will cause the motors to stop.

Downloading the NQC Program

Now that the program has been written (and saved to disk), it can be downloaded to the RCX by using the NQC.EXE program. This program does two things: It compiles your text programs to a form suitable for the RCX, and it transfers the code to the RCX via the Mindstorms' IR tower.

NQC is a command-line program. To use it, open a new MS-DOS window by choosing Start, Programs, MS-DOS Prompt. (Note: If you don't have the MS-DOS Prompt, choose Start, Run, then type "command.com" and press OK.) If necessary, change to the NQC program directory using the CD (change directory) command, such as:

```
cd \nqc
```

The above assumes NQC.EXE and your

LISTING 3

```
// Constants definitions
#define LIGHT     SENSOR_1
#define SWITCH    SENSOR_2
#define MOTOR     OUT_A+OUT_C

// Main task; run when Run button is pressed on RCX
// starts all tasks
task main()
{
    start play_song;
    start run_from_light;
    start timed_backup;
}

// Task for running away from the light (same as photophobe.ncq,
// except that motors run a little slower)
task run_from_light()
{
    while (true) {
        SetPower(MOTOR, 3);
        SetDirection (MOTOR, OUT_FWD);
        SetSensorType(LIGHT, SENSOR_TYPE_LIGHT);
        if(LIGHT > 60)
            On(MOTOR);
        else
            Off(MOTOR);
    }
}

// Task for backing up and spinning in response to switch touch
task timed_backup()
{
    while (true) {
        SetPower(MOTOR, 3);
        SetSensor(SWITCH, SENSOR_TOUCH);
        if (SWITCH == 1) {
            stop run_from_light;          // disallow run_from_light task
            SetDirection (MOTOR, OUT_REV);
            On(MOTOR);
            Wait (50);
            SetDirection (OUT_A, OUT_FWD);
            Wait (150);
            SetDirection (MOTOR, OUT_FWD);
            Off(MOTOR);
            start run_from_light;         // allow run_from_light task
        }
    }
}

// Task for playing a little tune
task play_song()
{
    while (true) {
        PlayTone(392,25);
        PlayTone(349,25);
        PlayTone(330,25);
        PlayTone(349,25);
        PlayTone(392,25);
        PlayTone(0,2);
        PlayTone(392,25);
        PlayTone(0,2);
        PlayTone(392,25);
        PlayTone(0,2);
        Wait (500);
    }
}
```


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programs are in a directory named NQC. Then compile and download your program with the following:

```
nqc -d program.nqc
```

where "program.nqc" is the actual program name you want to use. If you saved the example program as *photophile.nqc*, for example, type:

```
nqc -d photophile.nqc
```

and press the ENTER key. NQC will compile the program and download it to the RCX. If there are syntax errors in your program, NQC will alert you to them and display the approximate line where the error occurs (usually the actual error is a line or two above). Assuming the program compiles correctly, NQC displays "Downloading program: ..." and then finally "complete" when downloading is complete. Run the downloaded program by pressing the RUN button on the RCX.

Altering the Behavior of the Robot

It's easy to make changes to alter the behavior of your NQC-controlled robot creations. One small change you can make is to have the motors turn the other way when the light shines on the sensor. This has the effect of creating a "photophobic" robot—a robot that appears to run away from the light.

A complete code example that will accomplish this task is shown in Listing 2. If you retype this program, name it "photophobe.nqc" for obvious reasons.

Creating a Multitask Control Program

One of the most important powers of the RCX is that it is a multitasking device. You can run up to ten tasks "simultaneously" in one program. The microcontroller in the RCX divvies up a little bit of its processing time to each task, so that, in human terms, things appear to happen simultaneously. Of course in microcontroller terms, it's handling one instruction at a time, but at very fast speeds.

The following program is a rudimentary, but fully functional, example of an RCX program with multiple concurrent tasks. The program is based on the "photophobe.ncq" program in Listing 2. Added are separate tasks to play a little song (the first notes of "Mary Had a Little Lamb," or something close to it!) and another set to reverse the motors and spin if a touch sensor is activated. The touch sensor is attached to Input 4, as shown in Fig. 3, and mounted on the opposite end of the robot as the light sensor.

When the program is run, the robot exhibits three *events*:

Event 1. A song is played every few seconds. This event is free-running, and no other event in the program affects it.

Event 2. When a strong enough light strikes the light sensor, the robot backs away from it (of course, this depends on how the motors and light sensor are mounted on the RCX). The motors will continue to run as long as enough light strikes the sensor.

Event 3. When the touch sensor—mounted on the opposite side of the RCX as the light sensor—is activated, Event 2 is suspended. The robot reverses direction for a brief moment, then spins on its axis. Finally it stops moving, more than likely no longer facing the same direction as it was. At this time, Event 2 is reactivated so that the robot will once again "run away" from any light that shines into the light sensor.

See Listing 3 (let's call it "multitask.ncq"). It contains short comments, marked using the double slash // characters. The comments serve to describe the main functionality of the program.

Going Further

Of course, there's far more to Not Quite C than we're has been discussed here. The NQC download includes fairly robust documentation in Adobe *Acrobat* format (you'll need a copy of Adobe *Acrobat* on your computer in order to read the documentation; *Acrobat* is available free from *www.adobe.com*). The author of NQC, Dave Baum, provides additional information on using the language to program the RCX in *Dave Baum's Definitive Guide to LEGO Mindstorms*, published by Apress (ISBN: 1893115097).

As you explore NQC, you will discover that it supports a wide variety of programming statements, loops, variable assignments, conditional expressions, and more. With NQC, you can develop highly sophisticated programs for the RCX robot, with a surprising small amount of code.

Next month, we'll begin our in-depth look at the powerful BasicX-1 and BasicX-24 microcontrollers from Net-Media. Be sure to tune in! P

AMAZING SCIENCE

(continued from page 51)

keep your ROV from becoming a permanent part of the lake, bay, or ocean bottom should something go wrong. You don't need to go "high-tech," either. A suitable piece of large PVC pipe with a cap on one end and a makeshift acrylic window on the other to hold the CCD camera can get you started. Hoist the watertight camera over the side of a boat. You might need to add some low-voltage lights to get pictures.

A surplus weather balloon filled with helium (again, a tethered system) can loft the CCD camera for some aerial views. For the adventurous, you could experiment with untethered helium balloons that release their helium after a predetermined time (5 minutes, for instance) and float back down to Earth.

If you would like to see future articles that deal with ROVs (land, sea, or air) and telepresence systems, please write to me in care of the magazine. P

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TECH MUSINGS

DON LANCASTER

Pulse Electrolysis Myths, Extracting Acrobat .PDF URLs, Versatile Capacitor Switching, Contactless Charger Update, and More

Heads up. The contactless charger components that we reviewed in the December 1999 issue of ***Electronics Now*** were misidentified and are really TDK products. Additional details are at their Web site: *www.component.tdk.com*. Another manufacturer is Panasonic, with their model PHS contactless charger. Their Web site is *www.panasonic.com*. The MUSE142.PDF online e-zine reprint is now corrected. Sorry about that.

Pulse Electrolysis?

There are claims kicking around the Web that high-voltage pulses fed to water easily generate "miracle" amounts of hydrogen very cheaply. After a careful review, I personally conclude these claims are based on nothing but wishful nonthinking and appallingly incompetent labwork. In fact, the known physics turns out to be the exact opposite of the claims.

Apparently the Ross County, OH judge, who has found "gross and egregious fraud" and "a loose grip on reality" involved in this claim, seems to agree.

First off, "Faraday's Law" is a pretty basic electrochemical principle that has gotten verified untold times. This law clearly states that what you get out of a cell terminal depends absolutely upon the current through the cell.

Electrons *in* equal electrons *out*.

Second, electrolysis is a very poor way to generate hydrogen. Almost all commercial hydrogen gets produced more efficiently and more cheaply by the reformation of methane. Generating hydrogen is simply not a problem; finding a dense and safe way to store it is. STP (*S*tandard *T*emperature and *P*ressure) hydrogen has an energy density of 3.5 watt hours per liter. Well, gasoline is three thousand times better at 9600. Dense storage is what the carbon nanotube excitement is about. (We looked at this back in RESBN88.PDF, MUSE115.PDF, MUSE120.PDF, and MUSE141.PDF.)

Thanks to the *Fourier Series* of mathematical gymnastics, any old group of pulses is *exactly* equivalent to a DC term and some number of AC harmonics. We saw proof of this in MUSE90.PDF. Except for carefully chosen exotic waveforms, all higher order harmonics are normally very weak. Lots more on Fourier is in *www.tinaja.com/magsn01.html*.

Water has a dielectric constant of 81, so we could expect it to be hugely capacitive. It should low-pass filter all higher harmonics dramatically and weaken them further. Thus, a series of water cell pulses can get analyzed as a DC level plus a few very weak sinewave low harmonics.

To even suggest that the pitifully weak audio harmonics can remotely approach the microwave frequencies associated with molecular hydrogen resonance is absurd. Even if they did, there's flat out not the tiniest shred of credible evidence that anything unusual or unexpected would happen. This is especially true since the energy in a weak amplitude harmonic is that harmonic weakness squared.

Let's take a look at how electrolysis works. Figure 1 shows us some of the properties of an electrolysis cell.

Electrolysis takes place from the current that results when a DC voltage is applied to conductive water. Under the threshold voltage near 1.28 volts, nothing happens. In the *endothermic* region between 1.28 volts and 1.45 volts or so, heat has to be added to the water for electrolysis to occur. As much as one sixth of all your stored hydrogen energy can originate from ambient heat.

In this endothermic region, claims of "stays cool" operation would be normal and expected—because energy has to be absorbed to produce the gas.

At a thermoneutral voltage of 1.45 volts or so, all of the stored hydrogen energy comes from your electricity.

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Additional input energy is required, though, to cover overvoltage effects and system losses. If you go above the thermoneutral voltage, even more electricity gets wasted as additional heat in an exothermic reaction.

Naturally, there is no way to make a profit from the endothermic region. Although an electrolysis cell might be up to one-sixth endothermic, the finest fuel cell you could possibly build will, of course, have to be one-sixth exothermic or worse.

An optimum hydrogen generation cell would apply its nearly constant voltage in that endothermic region. All that superimposed sinewaves can do is move the system temporarily away from this optimum, reducing the overall efficiency.

Proof? Exotic *E*lectrochemical *I*mpedance *S*pectrometry (EIS) instruments routinely measure the pulse response of water and other electrolytes. We saw back in MUSE137.PDF how EIS sees use in everything from cancer research to corrosion protection.

The untold thousands of EIS tests made day in and day out tell us repeatedly that super-efficient pulse electrolysis flat out ain't gonna happen. In fact, they tell us the exact opposite.

There's also this new "hands off" water faucet design using the *Qprox* technology, which can be found at *www.qprox.com*. All of their published research clearly shows that very little high-frequency energy ever gets even remotely near the contacts of a water droplet. Higher frequency energy is instead internally converted to heat.

The Qprox faucet from Quantum Research, in fact, requires exactly the opposite operation than the claim for the pulses: High-frequency losses are actually carefully maximized.

As Fig. 1 shows, electrolysis current is extremely nonlinear. It is trivially easy to cause pulse power measurement errors. Use of plain old average-responding meters typically gives results that can be low by 300% to 500%. For meaningful results, you have to use the true rms methods we looked at in both MUSE112.PDF and MUSE113.PDF. Even then, there are lots of hidden "gotchas" to "gitya."

Figure 2 shows how the bulk properties of a water droplet act as a low-pass filter. Such a filter will prevent most pulse-energy components from ever getting even remotely near the electrolysis terminals.

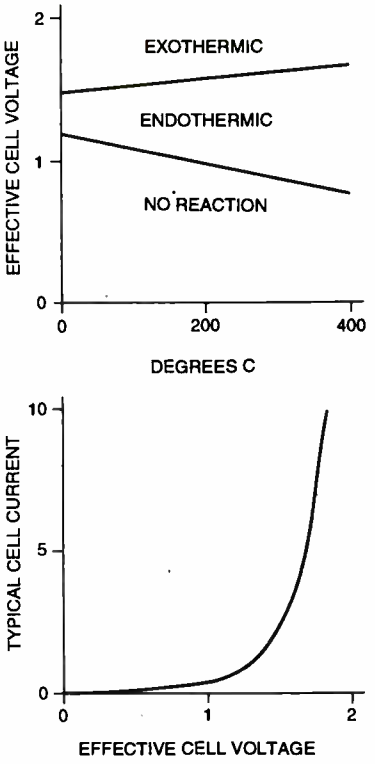

Fig. 1. According to Faraday's electrolysis law, the gram-equivalent weight of a substance deposited, liberated, dissolved, or reacted at an electrode is equal to the number of Faradays of electricity transferred through the electrolyte. One Faraday equals a charge of 96,519 Coulombs; one Coulomb equals the transfer of 6.281 x 10^{18} electrons. Maximum efficiency occurs with a chosen and stable DC voltage in the endothermic region. Extreme nonlinearity requires true rms techniques if accurate measurements of input energy are to be made.

These outrageous and "not even wrong" hydrogen-pulse-electrolysis claims are easiest to explain as bad lab work. Perhaps, a cell impedance mismatch plus a lack of understanding got combined with hugely misleading measurement errors and possibly a failure to remove excess water vapor from the output streams.

If you feel otherwise, please show me

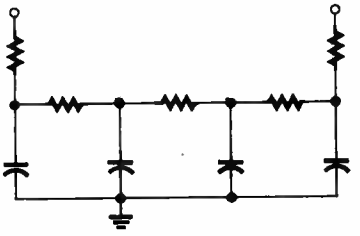

Fig. 2. A water droplet can act as a low-pass filter that largely prevents the high-frequency pulse components from ever reaching the electrolysis terminals.

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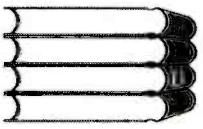

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/sourcepdffilename (C:\\Medocs\\Muse\\Muse 145\\muse145a.pdf) def
/targethtmlfilename (C:\\Medocs\\Muse\\Muse 145\\grabURLs.html) def
/wanthtmloutput true def % set flag here if html output wanted
/workstring 65000 string def % temporary workstring
% checkline tests to see if a /URI followed by a space and string is present...
/checkline {(/URI () search {pop pop truncateextra addURLtohtmlfile print (\n) print
flush}{pop} ifelse } def
% truncateextra crops everything beyond the closing URL parenthesis...
/truncateextra { () search {exch pop exch pop } (There was a sting closing error.\n) print
flush stringclosingerror } ifelse} def
% /starthtmlfile conditionally creates a html file object and writes a html header to it...
/ws {writefile exch writestring} def % file writing utility
/starthtmlfile {wanthtmloutput {targethtmlfilename (w+) file /writefile exch def
(<HTML>\n)
ws (<HEAD>\n) ws ( <TITLE>Acrobat PDF URL Extractor</TITLE>\n) ws
(</HEAD>\n\n) ws
(<BODY TEXT="#000000" BGCOLOR="#FFCC99" \n) ws (LINK="#0000FF"
VLINK="#008000" ) ws (ALINK="#FF0000"> ) ws (<P><B><FONT SIZE=5>\n) ws
(\n\nLinked URL list extracted from ) ws sourcepdffilename ws
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ws (</FONT><FONT SIZE=3>\n) ws } if} def
% /addtohtmlfile conditionally adds the current URL line to the htmlfile...
/addURLtohtmlfile {wanthtmloutput {(<A HREF=") ws ws (">) ws ws (</A><BR>\n) ws} if
} def
% /endhtmlfile conditionally finishes up and closes the htmlfile...
/endhtmlfile {wanthtmloutput {(</UL>\n</UL>\n\n) ws (</BODY>\n</HTML>\n\n) ws
writefile
closefile} if} def
% ain loop.reads one line of the source pdf file at a time...
/grabURLs {sourcepdffilename (r) file /workfile % make a file to read
exch def starthtmlfile % start html file if wanted
{mark workfile workstring readline % read one line at a time
{checkline}{exit} ifelse % test lines till done
cleartomark} loop
(\n\nDone extracting URLs from ) print % optional trailer
sourcepdffilename print (\n) print
(\n) print flush
endhtmlfile % complete html file if wanted
pop} def
grabURLs % This actually does it
```

credible and reproducible evidence. Sorry, but third-hand anecdotal "urban lore" hearsay from a few clearly misled gullible folks won't hack it.

You'll find more hydrogen info at *www.tinaja.com/h2gas01.html*.

It sure would be handy to have an "at the terminals" SPICE model of an electrolysis cell. I've been unable to locate one so far, so this just might make an interesting research project. Such a model clearly would eliminate pulse electrolysis hogwash before it got out of hand.

Electrochemistry Books

All the electrolysis fundamentals are quite well known and have been kicking around for several centuries. If you think you've found something new, the odds are overwhelming that you are making the very same stupid beginning mistakes that everyone else always does. There are untold layers of subtle "gotchas" here.

So, if you are at all serious about exploring electrolysis, it makes the most sense to start off with what has long been in print. With this in mind, I have gathered together a few of the better electrochemistry journals, a few newsgroups, and texts for you as this month's resource sidebar. A few of these are volumes in a series of ongoing books. I have included only one sample of the series titles. You can find more details or order these titles by going to *www.tinaja.com/h2gas01.html* and *www.tinaja.com/amlink01.html*.

Sneaky Tricks With Capacitors

Several unique new circuits involve repeatedly connecting two or more capacitors to each other. Quantum at *www.qprox.com* has a white paper and numerous technical journal reprints on this topic, mostly focused on faucet-proximity detectors and on obscure material like watching fruit ripen.

But by far the best paper of all is the little known, seldom viewed, and underappreciated *Application Note #3* from Linear Technology, also titled *Applications for a Switched Capacitor Instrumentation Building Block*. Be sure to get their LTC1043 data sheet at the same time.

Figure 3 shows where all these magic tricks start. All of them are based on switching a capacitor from an input source and then discharging it into a second capacitor at a rate that you chose. While CMOS analog switches such as

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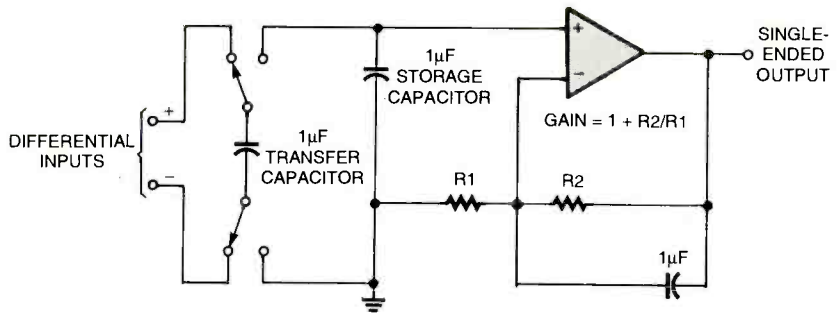

Fig. 3. This amazingly versatile capacitor-switching scheme offers unusual circuit possibilities.

the 4016 or 4066 can be used, special switches with lower and more balanced gate-charge coupling are the better choices. One good example is the just-mentioned LTC1043.

Let's take a quick tour of some of the amazing things you can do with a seemingly simple circuit.

By repeatedly connecting the first capacitor to a pair of inputs and then to the second capacitor, you can do a powerful differential- to single-ended conversion. Common mode rejection can easily go beyond a stunning 120 decibels for precise instrumentation op-amps. This is superb for hum reduction or to eliminate any ground loops, as well. You also gain input isolation and possibly get rid of a transformer—but only within the limits of the specification of the switches used.

If you put a small shunt resistance in the positive or ground lead, this same circuit can measure your supply current, automatically translating the voltage to something an op-amp can deal with more elegantly. Thus, this switched capacitor trick can easily measure millivolts near either supply rail.

By inverting the output switching so that the upper switch goes to ground, you invert the sample on your second capacitor. This generates a negative supply voltage or inverts the input signal. Use of multiple switches and capacitors can get you accurate positive or negative input multiples.

If the sampling capacitor is small and your transfer capacitor large, you could pile up a history of samples or integrate your results over time.

The speed at which you flip the switches determines how much energy gets transferred how fast. This switching acts like an electrically variable resistor, one that can be digitally programmed. Careful choice of sampling speeds gives you voltage-to-frequency and frequency-to-voltage capabilities. Taken together, these sampling speeds can also give you precision digital multipliers.

By sampling your input at a known frequency, you can do a synchronous demodulation, detecting a very weak signal out of very strong noise. These schemes also once went by the name of lock-in amplifiers, for very narrow bandwidth tracking filters. Other synchronous demodulation applications include the LVDT position sensors we saw in HACKAR2.PDF.

As we've seen, Qprox uses narrow-pulse-transfer capacitor switching to sense very small capacitance changes quite reliably, changes such as a hand near a faucet or the ripening of fruit that we mentioned before.

Many more examples of capacitor-to-capacitor switching techniques are found in the applications note and in various devices from Linear Technology, Texas Instruments, Maxim, Dallas, National, and others. More material on the fundamentals of analog switches is found in my *CMOS Cookbook*.

What can you come up with here?

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You can then view your created GRABURLS.HTML output to find obvious spelling or misdirection errors. Otherwise, you can view the file in a browser and check the links immediately.

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But best of all, there's a free new service on the Web called *Doctor HTML*. This checks most any HTML document for everything from bad links to spelling errors to poor program structure. However, they currently test only HTML files. You can easily reach them at *www2.imageware.com/RxHTML* or just click on the HTML button on my *Guru's Lair* homepage.

PostScript is exceptionally adept at reading or writing nearly any file in any format. This utility reads a disk-stashed .PDF file one line at a time. Each line then can get searched for the magic /URI which has to precede a valid URL. The URL then gets written to a log and to an output HTML file.

As usual, you first bring this utility up in any word processor or editor, modify it to match your .PDF filenames and locations, and then send it to *Adobe* Acrobat Distiller or GhostScript to auto generate the new GRABURLS.HTML file. Finally, you view the HTML link list, browse it, or feed it to *Doctor HTML*.

One "gotcha": Be sure to use double reverse slashes in all your filename strings every time you want a single reverse slash! As written, this code recopies any duplicate URLs. Fixing dups is easily done. Details are in *http://www.tinaja.com/info01.html*.

A few very rare URLs that do strange things with parentheses may generate errors. A non-Adobe .PDF generator could conceivably be incompatible. The unusually long string length used should freely pass most of the image formats stashed elsewhere in your .PDF file without overflow errors.

This ready-to-run GRABURLS.PS utility and more on PostScript as a language are on my *www.tinaja.com/post01.html* or in *www.tin aja.com/acrob01.html*.

New Tech Lit

Texas Instruments has started an *Analog Applications Journal*. Recent topics covered were precision voltage references, synchronous inverting, and crosstalk reduction.

A very useful fuel-cell link farm is up at *216.51.18.233/index_e.html*. One source of fuel-cell experimenter kits is Avista Labs, whose Web site is at *www.infotch.com/avista.htm*. The kit prices start under $400, but it's more like $900 when you add up all the necessary bits and pieces. More fuel cell resources can be picked up from *www.Webconx.com/fuelcell.hhtm* and from my *www.tinaja.com/h 2gas01.html*.

The bottom line is that we simply are not there yet with fuel cells. Big problems are costs, efficiency, and lifetime. However, a lot of big bucks are being thrown at these issues.

The latest self-published book by analog wizard Bob Pease is his nontechnical *How to Drive Into Accidents. And How Not To*. More at *http://www.tinaja.com/amlink01.html*.

More on CD ROM recovery that we looked at back in the January 2000 issue of **Poptronics**: A free trial of a CD-R Diagnostic utility is up at *www.cdrom-prod.com*. This code apparently allows recovery of many CDs with trashed directories or that insipid BURN bug.

A good possible source for odd networking cables and phone adapters is L-com. You can visit their Web site at *www.L-com.com*.

Our two featured trade journals for this month are *R.F. Design* and *Information Display*.

An interesting and unusual approach to managing motor harmonics can now be found at *www.borealis.com* in their *Chorus Technology*. Often, though, I have found the best solutions will mix fancy computing and plain old hardware. My own alternate solutions are found at *www.tinaja.com/magsn01.html*.

Most of the time, for many individuals and smaller tech startups, any involvement with patents is virtually certain to end up a net waste of time, energy, money, and sanity. Find out why and explore alternatives in my *Case Against Patents* package, or check my Synergetics ad, or search through *www.tinaja.com/patent01.html*.

The latest additions to our bargains at *www.tinaja.com/barg01.html* include thermoelectric power generators and highly collectible circular slide rules. Custom research solutions appear at *www.tinaja.com/info01.html*, while my

(Continued on page 69)

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CHARLES D. RAKES

"More Power, Igor!"

Working With High Voltage

This month's subject is one that is near and dear to any budding "mad scientist": experimenting with high-voltage circuits. Before we begin, there is something that I must say even if the publisher didn't insist on it.

Some of these circuits can be hazardous to health and life!

Do not attempt to implement or use the information presented here unless you are experienced and skilled with these types of circuits and materials. Working carelessly around high voltage is about as smart as crop-dusting blindfolded or chewing on a plugged-in lamp cord. I would very much like to see all of you here safe and sound next month.

Jacob's Ladder

That being said, let's start with one of the basics: a Jacob's Ladder. It is one of the simplest high-voltage projects to build that can grab the attention of most everyone with its fantastic climbing electric arc. The Jacob's Ladder is basically a single-component circuit that requires a current-limiting high-voltage source to power the climbing arc.

There are two readily available high-voltage transformers suitable for this application: a neon-sign transformer or a gas-furnace igniter transformer. Select a transformer that supplies at least 5000 volts at the lowest possible output current. The arc's best performance is achieved with the highest possible output voltage. A 15,000-volt, 30-milliampere neon transformer is an excellent choice. When there are voltages above 12,000 volts being used, the ladder's top spacing can be 2 inches or greater. Such spacing can produce a spectacular arc that will rise to the top of the ladder and jump off with a loud pop.

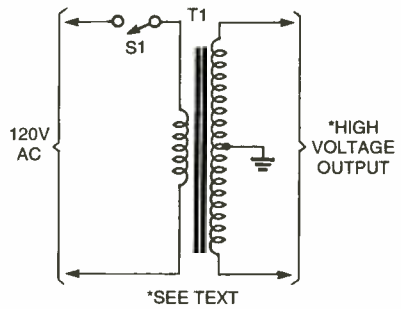

Fig. 1. Neon-sign transformers are good sources of high voltage for experimentation. Several safety features are usually built into these devices. For example, the center tap is usually connected to the circuit's case—a good ground for eliminating potential shock hazards.

PARTS LIST FOR THE HIGH-VOLTAGE SOURCE (FIG. 1)

S1—Single-pole, single-throw toggle switch

T1—6000- to 15,000-volt neon-sign transformer

Before we move on to the construction stage, let's take a look at one of these unique transformers and see what makes it tick. The electrical circuitry of a typical neon transformer is shown in Fig. 1. The majority of these transformers are wound with the secondary winding tapped at its midpoint and connected to the transformer's metal case. That arrangement reduces the insulation material needed between the secondary winding and the transformer's iron core. With the center tap grounded, the voltage at each output terminal to ground is only one-half of the total output voltage. That also reduces the "corona effect" at each output terminal. Above a certain threshold (a combination of voltage and distance), the air itself breaks down and becomes a conductor. The ionization of the atmosphere gases causes the bluish-

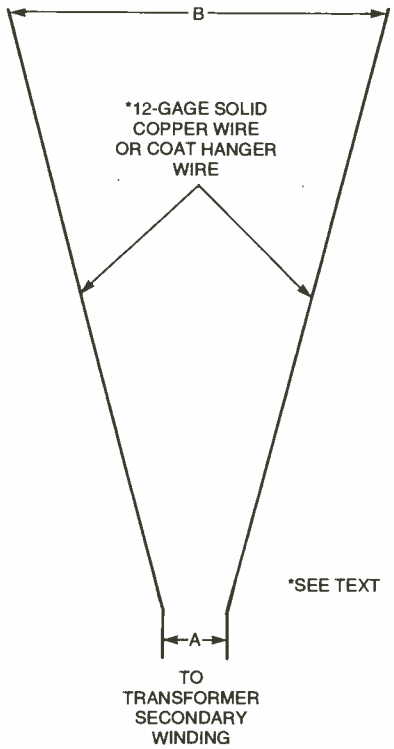

Fig. 2. A Jacob's Ladder is simply a pair of solid wires that form a "V" shape. When a spark jumps the narrow gap at the bottom of the device, it ionizes the air, creating a low-resistance path. The heat generated by the spark causes the air around it to rise, carrying it up the ladder. At the top, the spark breaks off. At that point, the path of least resistance for the current returns to the narrow gap at the bottom, and the show repeats.

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PARTS LIST FOR THE JACOB'S LADDER (FIG. 2)

Two lengths of 12-gauge solid copper wire or cloth hanger wire (see text)

pink glow that is called the corona effect. When there is a corona discharge, energy is being consumed; the discharge is a form of short circuit. That is why in any well-designed high-voltage circuit, attention to preventing corona discharge is important.

The other unique feature of this type of transformer is its ability to withstand a direct short between output terminals without causing damage to the transformer or producing an excessive increase in the primary current. The transformer's core is constructed in a manner that limits the secondary output current to a specific maximum value no matter what the actual output load happens to be. Another well-known electrical device that takes advantage of that unique transformer characteristic is the electric arc welder.

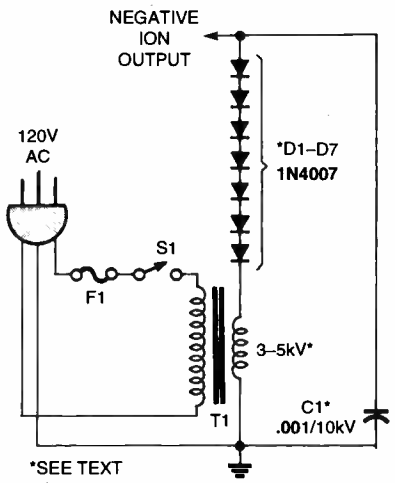

Fig. 3. Rectifying the high-voltage output of a tapless high-voltage transformer makes a simple negative-ion generator. It's a good idea to use four times as many diodes as their breakdown voltage indicates as a safety factor against one diode failing.

PARTS LIST FOR THE TAPLESS NEGATIVE-ION GENERATOR (FIG. 3)

C1—0.001-µF, 10,000-WVDC capacitor (see text)
D1–D7—1N4007 1000-volt, 1-amp silicon diode
F1—Fuse (size based on T1's current rating)
S1—Single-pole, single-throw toggle switch
T1—High-voltage transformer (see text)
Grounded power cord, output needle, wire, hardware, etc.

Let's get back to building the Jacob's Ladder. The ladder may be constructed from 12-gauge solid copper wire or from a solid-wire coat hanger; the basic shaping is shown in Fig. 2. Actually, just about any size or type of wire can be used as long as it will hold its form and stay in an upright position. The actual length of the two wires can be anything from a few inches to over two feet. The wire should be clean with all insulation removed and no sharp or rough edges along their length. The "V" shape formed by the wires should be such that the "A" dimension is just close enough to start the arc and the "B" dimension set at its maximum width where the arc just makes it to the top. Both settings will require some experimenting. **NEVER** make an adjustment to the ladder with the power on! Unplug the unit first and then move the wires.

To hold the wires in place, simply mount them in any suitable block of insulating material; most plastics, hard rubber, or PC-board material will do. Don't use anything porous such as wood—it will absorb moisture from the air and become a conductor at the voltages that we're working with. If you do, the bottom line is that you'll be expending all of that energy with no pretty show for it! Whatever mounting method you use, make sure that it is stable and won't fall over. If you accidentally yank on the supply wires and the Jacob's Ladder falls over on you while it is powered, you'll quickly find out what it feels like to be on the business end of a cattle prod!

Wonder why the arc rises to the top of Jacob's Ladder? As soon as the first spark jumps across the bottom of the ladder, the air begins to ionize, lowering the resistance path between the two wires. That lets the transformer's maximum output current flow through the arc and heat the air above it to a very high temperature. That rapid rise in air temperature causes the arc to climb until it reaches the top of the ladder. Since it can go no higher, the rising heat pulls the arc up, stretching it until it breaks the ionized path. Once the path is broken, the arc stops at the top and a spark starts once again at the bottom of the ladder to repeat the event.

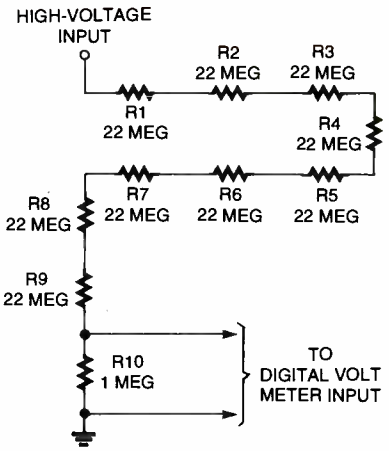

Fig. 4. When measuring high voltages with a standard voltmeter, a divider such as this will reduce the voltage by 200:1.

PARTS LIST FOR THE HIGH-VOLTAGE PROBE (FIG. 4)

R1–R9—22-megohm, 1/2-watt, 5% resistor
R10—1-megohm, 1/4-watt, 5% resistor

Time To Clear the Air

A positive effect from a negative output? That just might be true when using a negative-ion generator to clean the air, and it could also improve your mood as a byproduct. At least that is what many studies show and manufacturers of negative-ion generators claim. My own observations are that I feel more positive when I'm around a source of negative ions. If you would like to experience the effects of negative-ion-treated air, build one of the following circuits and see for yourself if the experience is beneficial.

Our first negative-ion generator circuit is shown in Fig. 3. Transformer T1 can be just about any low-current, high-voltage transformer with an output of 3000 to 5000 volts without a grounded center tap. If a tapless transformer can not be found, our next circuit will be of more use to you; we'll get to it in a moment. The diodes shown are rated for 1000 volts each. Since we have seven of them in series, you would think that that would be adequate for a 3000- to 5000-volt circuit. However, it's a good idea to use four diodes in series for each 1000 volts of transformer output. The 1N4000-series diodes are cheap; using four per 1 kV provides good insurance

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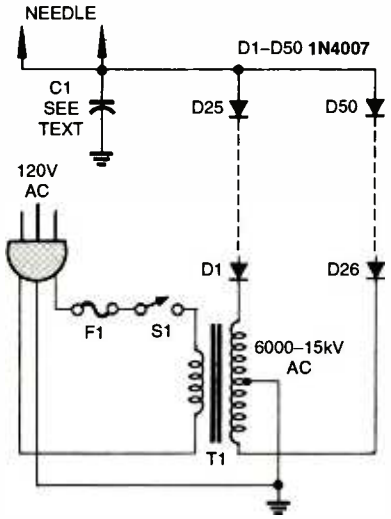

Fig. 5. If you'd like to build a negative-ion generator but can't find a tapless transformer, this circuit will fill your needs. Note that two strings of diodes are used instead of the single string shown in Fig. 3.

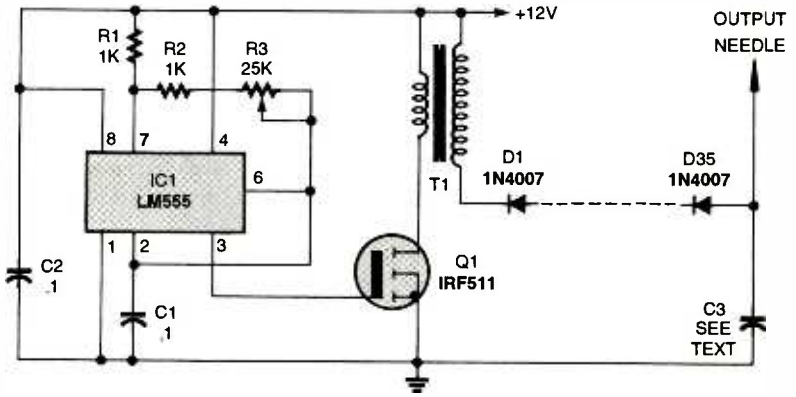

Fig. 6. A solid-state circuit is the most versatile method of building a negative-ion generator. By adjusting the frequency of IC1 with R3, you can tune the circuit to the resonance of T1 for greatest efficiency. Any 12-volt automobile ignition coil will do for T1.

PARTS LIST FOR THE CENTER-TAP NEGATIVE-ION GENERATOR (FIG. 5)

C1—0.001-µF, 15,000-WVDC capacitor (see text)
D1–D50—1N4007 1000-volt, 1-amp silicon diode
F1—Fuse (size based on T1's current rating)
S1—Single-pole, single-throw toggle switch
T1—6000- to 15,000-volt center-tap neon-sign transformer
Grounded power cord, output needle, wire, hardware, etc.

against a single diode going bad, causing the other diodes in the rectifier string to fail because too few diodes were used.

A sewing needle connected to the generator's negative output makes a good ion-launching terminal, or even a sharpened piece of solid wire will do. The needle should be pointed in a vertical position and located away from any other component. If any of the circuit's components give off a light blue glow (corona effect), try adding another ion launching terminal. If that doesn't fix the corona discharge problem, try a high-voltage spray such as "Fine-L-Kote AR." Those sprays provide an insulation coating to reduce or eliminate any high-voltage leakage. That particular product is stocked by Mouser Electronics (958 North Main St., Mansfield, TX 76063; 800-346-6873 or 817-483-6888; Web: *www.mouser.com*; e-mail: *sales@mouser.com*), but other similar high-voltage sprays are available from local as well as mail order suppliers. The only location where ion leakage is tolerated is at the output. Just make sure that the terminal(s) can not be touched!

A good method for testing the ion generator to see how well it is working is to place it in a 2- to 5-gallon glass tank (an empty fish aquarium is an ideal testing area) and to fill the tank with smoke. Cover the top with a piece of cardboard making the container as air tight as possible and turn on the generator. If the ion generator is doing a good job, the smoke should be greatly reduced in only a few minutes. In fact, you should see an ion column flowing up from the needlepoint stirring the smoke.

If your generator seems to be producing a large amount of ions, then a small fan might quicken the air cleaning process by moving more air over the output terminal.

The actual value of output capacitor C1 is not too critical, but the voltage rating is. Just about any value from 500 pF to 0.01 µF will work, but the capacitor's voltage rating must be greater than the circuit's output voltage. [*Making sure that the capacitor's working voltage is high enough can't be stressed enough. I once used a ceramic-disc capacitor in a 40-volt power supply. I assumed that it had a 50-volt rating; it was a 25-volt device. Within 45 seconds of power application, the capacitor burst into flames, setting the fiberglass-epoxy PC board on fire as well! It was a very thrilling lesson in the use of components that don't have ratings clearly marked on them! — Editor.*] That type of high-voltage capacitor is available from component suppliers for television and computer monitor repair parts.

PARTS LIST FOR THE SOLID-STATE NEGATIVE-ION GENERATOR (FIG. 6)

SEMICONDUCTORS
IC1—LM555 timer, integrated circuit
Q1—IRF511 power HEXFET transistor
D1–D35—1N4007 1000-volt, 1-amp silicon diode

RESISTORS
R1, R2—2000-ohm, 1/4-watt, 5% tolerance
R3—25,000-ohm potentiometer

CAPACITORS
C1, C2—0.1-µF, ceramic-disc
C3—0.001-µF, 15,000-WVDC (see text)

ADDITIONAL PARTS AND MATERIALS
T1—12-volt automotive ignition coil
12-volt DC power source, output needles, wire, hardware, etc.

If a suitable high-voltage capacitor can not be found, a simple low-cost version can be built using a drinking glass and aluminum foil. Wrap and glue a piece of aluminum foil around the inside of a regular-sized drinking glass; glass or plastic is the only acceptable material. Leave about 1/2-inch of space around the top of the glass. Wrap and glue another piece of aluminum foil around the outside of the glass with similar spacing. The two pieces of foil are the capacitor's plates with the glass acting as the dielectric. Connect the outside foil to the generator's ground circuit and the inner foil to the output terminal. Electrically, the connection order doesn't matter, but it's

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best from a safety standpoint to keep anything that can be accidentally touched at ground potential. Don't touch the capacitor even after the power is turned off because it will retain a high-voltage charge; discharge it first before working on the circuit.

Incidentally, those that are familiar with electrostatic devices will recognize our "capacitor" as a Leyden jar without its central charging electrode. Leyden jars are typically used to store electrostatic charges from devices such as Wimshurst electrostatic generators—just a few more examples of "must-have" toys for the budding mad scientist!

Measuring High Voltages

So far, we've been working with voltages that are higher than what we can measure with a standard digital voltmeter. A voltage-range extender circuit is shown in Fig. 4. Nine 22-megohm resistors are connected in series with a single 1-megohm resistor to form a 200:1 voltage-divider circuit. Almost any digital voltmeter can be used with this simple divider to get an idea what level of output voltage we're dealing with. Of course, there will be some loading effect on the circuit being monitored, but at least a general idea of the output voltage can be obtained using the divider.

If the digital meter used for testing is set to its 100-volt range, just multiply the meter reading by 200. A 50-volt reading means that you are looking at 10,000 volts—so be very careful. A safe and sane method to follow in taking a high-voltage measurement is to ***unplug*** the unit first and then connect the meter leads. Stand back, plug the unit back in, and read the meter. You just can not be too careful when working around high voltage circuits. It's also a good idea to borrow a trick from famed scientist and inventor Nikola Tesla. Whenever he was taking measurements around some of his high-voltage experiments, he always kept one hand in his pocket. That way, any accidental contact with a live or still-charged circuit would just result in a nasty shock. If the discharge were able to pass from one hand to the other, the current would pass directly through the heart—only about 60 mA or so of current is needed to stop the human heart! The bottom line is safety last...as well as first!

Center-Tap Ion Generator

Our next negative-ion generator circuit (Fig. 5) uses a typical center-tapped neon transformer as the power source. Since the center of the secondary is tied to case ground, a full-wave rectifier circuit is the way to go with this transformer arrangement. A 15,000-volt transformer will output 7500 volts on each side of the center tap with the peak voltage going slightly above 10,000 volts. While we show 25 diodes in series for each leg, the safety margin that we discussed before will de-rate the circuit to a bit over 6000 volts. If you want, you can increase the diode count to 40 units in each string for a total of 80 diodes.

Output capacitor C1 is similar in use and selection to the previous ion-generator circuit; you can use the homemade glass version detailed above or any value from 500 pF to 0.01 µF that can withstand the applied voltage. The generator circuit produces a large output so use several needles for ion launching. If a variable 120-volt transformer is available, use it to feed the neon transformer. Doing so will give excellent control over the generator's ion output.

A Solid-State Ion Generator

Our last circuit for this visit is a solid-state negative-ion generator. This circuit, shown in Fig. 6, is probably the safest of the lot to build and use. A 555 timer IC generates a low-frequency pulse that drives the gate of Q1, a power HEXFET. The IRF511 in turn sends a high-current pulse into the primary of automobile ignition coil T1. The secondary winding produces an output of several thousand volts that is rectified by diode string D1–D35 to charge C3. The ions are propelled into space from one or more sharp needles. As before, C3 may be homemade or purchased.

Potentiometer R3 adjusts the frequency of IC1; set it for the highest output voltage with the least input current. Experiment with R3 for the best output and circuit efficiency. P

TECH MUSINGS

(continued from page 65)

special partnering opportunities are at *www.tinaja.com/advt01.html* and at *www.tinaja.com/magsn01.html*.

As usual, most of the mentioned items should appear in our Names and Numbers or Electrochemical Resource sidebars. These are directly hotlinked at MUSE146.PDF. Be sure to check there first before calling our no-fee US tech helpline. Let's hear from you. P

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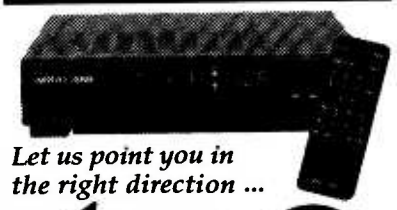

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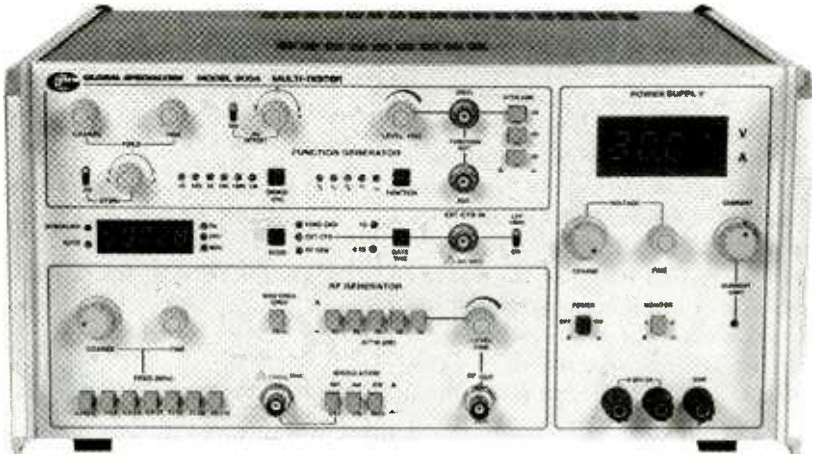

CIRCLE 60 ON FREE INFORMATION CARD

THE *MODEL 9004 FOUR-IN-ONE-Multi-Tester* combines four products into one: an RF Generator, a frequency counter, a function generator, and a digital power supply. Combining the most needed pieces of test equipment into one device is very useful for multitasking. For example, the multi-tester provides both a frequency source and a 60-watt power supply to power test circuits. Repair professionals and engineers will find that it covers a broad spectrum of test needs, while schools will see it run plenty of experiments in analog, digital, and RF circuits.

The RF generator covers a frequency range from 100 kHz up to 110 MHz—the commercial-FM band. Fixed internal AM and FM modulation plus external modulation are supported. The function generator features unipolar-type squarewave and pulse outputs to directly interface with digital circuits—in addition to the standard sine, triangle, and squarewave. The 50- and 600-ohm outputs match standard audio impedances.

Applications for this state-of-the-art unit include analog, digital and RF experiments; service and repair operations; and research and development. It is also meant for use in industrial sites loaded with test equipment, but short on bench space.

The 9004B's practical for service personnel or the test bench, and simple enough for a school lab. The touch of a button can select the 5-digit counter to accurately measure the function generator frequency, the RF generator frequency, or an external input signal. All functions are kept completely independent, providing functionality without a clutter of switches and knobs.

The Model 9004 Multi-Tester has a suggested retail price of $995.

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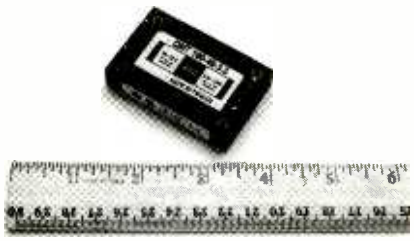

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For the business traveler, there's an updated trip organizer that helps users access address-to-address directions via the Internet, make hotel and airline reser-

(Continued on page PR-10)

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ProService Review

April, 2000

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VOL. XXVI, NO. 4

PURPOSE

ProService Review, included in each issue of *Poptronics*, is produced by NESDA, the National Electronics Service Dealers Association, 2708 West Berry St., Fort Worth, TX 76109. It is intended for the enlightenment, education and entertainment of the members of NESDA, ISCET, and other ethical professionals engaged in or connected with the appliance, computer, and electronics service industries.

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2708 W. Berry St., Ft. Worth, TX 76109-2397
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www.nesda.com
Executive Director: Clyde W. Nabors
Editor-in-Chief: Wallace S. Harrison
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Associate Editor/Production: M. Merrill
Email: Mary.Margaret@nesda.com

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A Linux Primer

You may have heard that there's a more stable operating system for your PC than Windows. You may have even heard that it operates with more efficiency using less resources. But, is it the right operating system for your needs?

by Mary Margaret Merrill

Many Internet Service Providers are using a UNIX operating system because it is more stable and is less likely to crash than Windows systems. An offshoot of UNIX, Linux (pronounced LIH-nucks, with a short "i"), is taking the Web World, and many small businesses, by storm.

Linux was initially created by a young student, Linus Torvalds, at the University of Helsinki in Finland. He released version 0.02 in 1991, while version 1.0 of the Linux kernel was released to the public in 1994. What makes Linux unique is that it was developed under the terms of the General Public License. The GPL states that the source code must be freely distributed. Anyone is allowed to make copies for their own use, or to sell or give to other people (with a few restrictions). A copy of the GPL can be obtained at www.gnu.org. Torvalds asked for volunteers to test and improve Linux. Thousands responded. Many developers contributed to improving the program that would not have otherwise worked on it. And, after seven years of continuing refinements, many computer professionals feel that Linux is now better than Windows NT.

Linux is considered to be an excellent, low-cost alternative to other, more expensive operating systems. Commercial operating systems, especially server systems like Windows NT Server and Novell IntraNetware, can cost more than $400 for a single copy and a limited number of user licenses. Linux is available in several formats, called distributions. Each distribution has its own set of features and functionality that makes it unique. Some are available as downloads from the Internet at no charge, while others are distributed on CDs or disks and have a nominal fee associated with them.

Some of the features that make Linux valuable are (1) true multitasking; (2) virtual memory; (3) the world's fastest TCP/IP drivers; (4) shared libraries; and (5) multi-user capabilities. Hundreds of people can use the one computer at the same time over a network, via the Internet, or by the serial ports of those computers. Linux runs fully in protected mode, and supports 32-bit and 64-bit multitasking.

Linux also has a completely free X Windows implementation conforming to the X/Open standard. Most existing X-based programs will run under Linux without any modification (X Windows is a GUI system that runs on Linux and UNIX operating systems similar to the way Microsoft Windows X runs on top of MS-DOS).

No matter what combination of systems you are running, Linux will fit easily into a Local Area Network. It provides full and seamless support for Macintosh, DOS, Windows, Windows NT, Windows 95 and Novell, all using their native protocols. And, it can do so with less RAM, when provided with enough disk swap space. It works more powerfully and with more stability on large computer systems and file servers than Windows-based programs. And, anyone who is technically capable can fix bugs by merely changing the code in question and recompiling.

According to an article by Scott Nipp (Dec. 18, 1999), Linux is also a very capable desktop platform. Several core applications which most companies use are already available for Linux, and many more are on the way. Linux supports a

(continued on PR-2)

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(Linux, continued)

number of productivity suites for offices, such as StarOffice, and (coming soon) Corel WordPerfect Office. Netscape, along with several other Web browsers and numerous e-mail clients are also supported. With the more advanced windowing environments available, Linux has become just as easy to use as Windows for many people. Its ease of use combined with support for common desktop applications makes Linux very attractive.

Nipp goes on to say that cost effectiveness is the ultimate strength of Linux for a small business. Unlike other operating systems, a company can purchase a single "shrink-wrapped" version of Linux for under $50. This single copy can legally be installed on every single machine in their entire organization, whether there are two or two thousand. This means that you do not have to incur the cost of properly licensing the operating system on every machine in the organization.

Linux is a competitive solution for managing a local network, serving in the following capacity: (1) file server: SMB protocol (Microsoft Windows, IBM OS/2), Novell Netware, AppleTalk, NFS, etc...; (2) print server; (3) fax server; (4) dial-up connection server; (5) Internet access sharing (built-in network address translation/firewalling ability); (6) backup server; and (7) CD-ROM sharing. Linux behaves well in heterogeneous networks, such as a UNIX/Mac/Windows mix. Linux can also emulate Novell Netware or Apple.

However, Tom Henderson of Extreme Labs (Dec. 20, 1999) feels that Microsoft still has the following advantages over Linux:

1. Microsoft communicates. Microsoft sends the following e-mails, most of them weekly: Microsoft SmallBiz, MSDN Flash, Exploring Windows, PressPass, Windows Platform News, TechNet Flash, Microsoft This Week, Office News Service, Special Alerts/Flashes, and Special Editions.

2. Microsoft promotes its own products. Whether you like the promotion or not, it's a largely unified message brought to the public around the world. And, there are just five websites to transverse.

3. Microsoft educates users. Microsoft Press, coupled to its education programs, is a unified vehicle to permit rapid adoption of its products. No parallel Linux program exists today.

4. Centralized hardware liaison. Microsoft uses WinHEC (Windows Hardware Engineering Conference) and other conferences to try to keep hardware developments/developers either aligned or informed.

5. Microsoft promotes third-party software. Microsoft actively recruits business partners to do the job of using Microsoft platforms.

6. Microsoft makes OEM deals. The Corel Linux distribution is just the tip of the iceberg when it comes to finding alternative methods of having distributions available at initial boot time for civilian PCs. While hardware platform makers are stumbling over themselves to offer Linux-specific systems, the amount of public cognizance of these platforms is muted because it's currently a distributed, non-unified effort to communicate the benefits.

7. Platform efforts. Currently, Microsoft's breadth is from 32-way Intel systems down to micro-browsers and HHC/PPC machines. Linux platform breadth runs from 8-way to tiny kernels. Of course, Microsoft doesn't play on dozens of non-Intel platforms.

In contrast, Bob Brand states in a recent article that "Compared to other operating systems, it (Windows NT/2000) turns in sluggish performance, has stability problems (it can crash), and suffers security flaws (hackers can break in). Yet, in spite of glaring weaknesses, NT continues to grow in popularity."

In its current state of development, Linux is too cumbersome to install and use by the vast majority of everyday PC users. However, Linux is very Internet-friendly (it is the system of choice for large and small ISPs — Internet Service Providers). PC users can find low-cost (or no cost) popular applications like word processing, spreadsheets and databases that run on Linux machines. More is becoming available all the time. Usually Linux applications do not have the graphics and advanced features found in many of today's Windows programs, although the Linux graphical environment, X Windows, gets closer and closer to "Windows." Linux runs Netscape as its Web browser.

Linux is not Windows. The process of installing Linux on older computers (386, 486, and Pentiums) with CD ROM loaded software from commercial vendors opens this operating system to a larger user base. However, learning how to configure Linux so that the user can play music on a CD ROM, share printers, con-

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nect to an ISP and many other networking tasks can take days of painstaking (and very often frustrating) reading and exploration. Keep a Linux guru on hand.

Overall, Linux is not for those who wish to run their software "out of the box." People who are not "techies" should look toward commercially available products, since most of the commercial software you may be used to using simply doesn't exist for Linux (but someone's working on it). Installers should have some familiarity with UNIX and some PC hardware knowledge.

To find out more about Linux, start at the "official" Linux Home Page, www.linux.org. There you will find an infinite trail of resources, each with its unique slant on Linux. For business applications, visit www.linuxbusiness.com/en/. There you will find a number of different business solutions via Linux, including the results of benchmark testing and case studies of companies actually using Linux systems. A rather extensive library of preferred reading is available for "Newbies" (those unfamiliar with Linux), many of which include versions of Linux on CD, such as the *WordPerfect for Linux Bible* (retail $39.95). It contains the full Personal Edition of WordPerfect 8 for Linux, as well as a full version of Linux. Some of the books that show appeal for beginners include *Linux in a Nutshell: A Desktop Quick Reference, Linux at Work: Building Strategic Applications for Business, The Complete Idiot's Guide to Linux, Teach Yourself Linux in 24 Hours,* and *Using Linux.* Many of these books are reviewed online.

Another interesting site is www.LinuxPowered.com. A large number of recently written articles about Linux are available here which address performance appraisals of different operating systems, the concerns of Microsoft Corp. regarding Linux, and the opinions and research of current Linux users.

Some other sites worth visiting are: www.linuxhome.org, www.linuxnewbie.org, www.linuxtelephony.com, and www.linuxtoday.com. MacIntosh users, check out www.linuxppc.org, a site devoted to the use of Linux on Power Macs.

The bottom line is this: as an alternative operating system, Linux shows a lot of promise. Its stability is legendary, its capacity desirable. When the software can meet your particular needs (do some research), it is certainly worthy of your consideration for *your* business. §

— Management —

In Search of the Right Search Engine

The Internet can be a valuable tool to you and your service business. But how do you get around the "Information Super Highway" without a map? Use the many "electronic" guideposts to point you in the right direction.

by Richard Ensman

Getting computerized is a must for service dealers. You need it to get technical information from the manufacturers, and for exchanging repair and management tips with your peers on NESDAnet. But the Internet offers access to many resources that can help you in other areas of business management — and in your personal life.

If you've wandered around the World Wide Web for any length of time, you know all too well that this internet resource is enormous in size and scope. The Web is an overflowing collection of tens of millions of different sites. It ranges from polished to amateur quality and from simple to complex in content and format.

And you learn early on that it's not always easy to find what you're looking for. When you begin to hunt for information on a particular topic, you might spend hours in a fruitless search, or become tangled in a Byzantine cyberjourney that produces nuggets of information alongside piles of junk.

Here's where search engines come in. Search engines, in their simplest form, attempt to catalog or index some part of the Web (or in the case of the large engines, most of the Web). Some search engines catalog other internet resources as well. If used properly, search engines make navigation much easier.

While many computer users liken search engines to the old-fashioned card catalogs in libraries, the analogy isn't correct. Each search engine — and there are a lot of them — categorizes information in a unique manner and searches the Web differently. What makes things even more complex is that search engines, like the Web itself, are constantly changing in format and scope.

While trial and error is still a good way to familiarize yourself with the capabilities of search engines, these suggestions will help you master the search process:

Use the forms. Most engines offer simple and advanced search capabilities. The easiest way to begin a search is to use the fill-in-the-blank form present on an engine's home page.

Read the instructions. While the quality of user assistance varies, most search engines offer instructions, either in the form of "help" or "FAQ" (frequently asked questions) pages. They usually explain the mechanics of the engine in non-technical terms: how sites are categorized, how to conduct a search in the most efficient manner possible and, at times, how to ask for clarification on thorny points. You can usually access the help menu from an engine's home page.

Think about your search terms before starting. You can conduct a search on any word or phrase you want. A few engines even allow you to conduct a natural language search (for example, "What have you got on personnel management techniques in the Soviet Union?") But don't be fooled by this freedom; overly broad searches will yield cumbersome and often ill-matched results. Time spent in defining your search terms is usually time well-spent. Let's say, for example, that you're interested in searching for information on quality assurance. Some advance thought, coupled with your knowledge of the field, might prompt you to search on "quality management," or "process control."

Match the tool to the job. Each search engine is unique. Familiarize yourself with at least several so that you know instinctively which is best for a particular search. For example, you might find that a directory-oriented engine like Yahoo! (www.yahoo.com) is useful for collecting general information on a topic quickly. You might find that another engine that searches site text, like AltaVista (www.altavista.com), will help you conduct a longer, but more exhaustive search. Don't, incidentally, assume a relationship between the number of sites generated by a search and the quality of the engine. What counts is the quality, timeliness and focus of the sites themselves.

Seek variety. Many search engines offer multiple ways to conduct searches. Ya-

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(Search Engines, continued)

hoo!, for instance, offers five search methods as of this writing, and allows you to specify the cyber-locations (such as general Yahoo! sites, news, events) you'd like to search. Lycos (www.lycos.com) allows you to customize your searches to people, pictures, sounds, companies and other broad parameters. When confronted with an option, you don't have to select a search method, however; most engines will default to whatever search technique the system labels as most appropriate.

Recognize the difference between directories and indexes. A simplistic explanation: Search engines using a "directory" approach attempt to categorize Web sites by topic. Engines using an "index" approach attempt to categorize sites on the basis of the appearance of key terms and phrases there. Directories often allow you to search for general information with a minimum of time and fuss; indexes, on the other hand, may allow you to search for very precise information or sites associated with obscure topics most efficiently. If, for instance, you're trying to find information on a general subject, say "product promotion techniques," you might be better off searching on that subject using a directory-oriented engine. If you want to find information on product promotion techniques at specific companies, you might be better off using an index-oriented engine to search on company names. The substantive differences between the directories and the indexes, though, will vary from topic to topic; the more you practice, the more you'll gain a feel for what's right for you.

Learn how syntax and word patterns affect searches. Some search engines attempt to "score" the number of times a particular word or phrase appears in a site's text. In other cases, a computer program (or even human intervention) might determine how a site is tracked and categorized. By understanding the process each engine uses, you're in a better position to conduct quick searches; visit the "help" screens of your favorite search engines to find out. Learn, too, whether your favorite engines allow you to search with a "wild card" — a symbol (such as the asterisk *) that substitutes for part of a word or phrase that you don't know. Wild card searches might turn up more hits than you want, but they may also allow you to uncover sites you didn't know existed.

Use the search aids. Search engines, primarily directory-oriented engines, attempt to categorize sites in hierarchical menus. For example, sites related to "health" may be grouped together, with sub-directories further grouping sites on "child health," "diseases," "preventive medicine," and other health subjects. When you need information on broad subjects, you may be better off using a menu-driven directory than roaming freely through the Web using a wide assortment of search terms. Many engines offer "rankings," arranging sites in order of the statistical probability they'll meet your needs. Ranking is far from an exact science, but if your search yields a thousand hits, a rank-ordered list is better than an indiscriminate collection of all of them. Look for more engines to offer reviews of popular sites (Magellan, www.mckinley.com, for example, is already doing this) to save search time.

Learn the Boolean basics. Computer programmers know all about Boolean operators — the quasi-algebraic commands that make computer code work and, in the case of the Web, help define searches. You don't need to become an expert in Boolean logic to perform Web searches, but if you learn the basics (just the terms "AND," "OR," and "NOT" will give you tremendous power) you can transform an excruciating search into a simple one. For example, by placing the operator "AND" between the words "home" and "construction," you can often narrow the search to sites concerned with "home construction." The Web is not always simple, however. Each search engine uses Boolean terminology in a slightly different manner. One engine, for instance, might assume that the words "home construction" deal specifically with that topic. Another engine might assume an imaginary "OR" between the terms and call up sites dealing with "homes" and "construction." Still another engine might use algebraic symbols instead of words. The secret: once you've settled on your favorite search engines, review their "help" pages to learn their search logic.

Use quotation marks. Often, when you place quotation marks around a search term, the engine will attempt to retrieve sites that match your terms exactly. But remember: this is not always the case; check the "help" section of each search engine to find if quote marks are required.

Be careful of symbols. If your search terms and phrases contain symbols or numbers, you may be headed for trouble. Each search engine interprets symbols in different ways; even experienced Web users have difficulty here. Best advice: limit search terms to text unless absolutely necessary.

Remember: the "big" engines aren't the only game in town. Search engines like Yahoo!, AltaVista, eXcite (www.excite.com) and Lycos are well-known, but they're not the only engines available to you. Hundreds of specialized search tools exist on the Web today, many of them focusing on highly specific subject matter. Want information on North American corporations, for example? You can use almost any search engine, but BizWeb (bizweb.com) will allow you to conduct fast, tightly-focused searches on companies or product-related subjects.

Run lots of engines at once when the time is right. Not sure which engine to use for a particular search? Consider conducting a meta search. Metacrawler (www.metacrawler.com) and Savvysearch (129.82.102.175:2000/form), for example, will submit your query to a number of different search engines. The only problem, of course, is that the search may result in duplications — and very possibly, a sprawling, disorganized collection of sites to visit. Still, if you don't know where to begin, this strategy might help.

Search the search engines. As the

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number of search engines proliferate, many users wonder which engine is best for searching specialized subject areas. Enter Search.Com (www.search.com). Not only can you submit conventional searches at this site, but you can scan a long list of available search engines and select one or more that seem especially appropriate for a particular search. Another place to start is Search Engine Watch (www.searchenginewatch.com), whose page on specialty engines includes sites that search archives of discussion postings (Deja News, etc.)

Don't limit yourself to the Web. The internet has many other resources available to you in your quest for information. For example, some 20,000 news groups — lists of people who correspond electronically on subjects of mutual interest — find a home on the Internet. Usenet is an internet resource devoted to these groups, and Deja News (www.dejanews.com) is a search engine that points you to the groups of special interest to you. If you're interested in what other people have to say about a particular subject, a company or a product, submit a DejaNews query. You'll soon be able to retrieve postings and, if you wish, join lists of interest.

Develop a personal search strategy. Once you become familiar with the available search engines, you can develop a personal search strategy: a sequence of search routines you can follow until you obtain the information you want. Your personal search strategy is unique: it will begin with a particular engine that typically gives you the best results for the smallest investment of time. It then moves to one or more successive engines if you need more results. Your strategy might culminate in a search of other internet resources.

Track your searches. If you haven't used search engines much, record exactly how you conduct each of your searches. Eventually this log will provide you with the guidance you need to conduct advanced-level searches or design your own strategy. The bottom line: by logging your searches, you'll eventually save time and boost your productivity on the Web.

Bookmark favorite sites. If you roam the Web at random, you'll quickly forget where you've been. So establish electronic "bookmarks," available in your internet access software, to remind you of favorite sites. Bookmarks will make return visits effortless.

Search and search and search again. The Web is constantly changing. New sites are forming all the time, new links are established, and new content appears on existing sites. So if you're unsuccessful in your search for up-to-date information on "intelligent furniture" on Monday, check again on Friday. Conducting a new search a few days or a week later is sometimes more effective than trying a different search engine.

Don't overlook the obvious. If you know exactly what you're looking for on the Web, and you suspect that a particular company or organization might host a Web site focusing on that topic, check the organization's print advertisements to see if they mention a Web site. Or take a guess; the site address may be easier to find than you think. If you're searching for a site run by the ABCD Company, search on the company's name; you might find the site under the address ABCD.com.

Stay abreast of the search engines. Just as the Web itself is constantly changing, so are the search engines. Search engine sponsors are constantly seeking ways to catalog and index more effectively, and make retrieval of sites easier. The future will bring more focused and refined search techniques. So check in with the "help" or "FAQ" pages of your favorite engines every once in a while. You may be surprised at the changes and improvements explained there.

A wide variety of multi-media resources are becoming readily available: sounds, snippets of television shows and movies, even personal reference information you choose to store on the internet! You have good reason to remain interested and enthusiastic over these developments: they'll put a world of resources at your fingertips, as well as a world of search tools that can help you find whatever you want, whenever you want it.

MORE SEARCH ENGINES

The Web offers numerous search engines, and more are forming all the time. Here are a few of the more popular engines:

- AltaVista: www.altavista.com
- eXcite: www.excite.com
- Galaxy: galaxy.tradewave.com
- GoTo: www.goto.com
- HotBot: www.hotbot.com
- InfoSeek: www.infoseek.com
- Lycos: www.lycos.com
- Magellan: www.mckinley.com
- MSN: www.msn.com
- Net Find: www.aol.com/netfind
- Northern Lights: www.northernlights.com
- OpenText: www.opentext.com
- SNAP: www.snap.com
- WebCrawler: www.webcrawler.com
- Web Places: www.webplaces.com
- Yahoo!: www.yahoo.com

When time is short and you don't know where to start, try a metasearch engine first. They can yield some very satisfying results:

- All-In-One Search: www.albany.net/allinone
- Ask Jeeves: www.ask.com
- Ask Jeeves for Kids: www.ajkids.com
- Dogpile: www.dogpile.com
- FindIt!: www.itools.com
- Inference Find: www.infind.com
- Mamma: www.mamma.com
- MetaCrawler: www.metacrawler.com
- MetaFind: www.metafind.com
- OneSeek: www.oneseek.com
- SavvySearch: www.savvysearch.com
- Search.Com: www.search.com
- Search Engine Watch: www.searchenginewatch.com

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— Association Trends —

A New Century, a New Direction for NESDA and Industry Relations

Using 'honey' instead of 'vinegar' continues to promote good relations between servicers and manufacturers. Now we must survive.

by Vic Gerry, Chairman
NESDA Industry Relations Committee

In the product service arena, NESDA has always worked to achieve situations that were optimally fair and useful to servicers, manufacturers, and consumers. Over the years, we have spent countless hours meeting with the national service managers of the major consumer electronics manufacturers. In working with these people, we have favored non-confrontational dialog and cooperation over loud but nonproductive rhetoric.

Over the years we have resolved many issues that have benefitted everyone involved. One notable example was Panasonic's acceptance of NESDA's costs-of-doing-business formula for negotiating individual rates on in-warranty home service. However, most of our successes have been in response to new policies implemented by individual manufacturers. Our efforts have not resolved the major dilemmas that servicers face because of the combined actions — or inactions — of the manufacturing community.

The service industry has achieved little manufacturer recognition, much less attention to the subject of warranty rate reimbursements, and regional or individual negotiations of those rates.

Now, at the beginning of a new century, the service industry finds itself in dire straits. Many service companies scaling back operations, changing directions or closing their business entirely. Not only are the smaller service businesses affected, but many of the large, seemingly efficient, and well-managed service centers are hurting financially, while others have been forced to close. What does this mean for those of us who remain in the product service industry? In some cases, the company has increased business, obtained new technicians and been able to negotiate slightly higher rates with some manufacturers. Others have joined together to form service consortiums, geared for high-volume discounted service across a large geographic area. However, most owners and managers are working harder and making less profit.

What can we do about this? We could continue the way we have for 50 years, or we can change our tactics and directions.

In our ongoing dealings with the manufacturer, the service representatives that we have met with on industry relations level have been extremely congenial, and very helpful at solving everyday minor policy problems. However, the majority of them have been totally ineffective in resolving problems of relevance to the service community. This includes, especially, the topics of warranty rates based on our cost of doing business, and receiving a profit on parts.

It appears the people we must start negotiating with are the presidents of sales and marketing. These are the people who truly control the purse strings, and allow for the few bread crumbs that trickle into the service industry. So where do we begin?

First, our publications must reflect more news of the industry; news that affects the average service center owner and manager. We also need more editorials by our association leaders to reflect the attitude that the number one issue is "money." We can't continue to work for less than our costs of doing business ("I lose twenty bucks on every item I repair under warranty, but I make it up in volume." Asinine, isn't it?)

Secondly, through our contacts with the manufacturers we must arrange meetings with the manufacturers' heads of sales and marketing. We must convince those people that keeping their authorized service centers alive and profitable is in *their* best interests. We should present a program that stresses the need for competent service of their new products, such as HDTV. We should be prepared to point out that we, the independent service dealers have delivered, and can continue to provide the highest quality of service to our mutual customers. We have to stress the importance of independent service, and how good service helps manufacturers sell new products.

Thirdly, and most importantly, we must be prepared to stand together. We must educate our members and, especially, our nonmembers about the need to associate for survival. We have to spread the word to more servicers about knowing their real costs of doing business.

We must lose our fear of "the guy down the street with the lower prices" who dictates our rates. Nor can the manufacturer continue to rely on "the guy down the street who will accept the low rates if you don't." That guy is not there anymore.

Let's go forth into this 21st century, and make your own destiny.

Mr. Gerry is owner of Page TV in Bethpage NY. He can be reached by phone at 516-931-7617, or via e-mail at NESDAirc@aol.com. §

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***Note:** Student Electronics Workbench is **required** for use with Study Guides*

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____	Student Electronics Workbench, Version 5.0	❑ $69.95 ea.	❑ $89.95 ea.
____	Associate CET Interactive Study Guide (78 questions)	❑ $39.95 ea.	❑ $49.95 ea.
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PEAK COMPUTING

(continued from page 43)

move other cards, if necessary, to free up a PCI slot next to it.

If your PC has on-motherboard sound circuitry, you have it even easier. Check the documentation for your system's motherboard to be certain, but disabling on-board audio is usually as simple as going into your machine's CMOS Setup on bootup and selecting the appropriate audio menu. Some kind of "enabled/disabled" option will be available. If you also have to change a jumper setting, your motherboard's manual will tell you; but this is most often not the case.

You're now ready to install the Montego II. As we normally do, we'll abstain from reiterating all the steps found in the manual, which is a good guide from this point on. It was only missing the uninstall details we filled in above.

Basically, you'll be inserting the card and connecting it to the I/O Board with a cable. You'll also have to connect your system's CD- or DVD-ROM drive to the Montego II.

Then it's off to driver and software installation—automated processes that begin once Windows boots, detects the new card, and asks for the disc that came with the Montego II. You're just moments away from aural delights when you insert that CD.

SOFTWARE TO START

With the card installed, your system will be ready to provide noticeably better sounding audio. Unless you had another studio-quality card installed (and why would you be upgrading if you did?), you should find that games, MP3s, and just about anything else coming out of your speakers sounds crisper and more vibrant—MIDI files will have added realism, explosions will suffer less distortion, quiet moments in music will be truly quiet ... you get the idea.

But should you want to use the card for what it's really intended—for *studio-quality* audio—consider experimenting with the included version of *Digital Orchestrator Pro* (more on this in the article "Making Music on a PC" on page 37). Combined with your new hardware, this software is the replacement for thousands of dollars of recording gear. You can synchronize multiple MIDI and digital-audio tracks (exactly how many depends on your PC's resources), and play and record them in real time (again, check out this month's *PC Tech* feature for more on this).

Right out of the box, the Montego II Home Studio lets you make or enjoy beautiful music. Add a killer set of speakers, and you may never touch your stereo again!

As always, if you want to get in touch, feel free to contact me care of *Peak Computing*, **Poptronics**, 500 Bi-County Blvd., Farmingdale, NY 11735, or directly via e-mail at *selinakyle@techie.com*. P

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— Management —

To Err is . . . Right? Or, at Least Necessary

Growth involves risk. Are you willing to take a chance for success, or are you simply trying "not to fail?"

by Jeffrey Tobe CSP

Most people are not comfortable with errors. We have been taught from an early age that "to err is wrong." We learn early that it is good to be right and bad to be wrong. These values are all a result of our educational system, which, when you think about it, rewards us by grading the number of right and wrong answers. It teaches us that we will be rewarded in life for being right and that we will have limited opportunities if we make mistakes.

The notion of not being able to make mistakes is still evident in every facet of our adult lives. There are few servicers who are willing to admit their mistakes in a very public arena. We tend to take risks only on a private level where we will not be found out.

This attitude makes sense in many circumstances. You wouldn't want your stockbroker to be wrong too many times. You would assume that the engineer did not make too many mistakes when designing the bridge you drive over every morning. And, every time you board an airplane, you are betting that the pilot is not overly comfortable with making too many errors.

But, when it comes to your business, to err is not wrong! Mistakes are a necessary by-product of the creative process. If you are willing to accept the norm because that is the way it's always been done, if you are prepared to sell the same old product because it's an old mainstay, then you are not exercising your "risk muscle" and your creative genius can only be stifled. As cliche as it may have become, try "coloring outside the lines" and see what happens. As Benjamin Franklin once said, "The man who does things makes many mistakes, but he never makes the biggest mistake of all — doing nothing."

One of the biggest reasons we don't tend to take risks when confronted with the many challenges we face is FEAR. Fear keeps us from turning that "one-in-a-million" idea into reality. Fear is the greatest hindrance to successful risk taking and to performing our best under pressure. To keep ahead of change and to successfully confront the many challenges we face in this industry, we need to learn how to overcome this obstacle.

The good news about the fear of failure is that we have plenty of company. Everyone is afraid when taking a risk or tackling a challenge. If you say you have no fears, you are either playing life much too safely or you just are not in touch with your own feelings.

"Heroes and cowards feel exactly the same fear," said Cus D'Amato, the great boxing trainer to such prize fighters as Floyd Patterson and Mike Tyson. But like all champions, D'Amato adds, "Heroes just react to fear differently."

Fear is like a wall that limits your view and creates boundaries to your growth and, especially to your creativity. The creative person recognizes that the breakthroughs in their own creative genius, learning and growth lie beyond the wall.

Education is a prime example of this. The need for service industry education is increasing, but participation at the National Professional Service Convention is not what it should be. Perhaps that's because servicers and technicians are afraid to risk the time and money required to participate. Or perhaps it's because they're uncomfortable with new ideas. And yet the payoff for investing the time and the money and giving fair consideration to new ideas can be phenomenal.

To get over the fear of failure, you must first acknowledge it. There is an old American Indian story that says fear is like a 60-foot, two-headed snake as big around as a large tree. Avoid it and the snake grows larger and comes closer, rearing its huge ugly head, ready to strike. But if you look the snake in the eye, it sees its own reflection, gets scared and slithers away. The next time you face a challenge that requires you to take the risk that you might be wrong — that you might fail — stand up to your two-headed snake of fear.

One huge misconception I hear all the time is that risk takers are a special breed, a rarity. The truth is, we are all born risk takers. How else do we learn to walk, talk, ride a bike, ski or get into our own businesses? I am not a scientist, but I would venture a guess that research would show that we learn more in the first decade of our lives than we ever will after that. That's no accident. Isn't this the period that we are more likely to take risks?

If we weren't born risk-takers, we would all be crawling around on our hands and knees! "I don't know if I should try to stand. I'm only one-year-old. I will fall. I will hurt myself. I think I will wait until I am older and stronger." As children, we don't know any better than to explore the unknown, the untried, the untested, every day. This is the prime time for making mistakes, picking ourselves up dusting ourselves off, and trying again!

It should seem evident that you can't learn *without* taking risks. It's the way we have mastered everything. Growth and creativity come from trial and error. As Lloyd Jones noted, "The men who try to do something and fail are infinitely better than whose who try to do nothing and succeed.

Jeffrey Tobe CSP is coauthor of the best selling books ***The Sales Coach*** *and* ***The Communication Coach.*** *He works with small businesses on marketing themselves. Visit www.jefftobe.com. FREE: "9 Ways to Solve Almost Any Problem." Fax your name on your letterhead with the words, "9 Ways," to 412-373-8773.* §

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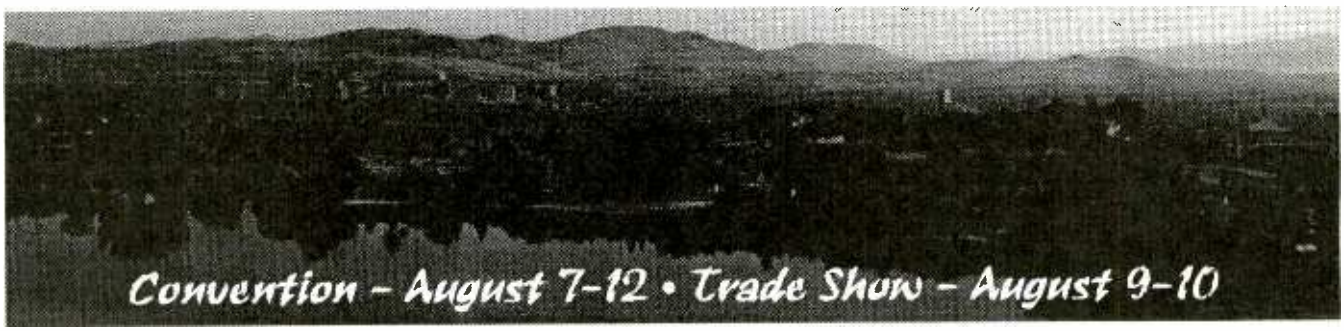

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Full convention registration includes all programmed meals, banquets, door prize drawings, trade show, dealer/manufacturer meetings, seminars and workshops. Activities may be scheduled for optional participation at an extra cost. There is no convention youth program. However, children 17 and under are free.

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REFUND POLICY: Register in advance. If find that you have to cancel — any time prior to convention — all money prepaid will be refunded except for a 10% processing fee per registered person.

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SIGNAL GENERATOR

(continued from page 23)

waveform on the scope, turn R3 fully clockwise. You should see a 1-kHz squarewave. Slowly turn R3 counterclockwise until the waveform collapses. Then advance R3 clockwise slowly past the point where the waveform returns. Increase the level until it stops bouncing. That setting gives the lowest possible distortion from the oscillator. On the prototype, the lowest available output voltage was 2.0 volts rms. It was increased to 2.5 volts rms (7.07 volts peak-to-peak) for faster startup and better compatibility with line-level inputs.

With the Audio Signal Generator built, tested, and calibrated, close up the cabinet and secure the cover with the screws that came with it; the unit is ready.

The Audio Signal Generator is easy to use on the job. Plug in T1. If you are working with equipment that has unbalanced inputs, use J1 or J2 as appropriate. Otherwise, connect balanced-line equipment to J3. Set S2 to the "LINE" or "MIC" position as needed by the equipment that you are working on and adjust R6 for the desired sound level. P

NEW GEAR

(continued from page 70)

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vations, record travel expenses, and find client locations using Rand McNally's database of over one million business listings. Minimum system requirements include Microsoft Windows 95, Windows 98, or Windows NT 4.0 or higher; a VGA card and 256-color monitor; 16-mega-bytes of RAM; a 486 CPU or higher; a double-speed CD-ROM drive and 125 megabytes of available hard-disk space.

The TripMaker Deluxe 2000 and StreetFinder Deluxe 2000 retail for $49.95 each.

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Models 382203 and 382213 supply constant voltage or current. They feature a current-limiting indicator and overload- and short-circuit protection.

The Model 382203 and the Model 382213 have suggested retail prices of $169 and $199, respectively.

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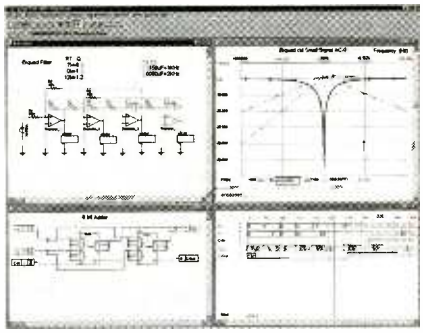

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The software also provides support for over 4000 device types. Editing existing parts and adding new parts to the parts database is easy to do, using the schematic editor.

The B^2 Spice A/D 2000 Lite has a suggested retail price of $99. The B^2 Spice A/D 2000 Standard has a suggested retail price of $299.

Beige Bag Software
279 E. Liberty
Ann Arbor, MI 48105
Tel: 734-332-0487
Web: www.beigebag.com P

NEW LITERATURE

(continued from page 18)

tion. The authors show inventors how to: draft with pen and ruler, use photographic techniques and computer drawing software, and make design patent drawings. They also explain PTO drawing standards, appropriate responses to Patent Office actions, and preparation of graphics for prospective manufacturers and customers.

Fundamentals of Telecommunications

by Roger L. Freeman
Wiley-Interscience
John Wiley & Sons, Inc.
605 Third Ave.
New York, NY 10158-0012
Tel: 212-850-6336
Web: www.wiley.com
$105

Providing an easy-to-understand introduction, this primer presents a guided tour for non-engineers and newcomers to the field. From bandwidth to data transfer protocol to ISDN, the author explains it all. He gives readers an overview of all branches of telecommunications—telephony, data communications, enterprise networks, television transmission, wireless systems, and cellular/personal communication services (PCS).

The book assumes no mathematical or technical know-how. All terms are clearly defined and illustrated with specific examples. Review questions at the end of the chapter test and reinforce the reader's understanding. Approximately one hundred figures highlight the text. P

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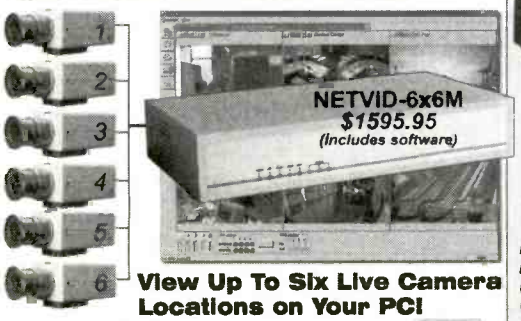

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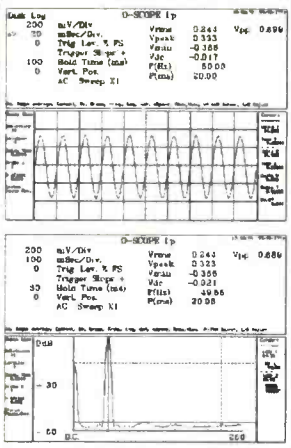

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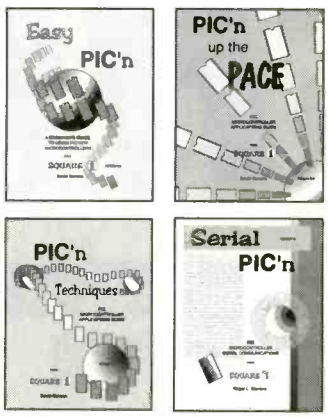

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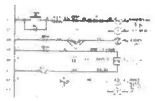

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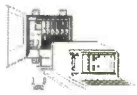

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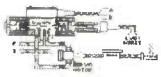

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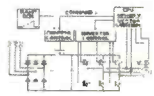

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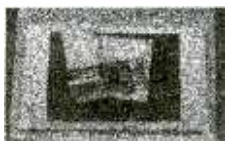

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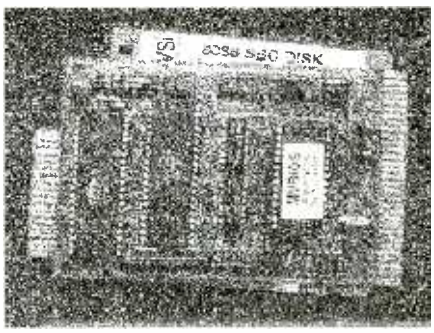

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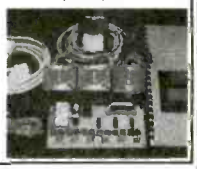

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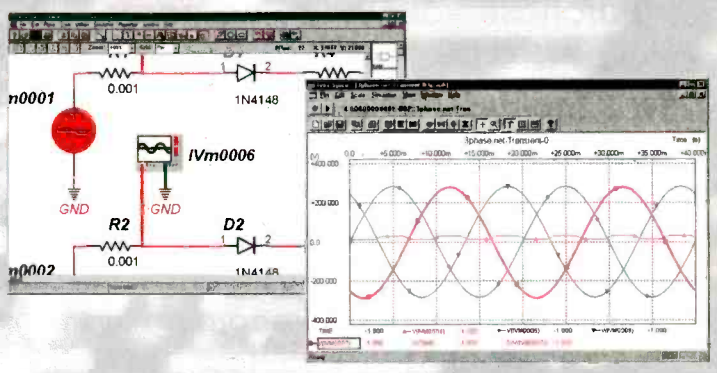

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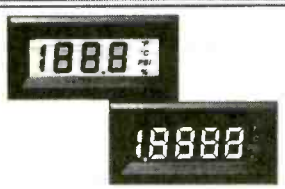

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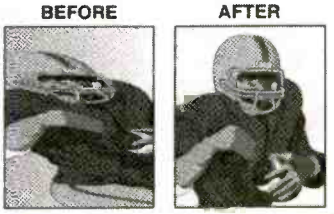

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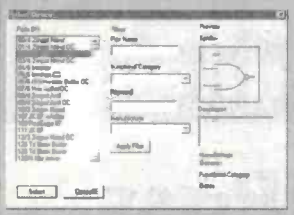

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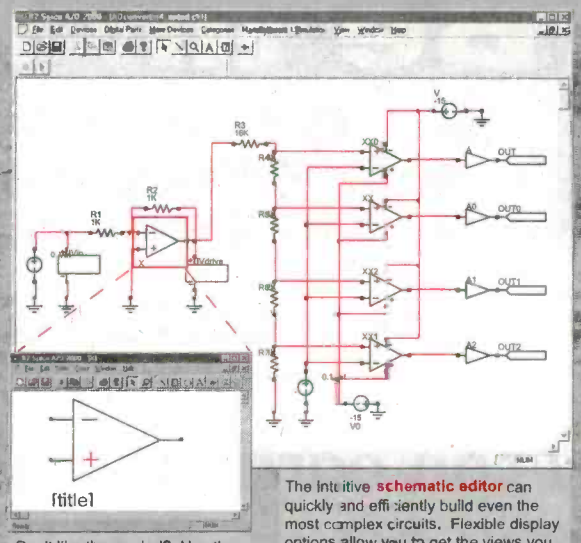

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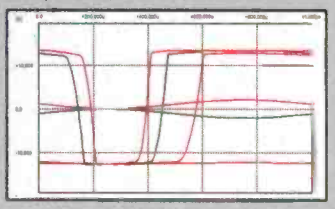

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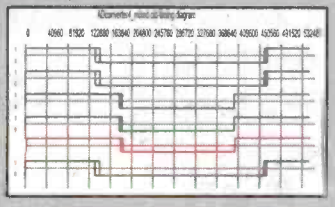

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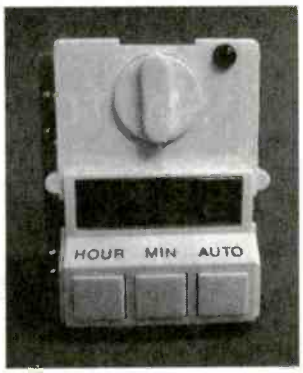

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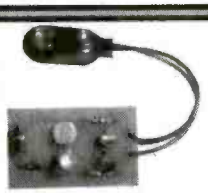

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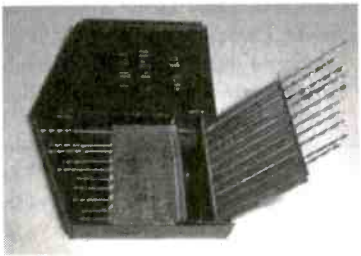

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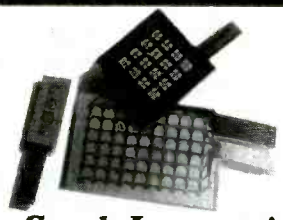

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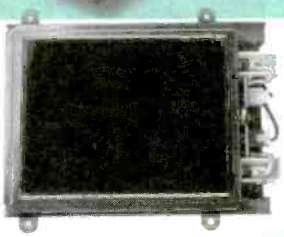

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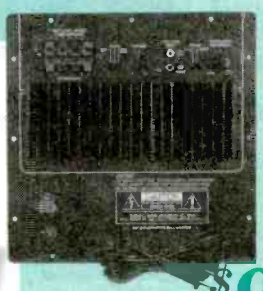

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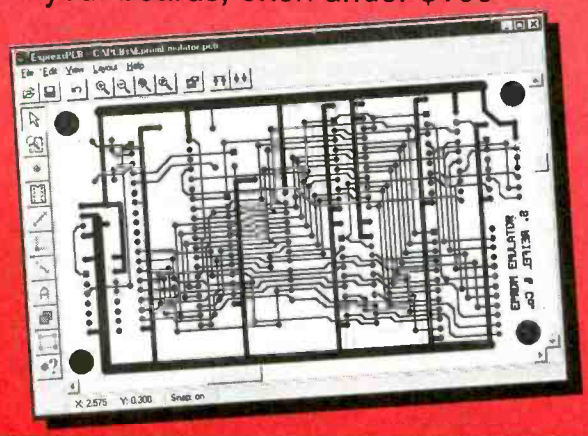

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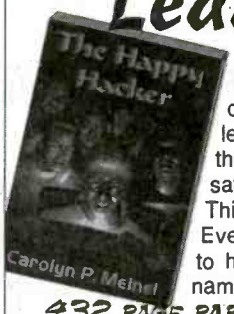

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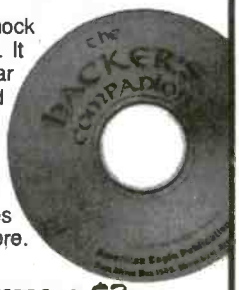

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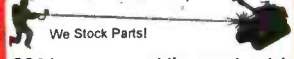

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Elenco Sweep Function Generator w/ built-in frequency counter Model GF-8036

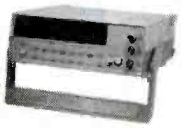
$225

This sweep function generator with counter is an instrument capable of generating square, triangle, and sine waveforms, and TTL CMOS pulse over a frequency range from 0.2Hz to 2MHz.

10 Function 1.3GHz Universal Counter Elenco Model F-1300

- Frequency .05Hz - 1.3GHz 3 Ranges
- Period - Can read 60Hz to 60.000000 F=1/T
- Totalize - Counts to 199,999,999
- RPM - 3 to 2099994 RPM
- Duty Cycle
- Max/Min/AVG with Time
- Stop-watch set .2 sec. to 100 hrs.
- Math Functions
- Timer - 2 sec. to 99 days
- Pulse Width - 0.1ms to 66666.6ms

$225



Multifunction Counter

B&K Model 1875

$189

10Hz - 2.5GHz Ultra sensitive synchronous detector bar-graph and RF strength.

3 Channels

Measures Frequency, Period, Data Hold, Relative, Memory (min., max., average). High Sensitivity, Microprocessor Controlled.

Elenco Handheld Universal Counter 1MHz - 2.8GHz Model F-2800

$99

Features 10 digit display, 16 segment and RF signal strength bar-graph.

Includes antenna, NiCad battery, and AC adapter.

Elenco RF Generator with Counter (100kHz - 150kHz) Model SG-9500

Features internal AM mod. of 1kHz, RF output 100MV - 35MHz. Audio output 1kHz @ 1V RMS.

$225

SG-9000 ..... $119.95
(analog, w/o counter)

B&K 20MHz Sweep/Function Generator with Frequency Counter Model 4040

- 0.2Hz to 20MHz
- AM & FM modulation
- Burst Operation
- External Frequency counter to 30MHz
- Linear and Log Sweep

$445

BK PRECISION

21.5MHz Model 4070	$1295
10MHz Model 4017	$319
5MHz Model 4011	$249

Kit Corner

over 100 kits available

Quantity Discounts Available

Model RCC-7K

Radio Control Car Kit

$29.95

- Fun & Easy to Assemble
- 7 Functions
- Radio Control Transmitter Included

Model AK-700

Pulse/Tone Telephone Kit

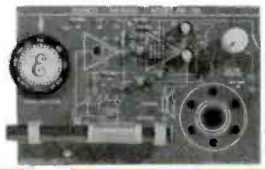
$15.95

Ideal School Project

Model AM-780K

Two IC Radio Kit

$11.95



Model OWI-007

Robotic Arm (Wired Control)

Teaches the basic robotic sensing and locomotion principles while testing motor skills.

$55.95

Oscilloscopes

Free Dust Cover and 2 Probes

S-1325	25MHz	Dual Trace	$325
S-1330	25MHz	Delayed Sweep	$439
S-1340	40MHz	Dual Trace	$475
S-1345	40MHz	Delayed Sweep	$569
S-1360	60MHz	Delayed Sweep	$749
S-1390	100MHz	Delayed Sweep	$995

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DS-203	20MHz/10Ms/s Analog/Digital	$695
DS-303	40MHz/20Ms/s Analog/Digital	$995
DS-603	60MHz/20Ms/s Analog/Digital	$1295

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Digital Multimeters

Elenco LCR & DMM Model LCM-1950

12 Functions
Freq. to 4MHz
Inductance
Capacitance
and Much More

$69

Elenco Model M-1740

$39.95

11 Functions:
- Freq. to 20MHz
- Cap. to 20 F
- AC/DC Voltage
- AC/DC Current
- Beeper
- Diode Test
- Transistor Test
- Meets UL-1244 safety specs.

Model M-2760 • $24.95
(9 functions)

Fluke 79III

$195

- Capacitance ranges from 99.99nF to 9999 F.
- Built-in frequency counter of voltage input from 1Hz to over 20kHz.
- Lo-Ohms range, a 40Ω range with Fluke's proprietary Zero Calibration, offers 0.01 resolution with increased noise rejection.

Fluke 87III

$319

Features high performance AC/DC voltage and current measurement, frequency, duty cycle, resistance, conductance, and capacitance measurement.

Elenco LCR Meter Model LCR-1810

$99.95

- Capacitance .1pF to 20 F
- Inductance 1 H to 20H
- Resistance .01 to 2000M
- Temperature to 750°C
- DC Volts 0 - 20V
- Frequency up to 15MHz
- Diode/Audible Continuity Test
- Signal Output Function
- 3 1/2 Digit Display

Elenco Digital Multimeter Kit Model M-1005K

$19.95

- 18 Ranges
- 3 1/2 Digit LCD
- Transistor Test
- Diode Test
- Training Course

M-1000B
(Assembled)
$15.95

Dual-Display LCR Meter w/ Stat Functions B&K Model 878

$225.95

Auto/manual range

Many features with Q factor

High Accuracy

B&K Video Monitor Tester Model 1275

$169

Great handheld unit to test PC and Mac monitors. The model 1275 is ideal for the field or the service bench. Small, portable and very effective, the 1275 generates crosshatch, dots, color bars and raster patterns in green, blue, red, black and white.

Quantity Discounts Available

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Introduction to PC Repair Self-Study Course™

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Provides you with the easiest and most effective way to learn the fundamentals necessary for a profitable and successful career as a PC Repair Technician. Ideal for Individuals new to the I.T. profession and as instruction prior to studying for A+ certification.

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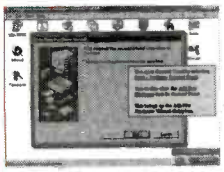

$379

DOS/WIN Exam

DOS 6.2
Windows 3.1 Installation and Configuration
Windows 3.1 Application Support
Windows 3.1 Devices and Drivers
Windows 3.1 Networking and Troubleshooting
Windows 95 Installation and Deployment
Windows 95 Basic Configuration
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Includes all the technical material, knowledge and interactive exercises needed to pass the A+ exams and excel in the competitive PC repair marketplace.

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Includes:
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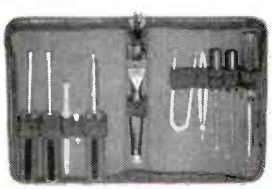
- 1/4" Nut Driver
- 3-prong Parts Retriever
- Reversible Bit Screwdriver T10 & T-15
- Reversible Bit Screwdrivers 3/16", 1/4", #1 & #2 Phillips
- Tweezer
- IC Inserter 14-16 pin
- IC Extractor
- 1/8" Flat Screwdriver
- #0 Phillips Screwdriver

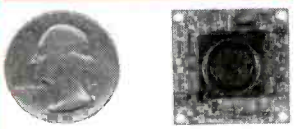
$12.95



CCTV Cameras

Cameras have 420 lines (360 color) of resolution, 0.08 Lux, 3.6mm/F2 90° field of view. Power requirement is 12VDC @ 100mA (order SC-1).

MONOCHROME CAMERAS



SC-12 - 35mm Lens (1.25"x1.25") $69
SC-15 - Pin Lens (1.25"x1.25") $69

Add $10 for lens • Add $10 for audio

Accessories:
SC-1 - 12V 100mA adapter $6.95
SC-2 - 50' cable with connectors $19.95

COLOR CAMERAS

SC-20 Pin Lens
SC-21 3.6mm Lens
360 Lines 1.25" x 1.25"
Infrared Sensitive, Audio Included

$109

Add $10 for case

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Pro-Sport FRS Two-Way Radio Model PRO-SPORT+

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Talk up to 2 miles!

- 1/2 Watt Output, 14 Channels.
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- 38 Privacy (CTCSS) Tones.
- Removeable Antenna.
- Water Resistant.
- 500mW Output.
- Palm Sized.

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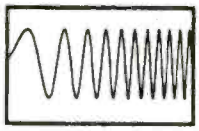
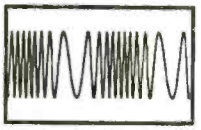
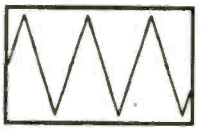
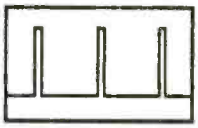
  Clean sinewaves DC-21.5 MHz, .001% accuracy! .01 Hz steps. DC Offset. RS232 remote control.
- **Arbitrary Waveform Generator**
  40 Megasamples/Second. 32,768 points. 12 bit DAC
- **Function Generator**
  Ramps, Triangles, Exponentials & more to 2 MHz!
- **Pulse Generator**
  Digital waveforms with adjustable duty cycle


DC to 21.5 MHz linear and log sweeps

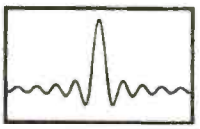
Int/Ext AM, SSB, Dualtone Gen.

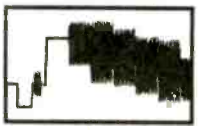

Int/Ext FM, PM, BPSK, Burst


Ramps, Triangles, Exponentials


Pulse Generator

Noise


Arbitrary Waveforms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RF Data Modules

AM Transmitter

- •Sub Miniature module
- •SAW Controlled
- •No adjustable components
- •Low current - 2.5mA
- •Supply 2.5-12Vdc
- •418MHz or 433MHz
- •Range up to 300ft
- •CMOS/TTL data input
- •7 x 11 x 4mm !

AM-TX1-xxx $12.60

AM Receiver

- •Compact Hybrid Module
- •Very stable
- •CMOS/TTL output
- •Patented Laser Trimmed
- •5Vdc. 0.8mA (HRR6)
- •2kHz data rate
- •Sensitivity -105dBm
- •38 x 12 x 2 mm

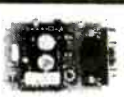
AM-HRR6-xxx... $16.33

FM Transceiver

- •Only 23 x 33 x 11mm
- •Up to 40,000bps data rate
- •Up to 450ft. range.
- •5V operation
- •418MHz or 433MHz FM
- •5V CMOS logic interface
- •Fast 1mS enable
- •Power saving feature
- •Carrier Detect output

BiM-xxx-F $87.36

RS232 Transceiver



- •3wire RS232 interface
- •19.2Kbps half duplex
- •418MHz or 433MHz FM
- •7.5-15Vdc. 20mA
- •TX/RX Status LED's
- •Up to 400ft. range
- •1/4 wave ant. on board
- •User data packetizing
- •58 x 40 x 15mm

CYPHERNET $139.30

AM Transmitter

- •Range up to 250ft.
- •SAW controlled stability
- •Wide supply range 2-14V
- •CMOS/TTL input
- •Low current. 4mA typ.
- •Up to 4kHz data rate
- •Small: 17 x 11mm

AM-RT5-xxx $12.10

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- • 8 CHANNEL 8 BIT A/D/ IN
- • 12 BIT COUNTER
- • UP TO 14K SMP/SEC

MODEL 45 ..... $189

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- • 2 ANALOG OUTPUTS
- • 2 COUNTERS-24 BIT

MODEL 100 ..... $279

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- • 8 ANALOG INPUTS
- • PWM OUTPUT

MODEL 70 ..... $239

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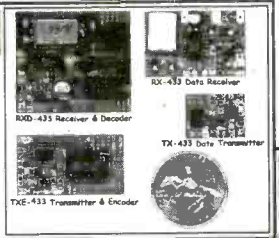
RAMSEY

Doppler Direction Finder

Track down jammers and hidden transmitters with ease! This is the famous WA2EBY DF'er featured in April 99 QST. Shows direct bearing to transmitter on compass style LED display, easy to hook up to any FM receiver. The transmitter - the object of your DF'ing - need not be FM, it can be AM, FM or CW. Easily connects to receiver's speaker jack and antenna, unit runs on 12 VDC. We even include 4 handy home-brew "mag mount" antennas and cable for quick set up and operation! Whips can be cut and optimized for any frequency from 130-1000 MHz. Track down that jammer, win that fox hunt, zero in on that downed Cessna - this is an easy to build, reliable kit that compares most favorably to commercial units costing upwards of $1000.00! This is a neat kit!!

DDF-1, Doppler Direction Finder Kit $149.95

Wireless RF Data Link Modules



RF link boards are perfect for any wireless control application; alarms, data transmission, electronic monitoring...you name it. Very stable SAW resonator transmitter, crystal controlled receiver - no frequency drift! Range up to 600 feet, license free 433 MHz band. Encoder/decoder units have 12 bit Holtek HT-12 series chips allowing multiple units all individually addressable, see web site for full details. Super small size - that's a quarter in the picture! Run on 3-12 VDC. Fully wired and tested, ready to go and easy to use!

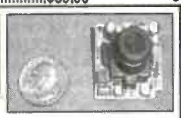
RX-433 Data Receiver..... $16.95 TX-433 Data Transmitter..... $14.95
RXD-433 Receiver/Decoder..... $21.95 TXE-433 Transmitter/Encoder..... $19.95

World's Smallest TV Transmitters

We call them the 'Cubes'.... Perfect video transmission from a transmitter you can hide under a quarter and only as thick as a stack of four pennies - that's a nickel in the picture! Transmits color or B&W with fantastic quality - almost like a direct wired connection to any TV tuned to cable channel 59. Crystal controlled for no frequency drift with performance that equals models that cost hundreds more! Basic 20 mW model transmits up to 300' while the high power 100 mW unit goes up to 1/4 mile. Their very light weight and size make them ideal for balloon and rocket launches, R/C models, robots - you name it! Units run on 9 volts and hook-up to most any CCD camera or standard video source. In fact, all of our cameras have been tested to mate perfectly with our Cubes and work great. Fully assembled - just hook-up power and you're on the air! One customer even put one on his dog!

C-2000, Basic Video Transmitter.....$89.95 **C-2001, High Power Video Transmitter...$179.95**

CCD Video Cameras



Top quality Japanese Class 'A' CCD array, over 440 line line resolution, not the off-spec arrays that are found on many other cameras. Don't be fooled by the cheap CMOS single chip cameras which have 1/2 the resolution, 1/4 the light sensitivity and draw over twice the current! The black & white models are also super IR (Infra-Red) sensitive. Add our invisible to the eye, IR-1 illuminator kit to see in the dark! Color camera has Auto gain, white balance, Back Light Compensation and DSP! Available with Wide-angle (80º) or super slim Pin-hole style lens. Run on 9 VDC, standard 1 volt p-p video. Use our transmitters for wireless transmission to TV set, or add our IB-1 Interface board kit for super easy direct wire hook-up to any Video monitor, VCR or TV with A/V input. Fully assembled, with pre-wired connector.

CCDWA-2, B&W CCD Camera, wide-angle lens $69.95
CCDPH-2, B&W CCD Camera, slim fit pin-hole lens.. $69.95
CCDCC-1, Color CCD Camera, wide-angle lens $129.95
IR-1, IR Illuminator Kit for B&W cameras $24.95
IB-1, Interface Board Kit $14.95

AM Radio Transmitter

Operates in standard AM broadcast band. Pro version, AM-25, is synthesized for stable, no-drift frequency and is setable for high power output where regulations allow, typical range of 1-2 miles. Entry-level AM-1 is tunable, runs FCC maximum 100 mW, range 1/4 mile. Both accept line-level inputs from tape decks, CD players or mike mixers, run on 12 volts DC. Pro AM-25 includes AC power adapter, matching case and bottom loaded wire antenna. Entry-level AM-1 has an available matching case and knob set that dresses up the unit. Great sound, easy to build - you can be on the air in an evening!

AM-25, Professional AM Transmitter Kit..... $129.95
AM-1, Entry level AM Radio Transmitter Kit... $29.95
CAM, Matching Case Set for AM-1..... $14.95

Mini Radio Receivers

Imagine the fun of tuning into aircraft a hundred miles away, the local police/fire department, ham operators, or how about Radio Moscow or the BBC in London? Now imagine doing this on a little radio you built yourself - in just an evening! These popular little receivers are the nuts for catching all the action on the local ham, aircraft, standard FM broadcast radio, shortwave or WWV National Time Standard radio bands. Pick the receiver of your choice, each easy to build, sensitive receiver has plenty of crystal clear audio to drive any speaker or earphone. Easy one evening assembly, run on 9 volt battery, all have squelch except for shortwave and FM broadcast receiver which has subcarrier output for hook-up to our SCA adapter. The SCA-1 will tune in commercial-free music and other 'hidden' special services when connected to FM receiver. Add our snazzy matching case and knob set for that smart finished look!

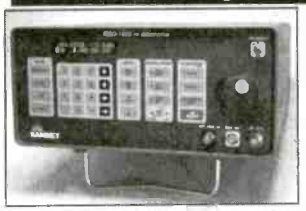
AR-1, Airband 108-136 MHz Kit..... $29.95
HFRC-1, WWV 10 MHz (crystal controlled) Kit $34.95
FR-1, FM Broadcast Band 88-108 MHz Kit $24.95
SR-1, Shortwave 4-11 MHz Band Kit $29.95
SCA-1 SCA Subcarrier Adapter kit for FM radio.... $27.95
FR-6, 6 Meter FM Ham Band Kit $34.95
FR-10, 10 Meter FM Ham Band Kit..... $34.95
FR-146, 2 Meter FM Ham Band Kit..... $34.95
FR-220, 220 MHz FM Ham Band Kit..... $34.95
Matching Case Set (specify for which kit) $14.95

PIC-Pro Pic Chip Programmer

Easy to use programmer for the PIC16C84, 16F84, 16F83 microcontrollers by Microchip. All software - editor, assembler, run and program - as well as free updates available on Ramsey download site! This is the popular unit designed by Michael Covington and featured in Electronics Now, September 1998. Connects to your parallel port and includes the great looking matching case, knob set and AC power supply. Start programming those really neat microcontrollers now...order your PICPRO today!

PIC-1, PICPRO PIC Chip Programmer Kit $59.95

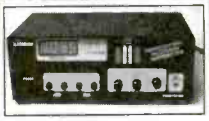
1 GHz RF Signal Generator



A super price on a full featured RF signal generator! Covers 100 KHz to 999.99999 MHz in 10 Hz steps. Tons of features; calibrated AM and FM modulation, 90 front panel memories, built-in RS-232 interface, +10 to -130 dBm output and more! Fast and easy to use, its big bright vacuum florescent display can be read from anywhere on the bench and the handy 'smart-knob' has great analog feel and is intelligently enabled when entering or changing parameters in any field – a real time saver! All functions can be continuously varied without the need for a shift or second function key. In short, this is the generator you'll want on your bench, you won't find a harder working RF signal generator - and you'll save almost $3,000 over competitive units!

RSG-1000B RF Signal Generator $1995.00

Super Pro FM Stereo Transmitter



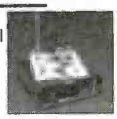
Professional synthesized FM Stereo station in easy to use, handsome cabinet. Most radio stations require a whole equipment rack to hold all the features we've packed into the FM-100. Set freq with Up/Down buttons, big LED display. Input low pass filter gives great sound (no more squeals or swishing from cheap CD inputs!) Limiters for max 'punch' in audio - without over mod, LED meters to easily set audio levels, built-in mixer with mike, line level inputs. Churches, drive-ins, schools, colleges find the FM-100 the answer to their transmitting needs, you will too. Great features, great price! Kit includes cabinet, whip antenna, 120 VAC supply. *We also offer a high power export version of the FM-100 fully assembled with one watt of RF power, for miles of program coverage. The export version can only be shipped if accompanied by a signed statement that the unit will be exported.*

FM-100, Pro FM Stereo Transmitter Kit $249.95
FM-100WT, Fully Wired High Power FM-100..... $399.95

FM Stereo Radio Transmitters

No drift, microprocessor synthesized! Great audio quality, connect to CD player, tape deck or mike mixer and you're on-the-air. Strapable for high or low power! Runs on 12 VDC or 120 VAC. Kit includes snazzy case, whip antenna, 120 VAC power adapter - easy one evening assembly.

FM-25, Synthesized Stereo Transmitter Kit $129.95



Lower cost alternative to-our high performance transmitters. Great value, easily tunable, fun to build. Manual goes into great detail about antennas, range and FCC rules. Handy for sending music thru house and yard, ideal for school projects too - you'll be amazed at the exceptional audio quality! Runs on 9V battery or 5 to 15 VDC. Add matching case and whip antenna set for nice 'pro' look.

FM-10A, Tunable FM Stereo Transmitter Kit..... $34.95
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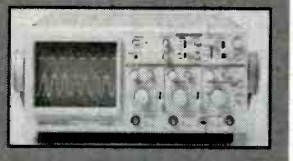

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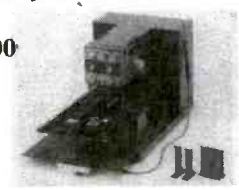

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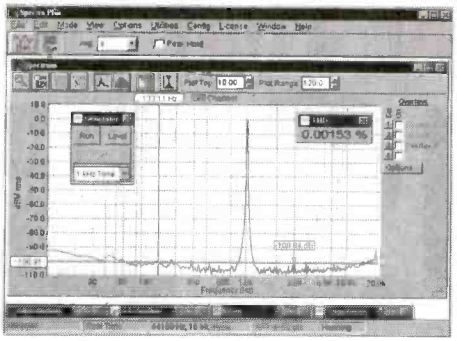

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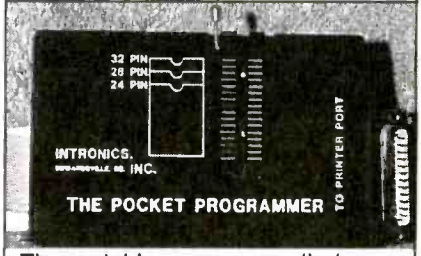

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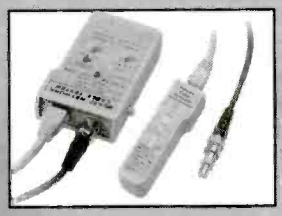

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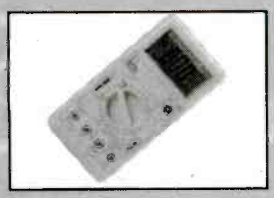

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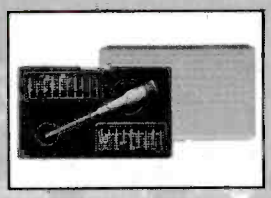

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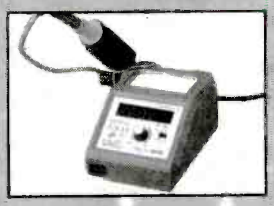

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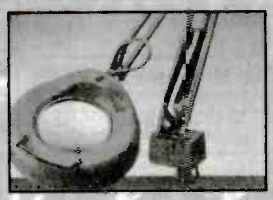

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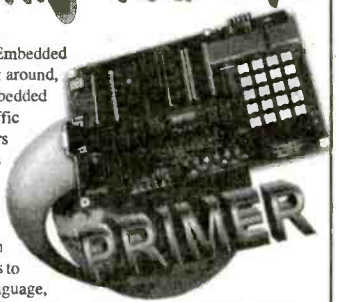

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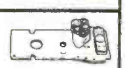

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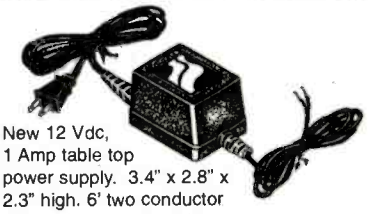

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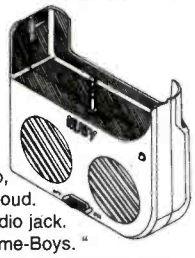

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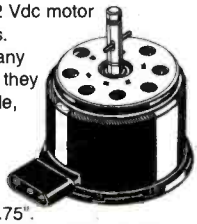

Bosch. Powerful new 12 Vdc motor with replaceable brushes. Purchased from a company making electric bicycles, they were used two per bicycle, powered with a 24 Volt battery pack. May have originally been fan motors for Ford automobiles. 4" diameter x 2.75". 0.31" (5/16") diameter shaft is 1.2" long. No load Rating: 2200 RPM @ 12 Vdc @ 2.8 Amps. Weight: 3.25 lbs. 0.25" quick-connect terminals.

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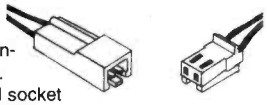

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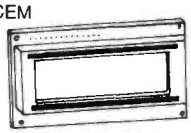

Optrex # DMC 20434-CEM (PWB 20434-CEM) 5 x 8 dot format. 3" x 1" viewing area. 3.88" x 2.38" module. Removed from new equipment. May have felt padding on metal bezel. 14 pin single row header is pre-attached. Spec/hook-up sheet included.

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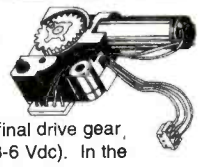

Omron # R2DG-41 Built-in control circuits allow this motor to be used in a continuous or a pulsed mode. In continuous mode the final drive gear turns at 22-45 RPM (3-6 Vdc). In the pulsed mode the final drive gear turns one revolution each time the controller is momentarily pulsed. The motor assembly is 1.75" x 1.25" x 0.5" overall. The nylon final gear is 0.62 diameter and has a little nipple slightly off-center to which a small push-rod could be attached. Motors are in good condition, removed from equipment. Hook-up instructions included.

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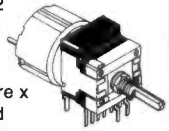

Alps Electric # 726T-10KBX2 Dual 10K linear pot powered by a small reversible 6 Vdc gearhead motor. Pot and motor assembly are 1" square x 1.7" long excluding shaft and bushing. 6 mm flatted shaft is 0.5" long. 9mm threaded bushing. PC pins and mounting tabs for pc board mounting.

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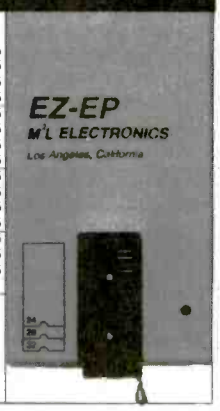

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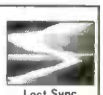
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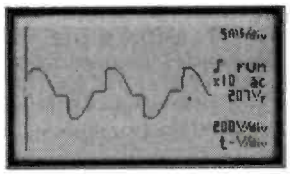

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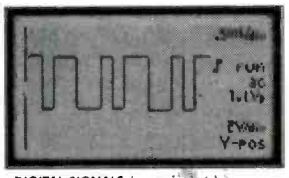
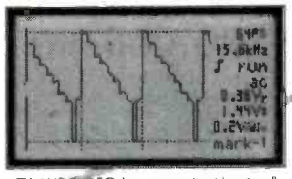


DIGITAL SIGNALS (e.g. pulse train)



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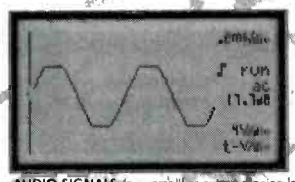

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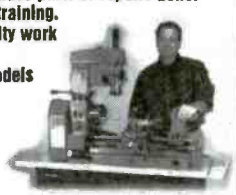

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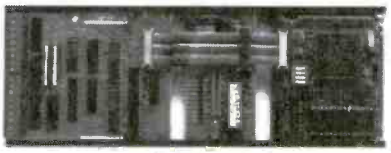

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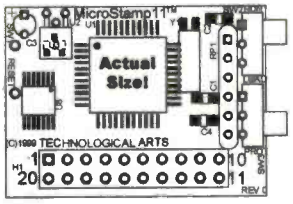

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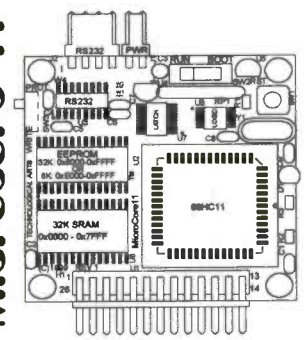

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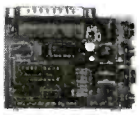

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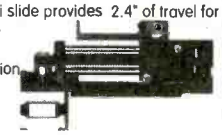

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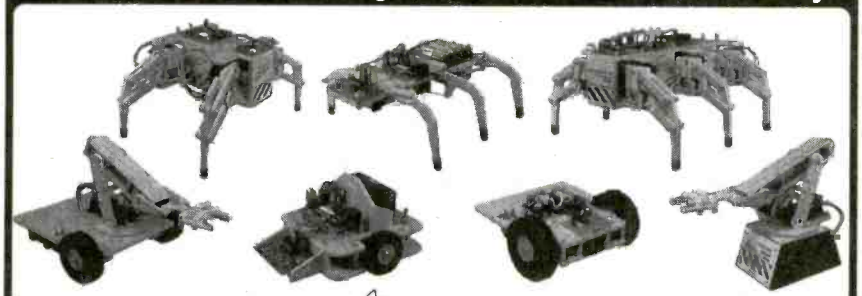

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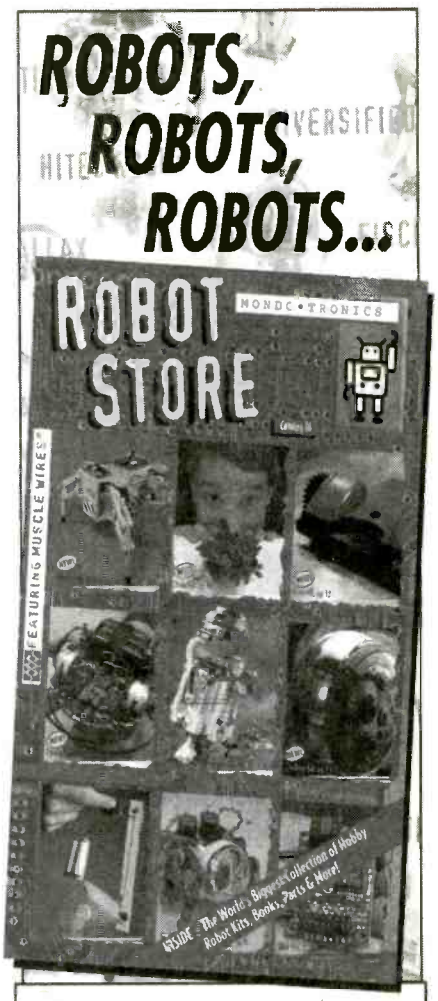

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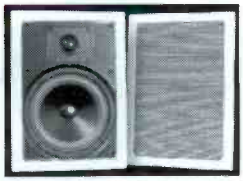

This is our most popular in-wall. You won't believe how good these really sound. Big enough to produce great home theatre sound and still fit everyone's budget. Put a pair in every room of your house. Great for front or rear speakers in your surround system. The 6-1/2" polypropylene woofer and 1" textile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

#300-036 ..... **$89.90**$_{(1\text{-}3\ PRS)}$ **$79.50**$_{(4\ PRS\text{-}UP)}$

Satellite Speaker Stands

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

#240-762 ..... **$39.80**$_{(1\text{-}3\ PRS)}$ **$35.50**$_{(4\ PRS\text{-}UP)}$

5 Function Remote

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

#180-806 ..... **$29.95**$_{(1\text{-}3)}$ **$26.95**$_{(4\text{-}UP)}$

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

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

#350-052 ..... **75¢**$_{(1\text{-}9)}$ **59¢**$_{(10\text{-}UP)}$

Gold Plated A/V Cables

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

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

6-1/2" Round Coaxial System

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

#300-408 ..... **$69.95**$_{(1\text{-}3\ PRS)}$ **$62.75**$_{(4PRS\text{-}UP)}$

3 Amp Power Supply

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

#120-530 ..... **$19.95**$_{(1\text{-}3)}$ **$18.50**$_{(4\text{-}UP)}$

DMM and LCR Meter

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

#390-513 ..... **$85.90**$_{EACH}$

2.5W Mini Audio Amplifier

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

#320-215 ..... **$9.95**$_{EACH}$

Weller WLC100 Soldering Station

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

#372-120 ..... **$39.95**$_{EACH}$

KESTER "44" Solder

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

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

Pro Wick

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

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

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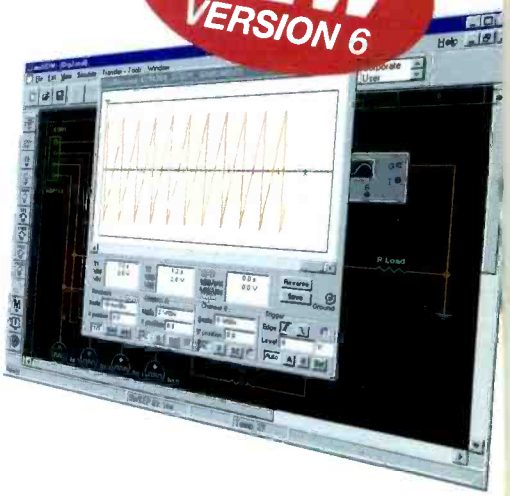

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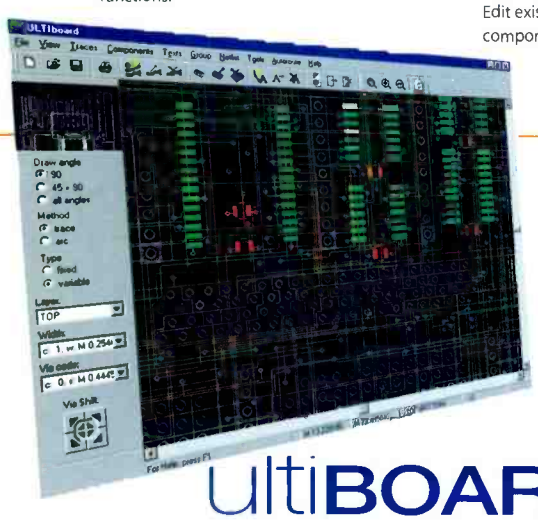

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