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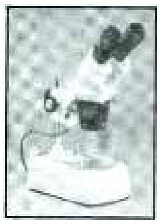

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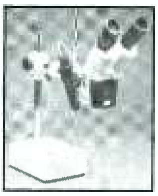

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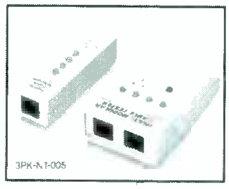

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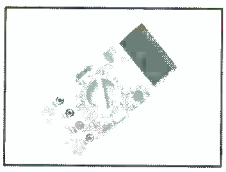

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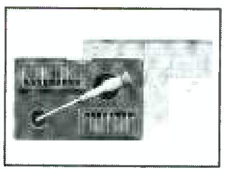

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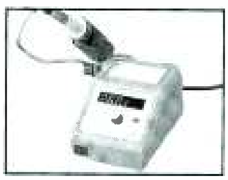

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February 2001, Vol. 2, No. 2

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The World's Worst Manual

A few weeks ago, I received a press release that made my initial chuckles grow to guffaws and full-blown belly laughs. Throughout the morning, I was flooded by inter-office messages from the rest of the staff begging and pleading, "Please, can we cover this somehow? Please? Please? Can we?"

The announcement that created this stir was from Jim Desmond, president of Technical Standards, Inc., a San Marcos, California documentation-services company. Rather than rehash his message, let's have Mr. Desmond speak for himself:

"Have you ever been so frustrated with a manual or set of instructions that you cursed the author and wished you had never bought the product? Do you remember the last time you used Help on your computer and every click of the mouse led to a new set of decisions?

"Does this sound familiar? How about $500 for your frustration? TSI is offering $500 for the winning entry in their "Worst Manual Contest." Send a manual or set of instructions that is hard to understand, poorly written, or just plain wrong. Send it if it has bad grammar, too much legalese, is poorly translated, or has missing steps. If it is the worst entry, you will win $500.

'We thought we would have fun with this contest. Everyone has had trouble with a manual,' says Michelle Wier, Director of Operations of TSI. 'That's why we started our company. People like products they understand how to use, and good technical documentation reduces the need for technical support. That's why good manuals are so important.'

"You don't have to send the whole manual; excerpts of the worst parts are okay. The deadline for submissions is January 15, 2001, so check those holiday gifts for potential entries. Entries must be in English. For complete contest rules, see the TSI Web site at *www.tecstandards.com*."

A quick check of the **Poptronics** calendar shows that this issue hits the newsstands just after the New Year. That being the case, get busy; you've got about two weeks. Let's see if we can make a **Poptronics** reader the winner.

Joseph Suda
Managing Editor

Colorburst Adjustments

I offer the following corrections to the article "A Colorburst-Based Frequency Reference" in the September issue.

This circuit was presumably originally designed to use a 74LS04 for IC2, since the unused inputs are left open-circuited. This is common (though poor) practice with TTL logic, since they will rise to a logic 1 level automatically. With a high-speed CMOS 74HC04 however, it is exceedingly poor practice to do this since the near-infinite input resistance will cause the input voltages to float around in the linear- and current-drawing range of the input transistors and cause excess and variable current drain by the IC. Because of the high gain, if the input voltage floats to around the transition point, the outputs can even have an oscillation or amplified noise present. This is prevented by tying the unused inputs, pins 3, 5, 9, 11, and 13, to either ground or +5 volts. Also, the power and ground connections for IC2, which are pins 14 and 7 respectively, are not shown on the schematic.

The text mentions the possibility of extracting vertical sync from IC3, but does not say how. Vertical sync is present at pin 3, composite sync at pin 1, and odd/even field information at pin 7.

Figure 1 has a typo: 1400 IRE should read 140 IRE.

The 14.318 crystal is not adequately specified. These are available with either series-resonant or parallel-resonant calibration, and in this circuit it appears an 18-pF load-capacitance crystal should be purchased. As a fussbudget, I object to the moving piezoelectric quartz element being shown as grounded in the schematic. In reality, of course, it is just the metal surrounding can that is grounded. A preferable approach, which gives some shock resistance to the breakable crystal, is to instead mount it on a piece of double-stick foam instead of hard-fixing it to the board. Since we started doing this with our products, we have had zero problems with fractured crystals.

The 75-ohm termination of the input should, I think, be a rear-panel switch instead of a hidden internal jumper. But that's just me.

Otherwise, this was a very useful and informative issue.

CLIVE TOBIN
Tacoma, WA

Dangerous Computers

I would like to add my comments to those of Reid Goldsborough in "Surveying the Digital Domain," October 2000, in which he discusses health risks and Web computing. I have problems with focusing and blurry vision, mostly after using a fluorescent backlit LCD laptop. I have always heard it wasn't good to read under fluorescent lighting; it's got to be worse having such light staring you in the face. I don't seem to have problems with regular monitors. Now with the new monitors going LCD, what more risks are there in the future?

I don't trust putting data on the Web, which I think happens whenever you use online software. Would our National Security Agency use software such as this?

A few months ago, I went to *kbb* and *edmund.com* to evaluate the price of a used automobile. Since then, I get at least six e-mails spams daily for automobiles and loans. If people can get your information this way, they surely can find a blueprint of your data on the Web somewhere. The best security is to have your own software and pull the phone plug when not online.....and be very careful when online.

LARRY LAYMON
Rockwood, TN

[You've got some good points—especially on the use of the Internet. However, I think that pulling the phone plug is a bit drastic, unless you have some type of computer virus or Trojan Horse that can dial out for you. The spam that you speak of is not difficult for Web sites to harvest; that type of information is routinely divulged by your browser when receiving Web-page data. If you're that concerned about privacy and security (which we all should be), look into "proxy servers;" servers that fetch Web pages for you without revealing your browser information. Some of them also handle cookies as well.—Editor.]

KEEP IN TOUCH

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

You can write via snail mail to:

Letters
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Editorial Remarks

Your editorial in the October issue "Whose Copyright Is It Anyway?" was interesting, but let's be fair. A "hit" song takes a lot more than the notes and lyrics. The performing artists, the recording, the arrangements, the packaging the promotion, the P/R— all go together to make a "hit." Who pays for all of that? Who "fronts" the money or takes the gamble to pay for all of these ingredients in the hopes of making a "hit?" The record producers. It's great that Napster pays the author of the song, but his song would most likely NOT be a hit without all of the investment of the record producers/labels. They ARE entitled to get paid for their "gamble."

History is full of examples of "great" songs that lay dormant until all of the ingredients came together. A classic example is "What a Wonderful World," which was a nothing song until the

Louis Armstrong recording was used in *Good Morning Vietnam*. It took the exposure, packaging, and marketing.
GORDON WOLFE
via e-mail

[Your comments are quite correct, and ones that, although a part of the first draft of the editorial, couldn't be addressed in the magazine's limited space. However, there's a deeper issue brewing under the surface. Sure, anyone who invests in something should be able to reap the rewards of their gamble. Sadly, most musicians are not a part of that mix. How many times has a band never gotten a break because the record companies want to keep the market locked up? How many times has a band been signed to a contract by one company to keep said talent away from a competitor...and never allowed to record or perform their music?

How many times have you bought a CD because you only wanted one song, and found that the rest of the CD's content was, well, not up to par? Napster and MP3.com have both shown that there's an untapped market for selling individual songs. Does anybody remember the Personics system from the 1980s? You selected what songs or sound effects you wanted and their order. A few hours later, your custom cassette was ready. Although it was extremely expensive (one album for the price of three), every song was a guaranteed hit. What's more, the artist and record companies were compensated. I understand that a new system, based on CD-R technology, is being developed and test-marketed.—Editor.]

Whose Copyright Is It, Anyway?

In the Editorial in the October issue, Chris Rupert's comparison of .MP3 sharing to someone scanning and posting an issue of **Poptronics** is undermined by a prior action of the RIAA. They succeeded in getting Congress to enact a tax on audio-certified CD-R media that compensates them for the copying of copyrighted material.

If someone is creating CDs from .MP3 downloads to play on standard players using one of those appliance store recorders that demands those taxed disks, then they are not stealing from RIAA. However, since most .MP3 files stay in the .MP3 format (i.e. are not downloaded to disks), the taxed disks would not fairly compensate the artist anyhow.

I would prefer to pay by the successful download (don't forget that connections fail).

I wonder why neither the RIAA nor BMG nor Sony has set up a site where honest people could download music files for a reasonable fee. I suspect it is because they fear extra copies will be made, so their all-or-nothing stance earns them nothing.

The only reason I use Napster is that the obscure stuff I like is mostly out of print; and, even if it is available, I don't want to buy 20 songs to get just one (there is no digital equivalent to the old 45 RPM single). I can't think of another industry that refuses to sell its products to a market ready, willing, and able to buy it.
DENNIS L. GREEN
Detroit, MI

[A good point on the pre-taxed CD-Rs; I didn't know that the "piracy" tax on blank cassettes was extended to the "next-generation" format.—Editor.]

Basic Circuitry Comments

I disagree with Randy Heisserman's comments on "Basic Circuitry" in the October "Letters" column. I feel that "Basic Circuitry" is okay just the way it is. After all, it is supposed to cover the basics. In my view, the simple circuits presented in the column are little "add-ons" to larger circuits or something that could be used to prove a theory or an experiment.

By the way, there is a typo in "Q&A" in the same issue. In "Wrong Answer to Scanner Question," TRB's letter should have been cited as being in the May not the March issue.

Lastly, I want to build a battery-powered three-band equalizer for my radio. I would like to suggest this project as a future article.
RAUL ROSADO
Bronx, NY

*[Thanks, Raul. We feel the same way. "Basic Circuitry" is a teaching tool for the "newbie" in all of us, no matter how experienced we are. After all, if the subjects progressed to more advanced topics, how would the next crop of novice hobbyists get up to speed? Remember, folks, every month, someone is discovering **Poptronics** for the first time.—Editor.]*

Basic Circuitry Applause

I have always enjoyed Charles Rakes' "Basic Circuitry" column and have been a reader of your publications since 1972. Just wanted to let you know that I really enjoyed your simple test circuits in The September 2000 issue of **Poptronics**. I built them all into a small box and they add ready-to-go features to my test bench. Because I then had no further excuses, I went through the piles of semis in my junk box collected over decades and sorted them all out!
HOWARD KRAUSSE
via e-mail

Superconductor Experiment Exchange

In reading John Iovine's "Amazing Science" column, entitled "Superconductors, Part II" (**Poptronics**, September 2000), I noticed an error in his second experiment section about making a Frictionless Magnetic Bearing. The major component of friction is not from air resistance, but from some of the magnetic flux lines that are trapped in the superconductor. A demonstration to verify these flux lines is to tilt the superconductor with a floating magnet and notice that the magnet does not easily slide away.

(Continued on page 53)

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Digital Multimeter

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DESIGNED TO MEET THE NEEDS of plant maintenance, electrical, control, and process technicians, the *Fluke 180 Series Digital Multimeters* provide .025% accuracy and 50,000 counts of resolution. The top-of-the-line Model 189 can store up to 1000 measurements in stand-alone operation, allowing users to log data based on events or time, or to log the data manually. This model has a bright red two-level LED backlight, as well as an enhanced LCD with larger digits and a wide viewing angle. All measurements are available for later viewing on the meter's display that includes a real-time clock.

Both the 187 and 189 meters measure volts, ohms, amps, capacitance, and continuity, as well as temperature in Celsius and Fahrenheit. In addition to relative mode and Min/Max/Average, there's a 250-µs Fast Min/Max capability for capturing peak transients.

The design of the 180 Series makes for ease of use and handling. The ergonomic case houses the multiple reading display that provides simultaneous readouts, such as true rms AC and DC, as well as Hertz, dB, and mV DC. The closed-case-calibration feature allows calibration adjustments to be made directly from the front panel or through the infrared port. The battery access door enables the user to change batteries and fuses without breaking the calibration seal.

The Fluke 189 can be loaded with the optional *FlukeView Forms* software, which enables users to maximize the 189's logging capability through template-driven custom reporting. This software is ideal for documenting test procedures for new equipment installation. Other accessories for the 187 and 189 include a ToolPak that provides strap and magnet hangers for hands-free use and the LockPak for locking them. The meters come complete with probe holder, test leads, and a manual (available in 16 languages).

The Fluke 180 Series Digital Multimeters range in price from $379 for Model 187 to $399 for Model 189.

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CIRCLE 63 ON FREE INFORMATION CARD

A small handheld tester, the Model 240 allows users to quickly read the status of Ethernet twisted pair cables—testing for faults such as open circuits, shorts, crossed pairs, reversed pairs, and split pairs in seconds. Its tone generator feature can be used to trace installed cables and locate areas of discontinuity. When used with any tone generator, the *Model 240P Probe* can trace cables and locate faults, even when cables are in a bundle or are hidden. The Probe is equipped with a tone amplifier and an LED indicator that detects audible frequency tones for accurate tracing and identification of wires.

The Model 240 Remote Network Cable Analyzer and Model 240P Probe have suggested retail prices of $169 and $59, respectively.

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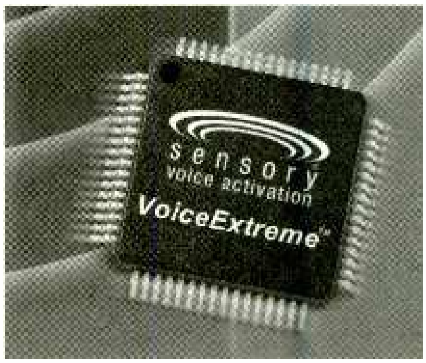

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(Continued on page 12)

NEW LITERATURE

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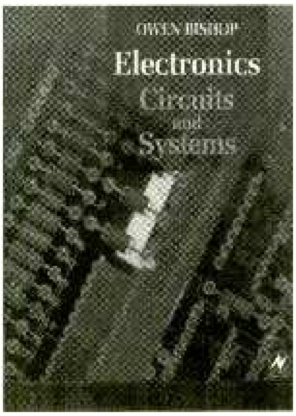
Geared for a range of college courses, this textbook uses a student-centered approach. Key facts, formulae, and definitions are highlighted; and theories are supported by numerous examples.



Subjects covered include circuits, FET and BJT amplifiers, and oscillators. There are also chapters on telecommunication systems, radio communications, microelectronic systems, and programming and computer routines. Each chapter ends with a problem set, which includes exam-style and multiple-choice questions.

Building Linux Clusters

by David HM Spector
O'Reilly and Associates, Inc.
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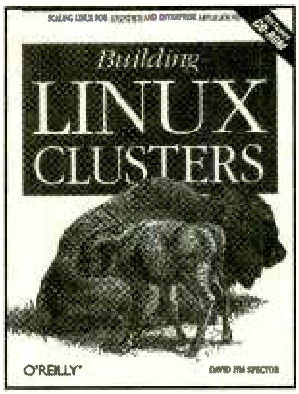
One of the hottest topics in Linux today is the ability to cluster Linux machines to mimic the performance of supercomputers (costing hundreds of thousands of dollars) for a fraction of the cost. This hands-on guide introduces the basics of



cluster installation and configuration.

In addition to a step-by-step tutorial on how to install Linux on a cluster of machines, the book explains how to customize the installation and discusses parallel programming. It also offers tips on parallelizing existing software. An included CD-ROM with Red Hat Linux customized for clustering support enables readers to build a fully functional cluster right from the box.

Modern High-End Valve Amplifiers

by Ir. Menno van der Veen
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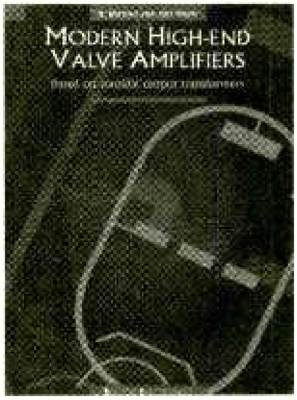

this book focuses on valve amplifiers (British)—or vacuum-tube amplifiers (American)—that are based on toroidal output transformers. It starts with elementary concepts and culminates in complete mathematical descriptions. Do-it-yourself-ers and general readers will come away with an in-depth understanding of the subject.

Interactions of output valves, transformer, and loudspeaker are fully explained. In addition, there is material on a number of special valve amplifiers and on the theory and practice of negative feedback. The schematic diagram of the valve amplifier is examined in detail, in connection with designs for amplifiers with output powers ranging from 10 to 100 watts.

Hints & Kinks for the Radio Amateur, 14th Edition

Edited by Robert Schetgen
and David Newkirk
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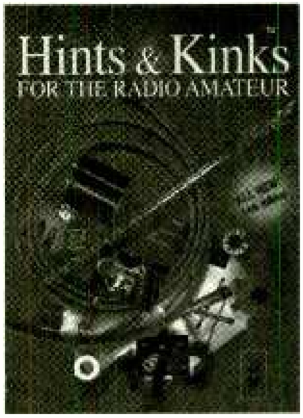


Commercial or home-brew, antenna or mike, keyer or computer—radio gear can always be made to work better and more efficiently. Hams who love to tinker with and tune their equipment also love to share their techniques with others.

(Continued on page 44)

A LOOK AT
TOMORROW'S TECHNOLOGY

PROTO

Business Buzz

THE INTERNET-ENABLED CAR

The automotive industry is exploring the vehicle of the future. At the same time, members of the Open Services Gateway Initiative (OSGi)—an independent, non-profit corporation composed of 75 technology companies—are working to develop automotive solutions for the network delivery of managed services to the automobile, using the OSGi Specification Release 1.0 as the platform. This specification defines an open framework that enables multiple software services to be loaded and run on a services gateway. Once placed in a vehicle, an OSGi-compliant services gateway enables the delivery of managed services and information to the vehicle on demand, applications from remote door lock/unlock, on-demand navigation, and remote diagnostics to banking, entertainment, and Web browsing.

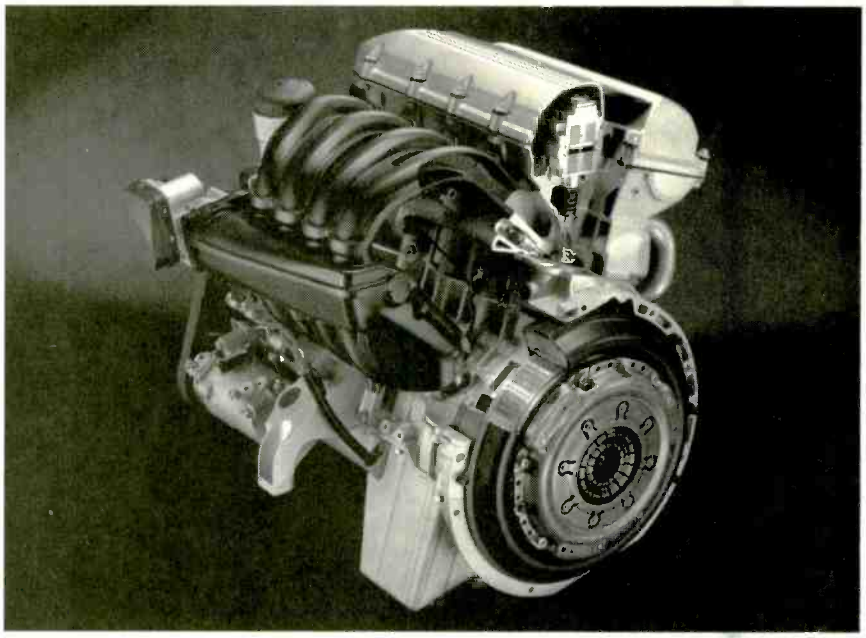
COPPER TECHNOLOGY

Two new production processes introduced by ACM Research Inc. solve major challenges in the use of copper interconnects for integrated circuits with line widths from 0.13 microns and beyond. Two prototype production tools based on these processes will enable the deposition of copper interconnects on silicon wafers down to the 0.035-micron device generation and the stress-free polishing of copper-integrated dielectrics with a value of 1.5, regardless of wafer size. Both systems are capable of operating with manual loading of 200-mm silicon wafer cassettes or automated guided vehicle loading of 300-mm wafers.

BOUNDLESS BATTERIES

Under contract to the NASA Goddard Space Flight Center, Boundless Corp. is developing a unique "structural battery" delivering twice as much power-per-kilogram as current batteries. Under the three-year contract, Boundless will build batteries for tiny satellites, or nanosats. In some space missions, dozens of inexpensive nanosats may work more reliably than one large, complex satellite. In the design, custom lithium-polymer battery panels make up the spacecraft's hull. This reduces overall vehicle weight by eliminating the stand-alone battery plus its supporting structure and enclosure.

Loaded 42-Volt Electrical Systems



This BMW engine features a 42-volt starter/alternator that drives an electromechanical valvetrain.

Heated seats and windshields, cell phones, navigation systems, computers with Internet access, and other electrically powered items are constantly being added to vehicles. It is clear that today's nominal 14-volt DC electrical systems and 12-volt batteries will not be able to handle the power requirements of future cars, light trucks, vans, and sport utility vehicles. Current luxury vehicles typically use up to 2.8 kW of power, and this is expected to double within the next five years. Even today there are vehicles where the radio may cut out momentarily under sustained braking when the overall electrical load becomes too great. Further compounding the problem will be the many pollution-reducing technologies that will require substantial amounts of electrical power like catalytic converters that are preheated to reduce emissions at startup and electromagnetically controlled engine valvetrains.

The MIT/Industry Consortium on Advanced Automotive Electrical/Electronic Components and Systems was established a few years ago to find solutions to these potential problems. Sponsored by the Society of Automotive Engineers, the consortium now includes 44 automakers and their suppliers. The consortium is advocating a 42-volt system with a 36-volt battery.

More Electric Power

Switching over to 42 volts could bring big changes in how things are done under the hood, besides making more electrical power available. For starters, 42-volt systems could eliminate power-robbing and heat-producing pumps, such as the belt-driven water pump and the power steering pump, as well as the air-conditioning compressor. Instead, the 42-volt system could be used for steer-by-wire power steering (See "Prototype," January 2001) and brake-by-wire power brakes, which operate and consume energy only when needed. Likewise, electrically powered air conditioning and heating would provide climate control even when the vehicle is parked with the engine off. These changes could result in a 5, 10 or even 20% reduction in engine energy consumption, which translates into more mpgs, and less emissions. These "beltless" systems would also allow designers much more flexibility in where engine parts are located, so that they could be placed just about anywhere in the vehicle—not only in already crowded engine compartments.

More Environmental Friendliness

One way to consume less fuel and reduce emissions is to shut off the engine when not needed, even for short periods, such as when waiting for a traffic light to change to green. A 42-volt electrical system would allow the use of stop-start engines that would be shut down rather than idling. One example is DynaStart developed by Mannesmann VDO AG in Germany. This combination starter and alternator, which is designed for stop-start operation, is planned for an upcoming, but yet unannounced, German production car. Siemens AG also has a 42-volt system starter-alternator-flywheel system in the works. Siemens' system will have peak output of 8 kW with up to 15 kW for brief periods. Its efficiency of over 80% is a marked improvement over current 12-volt systems with 1.5 kW output and a maximum efficiency of 70% that drops to 30% at high speed.

Are We There Yet?

The first 42-volt systems could appear in Europe as early as 2003, but a surprise introduction by Japanese automakers is definitely possible. Most likely, such systems will first appear in luxury cars, where power demands are the greatest and customers are more willing to pay extra for new technology. Initially, dual or hybrid systems would probably be used. There would be 42 volts available for power steering, power brakes, and air conditioning, while 14 volts could still be available for lighting and AM/FM/stereo systems. DC-to-DC converters would be used on 14/42-volt systems to transform 42-volt currents to 14-volt for lights and other low-power applications. However, one manufacturer, BMW, says it would use 42 volts exclusively and as early as 2004.

Switching to 42 volts requires changing virtually every electric component from connectors and wiring to alternators and switches. This overall change would provide an added benefit, since wiring cable bulk and weight can be reduced by half or two-thirds because the lower current of the higher-voltage system means smaller diameter wiring. **—by Bill Siuru** PT

Powering The Future: Fuel Cell Research

The energy source that powered the Space Shuttle, Apollo, Skylab, and Gemini spacecraft might one day operate your portable phone, your car, and your neighborhood's electric power plant. This source—the fuel cell—is a primary focus of a new research center at the Georgia Institute of Technology. The Center for Innovative Fuel Cell and Battery Technologies will take a multidisciplinary approach to fuel cell and battery-related research, said center director Dr. David Parekh.

A fuel cell is an electrochemical device that operates much like a battery. (Also see the discussion of fuel cells in the "Amazing Science" column.) It combines hydrogen fuel with oxygen to produce electricity and heat, releasing water as a byproduct. Fuel cells are a clean, environmentally friendly, versatile, reliable, and efficient power source. Research is being conducted worldwide in this area with the goal of developing more sustainable energy sources. Additionally, recent research at Georgia Tech on fuel cells and related electrochemical devices has led to the invention of several processes that enable waste streams from commercial chemical manufacturing to be profitably recycled

Research Notes

WHERE ARE THE HOTSPOTS?

Researchers at Penn State's Microsystems Design Laboratory have developed a new energy estimation tool, called SimplePower, that not only evaluates a system-on-a-chips' power consumption faster than other available techniques but also points out the power-hungry "hotspots" in both hardware and software so that designers can fix them. Software is becoming an important aspect of emerging embedded systems and the study of the integrated impact of software and hardware optimization needs to be supported with new tools. SimplePower uses a "generic" chip—the instruction set of Simplescalar, which is a suite of publicly available tools to simulate modern microprocessors. In addition, SimplePower is based on input transitions rather than input statistics. The developers are planning to make the prototype package available at *www.cse.psu.edu/~mdl.*

CHEAP CHIPS

Engineering faculty at The University of Texas at Austin have created a process with the potential to make the smallest, fastest, and cheapest computer chips. The new method uses simple molds and is the only one based on reactions that occur at low pressure and room temperature. They call their process "Step and Flash Imprint Lithography." Standard microlithography procedures involve projection printers with lenses that weigh nearly a ton. The Texas team's procedure is based on production of a rigid, transparent, quartz template and the use of ultraviolet light.

3-D PROTEINS

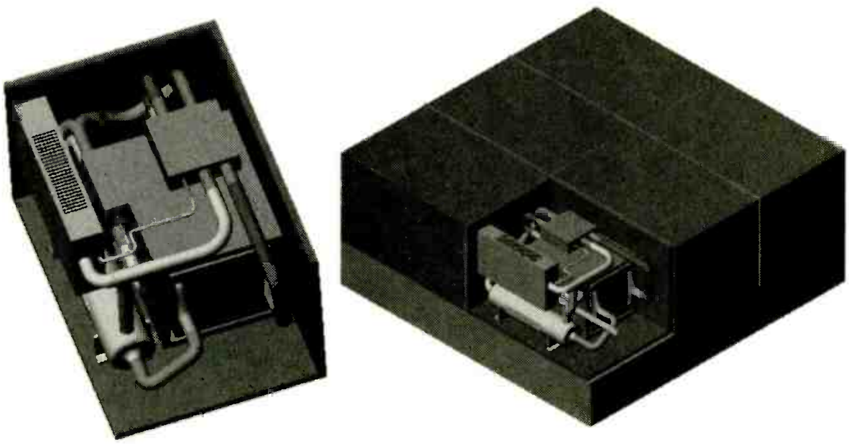
Five New York research institutions have joined together to develop high-speed methods to decipher the three-dimensional structure of proteins. The member institutions are Albert Einstein College of Medicine, Brook-haven National Laboratory, Mt. Sinai School of Medicine, The Rockefeller University, and Weill College of Cornell University. Pro-teins—long chains of building blocks called amino acids that fold into compact yet flexible shapes—carry out virtually all of life's essential functions through chemical reactions. It would take decades to determine every three-dimensional structure of every protein encoded by the human genome; therefore, scientists in the consortium plan to focus primarily on disease-related proteins.

Georgia Tech researcher Jessica Johnson examines a fuel cell—an electrochemical device that operates like a battery.

to provide fresh feed to the manufacturing plants.

Georgia Tech's center will focus on fuel cell and battery technology for wireless telecommunications, ultra-low emission vehicles, and distributed stationary power supplies. Key industry partners will be invited to join the center to share their technology needs and collaborate on open and proprietary research projects.

Georgia Tech researchers hold numerous patents in fuel cell and battery technology areas. Their contributions to fuel cell and battery technologies include developing of thin-film electrolytes and mixed-conducting electrodes, extending the technology for use with electrochemical membrane devices, and providing enabling technologies for compact, small-scale or micro proton exchange membrane fuel cells. Battery research at Georgia Tech has also led to advances in the development of an advanced room-temperature, sodium-based battery for high power and energy density and modeling of battery power sources for electric and hybrid-electric vehicle designers and users.



A proposed 5-kW solid-oxide fuel cell module (left) under development at Pacific Northwest National Laboratory and the National Energy Technology Laboratory will be used by itself or combined ("stackable") with other identical modules (right) to meet a variety of energy needs.

For more information on the Georgia Tech center and this research, go to *www.fcbt.gatech.edu*.

In related developments in fuel-cell research, Pacific Northwest National Laboratory and the National Energy Technology Laboratory are investigating putting clean, affordable solid-oxide fuel cells on the market in the next ten years. The two laboratories are heading a new industry-government-university consortium called the Solid-State Energy Conversion Alliance (SECA). Their goal is to develop a fuel cell that runs on abundant fossil fuels, such as natural gas, gasoline, and military fuel.

Members of SECA believe they can reduce fuel-cell costs through mass production of a versatile, miniature, five-kilowatt fuel-cell module. The earliest possible applications will be in auxiliary power to operate heaters, air conditioners, and other accessories in various types of vehicles and in complex electronics on military equipment. Researchers also foresee modules that are "stackable," so units can be combined to accommodate larger power needs. PT

Energy Innovations

An expert panel focus group from Batelle and several DOE laboratories (including Pacific Northwest, Brookhaven, and Oak Ridge National Laboratories, and the National Renewable Energy Laboratory) has identified the top ten most economically significant energy innovations expected by the year 2010.

Their forecasted advances cover everything from fuel to fuel cells, and from solar energy to energy farms:

- Energy super utilities will emerge. Oil companies will become energy companies and auto companies will become formidable influences in the energy industry.
- Hybrid vehicles with mileages of seventy-miles-per-gallon will come out. The first generation of these vehicles is already here in a sporty Honda two-seater.
- Computers, the Internet, and Global Positioning Systems will increase

transportation efficiency and lead to smart energy management systems.

- The current national power grid may be on the way out. Power may be generated locally for neighborhoods and individual residences and businesses, via micro-turbines, internal combustion engines, and fuel cells.
- Fuel cells will become increasingly popular for transportation and for portable and stationary power generation over the next decade.
- Chemical engineering processes will be developed to transform hydrocarbon compounds from gases to liquids, permitting more flexible use and storage of fuels.
- Next-generation batteries will be based on lithium-polymer technology and have about three times as much energy capability as batteries today, helping with the transition to hybrid and electric vehicles.
- The use of bio-engineered crops for fuels will be expedited by the genetic revolution that permits crop cultivation to produce fuels such as ethanol on energy farms. According to Dr. Steve Millert, Thought Leader and manager of Batelle's forecasts, "We will grow gasoline, so to speak, to lessen our dependence on imported oil. With advances in DNA engineering, we will be able to grow energy as well as food crops."
- Substantial improvements are expected in using solar energy for the heating and cooling of buildings and in the development of efficient photovoltaic cells.
- Geologists have discovered rich deposits of frozen natural gas crystals on the ocean bottom. It is believed that this energy source will emerge in the next decade to add to our natural gas production. PT

NEW GEAR

(continued from page 6)

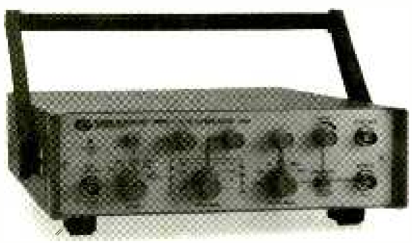
Synthesis Tool, which allows developers to quickly convert and compress .wav files for use as synthesized responses to verbal commands.

The Voice Extreme Speech-Recognition Kit has an MSRP of $395, and individual chips are $8 each.

SENSORY INC.
521 East Weddell Drive
Sunnyvale, CA 94089-2164
408-744-9000
www.Voice-Extreme.com

Pulse Generator

THE *10-MHZ PULSE GENERATOR (Model 4010)* is designed to permit precise tailoring of pulse repetition rates and duty cycles over a wide range through the independent setting of pulse width and pulse spacing. Both pulse width and pulse spacing are continuously variable over five decade ranges from 50 ns to 5 ms, with variable adjust.



CIRCLE 65 ON FREE INFORMATION CARD

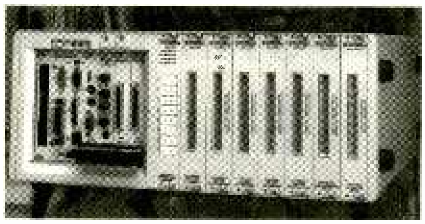
Features include a wide pulse rate (1 Hz to 10 MHz), a fast pulse rate (up to 10 MHz), seven crystal-derived spot frequencies, a low rise and fall time, and a manual triggering facility. The easy-to-use front panel provides a normal/inverted output-polarity pushbutton switch and special sync output.

The 10-MHz Pulse Generator (Model 4010) has a list price of $355.

GLOBAL SPECIALTIES
1486 Highland Ave., Unit 2
Cheshire, CT 06410
800-572-1028
www.globalspecialties.com

Computer-Based Measurement Platform

THE *PXI-1011 PXII/COMPACTPCI Platform* is a 12-slot chassis that combines SCXI™ signal-conditioning tech-



CIRCLE 66 ON FREE INFORMATION CARD

nology with the PXI/CompactPCI module instrumentation platform. This combination platform gives users a computer-based measurement and automation platform for developing integrated systems.

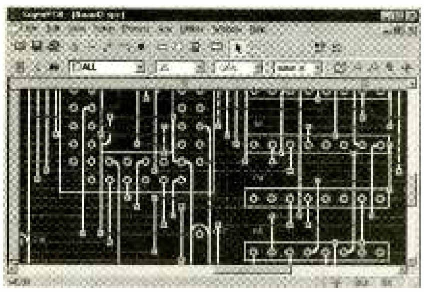
The rugged, low-noise PXI-1011 chassis integrates four PXI/CompactPCI slots with eight SCXI slots. The chassis is designed for developing high-channel count systems that solve data-acquisition, test and measurement, and industrial-control applications. In this system, users can measure up to 256 channels of temperature, pressure, strain, voltage, current, or frequency. In test and measurement applications, designers can select up to three different instruments to analyze.

The PXI-1011 PXII/CompactPCI Platform sells for $2795.

NATIONAL INSTRUMENTS
11500 N Mopac Expwy.
Austin, TX 78759-3504
800-258-7022
www.ni.com

Circuit-Board Software

THE 32-BIT *SUPERPCB VERSION 4.0* has been extensively rewritten to allow a 10X improvement in resolution, which enables designers to work with the latest surface-mount parts Users can specify object dimensions and positions down to $\frac{1}{10}$ mil. The drawing scale can be set in a range from 20 to 5000% scale.



CIRCLE 67 ON FREE INFORMATION CARD

Among the new features are a backup timer, multiple levels of undo, easy-to-see animated markers for search, and a library utility for copying parts. The new Voice-Response feature announces program status (file loaded, error conditions, etc.). The Multiple-Document Interface (MDI) allows users to open more than one artwork file at a time or open a library part for editing along with an artwork file.

SuperPCB Version 4.0 (the full version) sells for $549. (Other versions, including an introductory version, are also available.)

MENTAL AUTOMATION, INC.
5415 136th Place, S.E.
Bellevue, WA 98006
425-641-2141
www.mentala.com

GIZMO®

DVD + MP3

Aiwa's *XD-DV370* ($300) is a full-featured DVD player that offers built-in MP3 decoding, allowing it to play MP3-encoded CDs. MP3 music files that have been dubbed uncoded onto a CD-R or CD-RW disc can be played back on the XD-DV370. The DVD player also features a 96-kHz/24-bit audio D/A converter, a 10-bit video D/A converter; digital coaxial and optical outputs; dual stereo RCA outputs; and component, S-video and composite-video outputs. Four forward-search speeds, four reverse-search, four forward slow-play, and three reverse slow-play speeds are provided. The deck offers X4 and X16 zoom levels and a multi-language on-screen display.

Aiwa America, Inc., 800 Corporate Drive, Mahwah, NJ 07430; 201-512-3600; *www.aiwa.com*.

CIRCLE 50 ON FREE INFORMATION CARD

Talk the microTALK

Cobra's *microTALK* two-way radios provide a safe and fun way for kids and parents to communicate in shopping malls, amusement parks, or just around the neighborhood. The durable, sporty design makes the microTALK radio a good choice for use in outdoor activities such as camping, hiking, skiing, and fishing. The radios sport a distinctive, athletic design and are available in a wide range of colors. Each unit comes with a belt-clip holster that also functions as a desk stand for at-home or at-work use.

The microTALK FRS (Family Radio Service) units provide clear, two-way communications for up to two miles and access to all 14 available communications channels. A backlit LCD is easy to see at night. Convenience features include incoming "call alert," which allows one microTALK user to ring another simply by pushing the "call" button, and "roger beep" to indicate the completion of one user's transmission and signals the other user to talk.

Prices for the microTALK line range from $89.95/pair for the FRS 110-2 to $129.95 each for the FRS-315 WX "Platinum Mist" (pictured here), which provides access to 10 NOAA weather channels for 24-hour weather reports anywhere in the United States. They also include Cobra's WeatherAlert feature that works with NOAA emergency alert broadcasts to warn of impending severe weather.

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

CIRCLE 51 ON FREE INFORMATION CARD

"Game Boy" Tether

When you think of expensive things that children tend to lose, items like eyeglasses, retainers, and jackets immediately come to mind. Toys—especially favorite ones that are taken everywhere—also tend to disappear without warning.

Help your kids keep the reigns on their Game Boy Colors with the *Hip Clip* ($7.99) from Nyko. The holster-style holder fastens securely to a backpack or belt for hands-free transport, allowing gamers to bring their portable game anywhere without worrying that it will be lost or dropped. The Hip Clip comes in four translucent colors (light blue, light purple, frosted clear, and smoke) and is made of durable, scratch-resistant material that provides protection for the stored Game Boy Color. Now, if you could just find a way to keep those glasses and retainers from being misplaced ...

Nyko Technologies, Inc., 2311 South Cotner Ave., Suite D, Los Angeles, CA 90064; 888-445-NYKO; *www.nyko.com*.

CIRCLE 52 ON FREE INFORMATION CARD

Garden Sounds

You won't be listening to buzzing bees or chirping birds if your garden takes root in *Omniplanters* ($900/pair) from Rockustics. Each 24-inch diameter, 20-inch-high planter has a built-in, high-fidelity speaker system that provides 360 degrees of dynamic, omnidirectional sound to your deck or patio. The speakers deliver a lift at higher frequencies for maximum dissipation in the open air with a special non-parallel internal design feature said to minimize unnatural resonance.

The Omniplanter is made of terra cotta or granite gray polyethylene. The speakers are completely waterproof and weatherproof. Loudspeaker components made of fiber-reinforced polymer composite resist rain, frost, snow, and ice. The planters provide adequate drainage for live plants.

Rockustics Inc., 5080 Paris St., Denver, CO 80239; 800-875-1765; *www.rockusticsinc.com.*

CIRCLE 53 ON FREE INFORMATION CARD

Street-Smart Travel Case

The compulsively organized, as well as those of us who just hope we remembered to throw in everything we might need, will appreciate the *MegaMedia Computer/Electronics Bag* ($179.95) from RoadWired. With 36 compartments and pockets, the case is specially designed to hold and protect a portable computer or PDA and assorted other gear—digital camera, cell phone, MP3 player, memo recorder—and all the media and accessories that go with them.

The lightweight, streamlined bag is designed to keep more delicate and expensive items toward the center. The main computer section has fully adjustable padded divider panels and a double-padded floor. It holds any notebook computer measuring up to 14 × 12 × 2½ inches, with room for a looseleaf binder, too. Three panels fan out from the main space to provide easy access to additional electronic devices, media and supplies, and file folders. Each panel features elasticized organizers, mesh pockets, and other storage accommodations. The bag also offers a removable travel-document organizer, a secret compartment for stashing emergency cash or keys, and a top-opening design that allows easy on-the-shoulder access to all contents. Fully loaded, the MegaMedia case measures only seven inches in depth.

RoadWired, 235 Middle Road, Henrietta, NY 14467; 716-334-6969; *www.roadwired.com.*

CIRCLE 54 ON FREE INFORMATION CARD

Translucent Boombox

Now you can "see" your music as well as hear it. The Jeep *Translucent Series Boombox* ($199.95) introduces an innovative translucent casing that shows off the technology. Water- and shock-resistant, this portable entertainment center features a multi-function CD player; AM/FM stereo tuner with Weather Band, bass boost, and tone control; and a larger amplifier for superior sound quantity.

The rugged and durable casing with its tread design houses a sleek CD compartment with the Jeep signature "X" mark. The Boombox uses eight "D" batteries (not included). It comes in three translucent colors: flame red, aqua, and sport yellow.

Kash N' Gold Ltd., One Trade Zone Court, Ronkonkoma, NY 11791; 800-354-8785 or 631-981-1600; *www.jeep.com.*

CIRCLE 55 ON FREE INFORMATION CARD

Wireless Modem Phone Jack

The wireless *TL96597GE InstaJack* ($89.99) simply plugs into any AC outlet and instantly provides access to your phone line for connecting computers, fax machines, Web TV boxes, and modems. Caller-ID-compatible, it works with all personal computers, notebook computers, and Macintosh and TV Internet boxes with either internal or external modems.

Jasco Products Company; 800-654-8483 or 405-752-0710; *www.jascoproducts.com.*

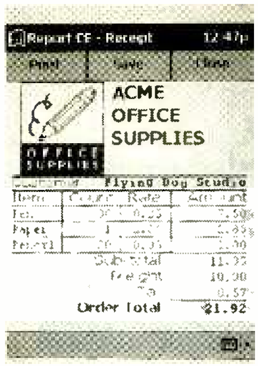
CIRCLE 56 ON FREE INFORMATION CARD

Catch That Mouse!

The IBM *ScrollPoint Pro Mouse* ($39.95) enables users to surf the Web more comfortably, offering one-touch access to the Internet with 400 step-per-inch accuracy. Designed with a modern contoured shape and sure-grip rubberized sides, the ScrollPoint Pro is available in antique sage and slate blue. Its programmable third button is preset as the back browser control and automatically returns to the previous link in the browser.

IBM, 1-888-SHOP-IBM; *www.ibm.com/shop.*

CIRCLE 57 ON FREE INFORMATION CARD



Report-Writing Software

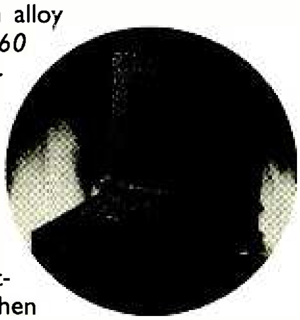
Report CE 2.0 ($79) is a major new release of the report-writing tool for Windows CE and Pocket PCs. A wealth of new features enables users to quickly design professional reports, including text features such as fonts, point sizes, underscores, and italics. Reports can also include lines, bit-map images, drawings, and signatures.

Syware; 617-497-1300; *www.syware.com.*

CIRCLE 58 ON FREE INFORMATION CARD

Built to Survive

A rugged notebook computer that weighs 12 pounds and has a sealed magnesium alloy die-cast chassis, the *A760* ($4495) is designed to withstand extreme temperatures, is shock- and vibration-resistant, and is water-, dust-, and dirt-proof. The non-glare LCD display of the A760 is available with a daylight-readable display or a direct-sunlight readable display. When it's very dark, the optional backlit keyboard makes it easier to send or retrieve information.



GETAC Inc.; 949-699-2888; *www.getacusa.com.*

CIRCLE 59 ON FREE INFORMATION CARD

Multi-Purpose Office Machine

Need one machine for the home office or small office that does it all? The *HP OfficeJet G Series* all-in-one printer/scanner/copier/fax machines provide photo-realistic color printing, high-quality flatbed color scanning, stand-alone color faxing, and color copying. The devices can be operated from any PC within a networked office and feature USB connectivity.

The HP OfficeJet G55 pictured here is expected to retail for $499, and other models with additional features have higher prices.

Hewlett-Packard Company; 888-999-4747; *www.hp.com/all-in-one.*

CIRCLE 68 ON FREE INFORMATION CARD

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

CD ROM based resources for learning and designing

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

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

matrix multimedia

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

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

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

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

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

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

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

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

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

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

Order Form:

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

	Student	Institution
Electronic Ccts. & Comps.	$50	$99
Digital Electronics	$50	$99
Analog Electronics	$50	$99
Electronic Projects	$75	$159
PICtutor	$179	$350
C for PICmicros	$179	$350
Digital Works	$50	$99
CADPACK	$75	$159
Analog Filters	$75	$159
Postage - USA	$5	$5
Postage - Canada	$5	$5

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Signature: ______________________

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Phone your order to us on:

631-592-6721

or send your order to:

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PO Box 12162
Hauppauge, NY 11788

CL02

Order online NOW from: www.poptronics.com

mailto: netwatch@gernsback.com

CHRIS LA MORTE

Bandwidth: How Wide is Yours?

The days of the analog/digital 56K modem are numbered. On the forefront of Internet access, there stand the behemoths of wider bandwidth: ISDN/DSL, the baud-busting radio-frequency cable modems, and evolving fiber-optic technologies. Each one has its positive and negative traits, yet fiber optics is predicted to be the leader of data transfer. Some of us remember when Commodore Vic-20s were the toys of the elite and the online frontier was explored at speeds such as 75 and 300 bits per second—oh, have we advanced. Now with connection speeds well over fifty times faster, Net surfers have the audacity to bicker and whine, "My connection is too slow!" Let's examine two faster alternatives to accessing the Internet: ISDN and cable modems.

Welcome to ISDN Zone*! This site will get you up to date with Integrated Services Digital Networks.*

DECISIONS, DECISIONS

There are several factors to consider when comparing data-transfer technologies, including cost, ease of use, availability, and bandwidth. Bandwidth is a major variable in predicting data-transfer speed on the Net. Perhaps, it looks as if analog phone lines have reached their limit of 56 Kbps, but this does not render the existing commercial-telephone infrastructure obsolete. *I*nternet *S*ervices *D*igital *N*etwork (ISDN) technology uses the same copper-wire network, which is the backbone of commercial-telephone networks. The ISDN signal passes through a series of digital adapters and signal routers located in a central-office-switch facility, is transmitted to another central office via copper wire, and then is brought into the subscriber's home. Digital signals riding an analog path over a long distance are susceptible to noise, which is why a subscriber can not be more than four miles from the central office. There are two types of ISDN commonly available—*B*asic-*R*ate *I*nterface (BRI) and *P*rimary-*R*ate *I*nterface (PRI).

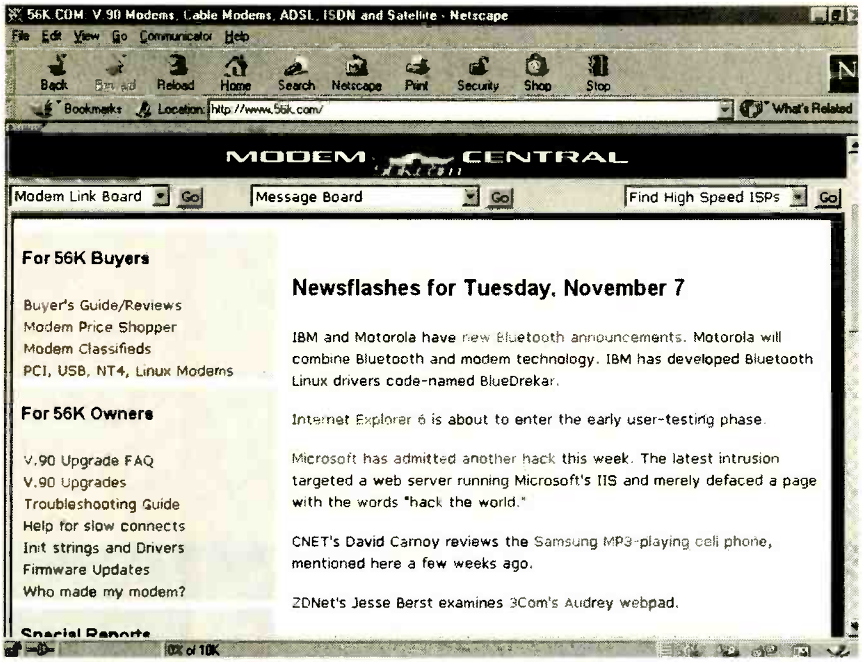
The BRI line is a modest change from a 56K modem. Cruising at a bandwidth of 144 Kbps, the BRI line contains three channels: two B (bearer) channels, each with a bandwidth of 64 Kbps; and one D (data) channel with a 16-Kbps bandwidth.

The hefty PRI consists of 23 B channels with a bandwidth of 64 Kbps and one 64-Kbps D channel. The total multiplexed bandwidth of PRI is 1536 Kbps. European PRI networks add an extra 7 B channels, resulting in a 1984-Kbps bandwidth.

ISDN, with its multiple channels, gives the user the option of using multiple communication devices across the same wires. For instance, a telephone and a computer can be used simultaneously across the same line, yet each device thinks it has a line all to itself.

THE NEED FOR SPEED

Another option to consider is a cable modem. Cable modems are becoming a mainstay in homes all around the country. Local cable companies provide Internet access via the same coaxial cable used for cable television. Some cable-based systems reach 36 Mbps.



The last bastion of analog users, 56k.com *is the place for phone line modem enthusiasts.*

HOT SITES

56k.com
www.56k.com

catv.org
www.catv.org

isdn.com
www.isdnzone.com

Offering the convenience of a 24-hour connection at less than $50 a month, local cable companies are becoming inundated with subscribers wanting lightning fast downloads.

Data transfer on cable is often called *upstream* (uploading) and *downstream* (downloading). Using a cable connection, upstream rates can reach 128 Kbps, while downstream rates near the 30-Mbps mark.

WANT TO LEARN MORE?

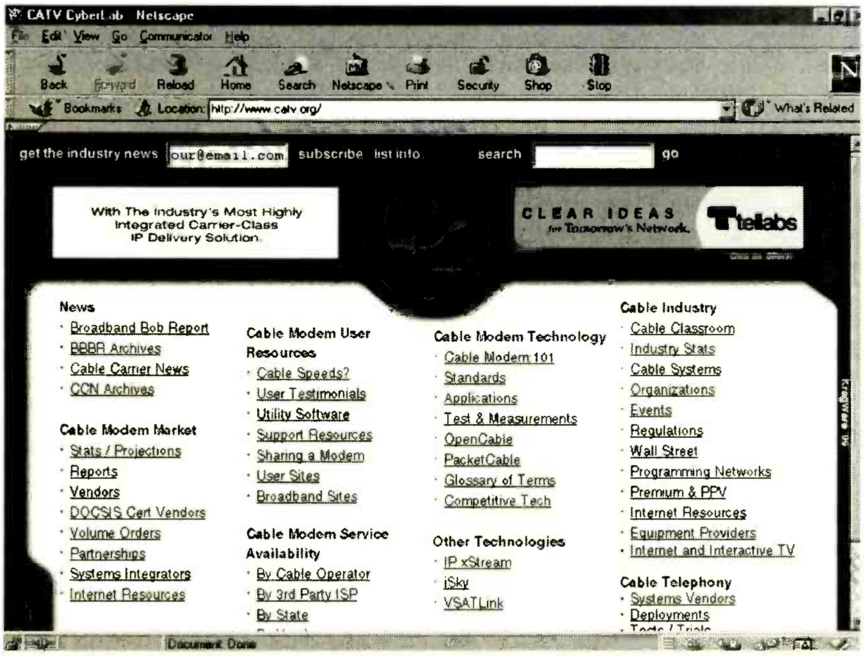
Don't be discouraged if you are an analog user. Some tech heads predict that more than 50 percent of home users will still use 56K-phone modems in the coming decade. The reason: It is still the cheapest and easiest way to access the Net. Here are some sites offering information about ISDN, cable, and traditional 56K-phone access.

ISDNZONE.COM—An excellent resource site for information regarding ISDN connecting can be found at *www.isdnzone.com.* Everything from technical information explaining how ISDN functions to sections on service and prices is available on this helpful site. A showcase section highlights cutting-edge Web sites, which show off the advantage of high-speed connections as they relate to multimedia on the Web.

CATV.ORG—Whether you want to compare your current connection to that of a cable modem or you want to learn more about the way a cable modem works, this site will guide you. There is a section on user resources that includes sites and software, another section with links to service providers, and a crash course in cable modems. You can even impress your friends by memorizing the glossary of cable terms listed at *catv.org.*

56K.COM—For those of us who are still traveling along the information superhighway aboard the analog express, there is *56k.com.* This Web site has useful items designed solely for phone-line modems. Recent press releases pertaining to 56K tech issues, links to modem manufacturers, command string files, and the latest drivers are all here at your fingertips. There is also a primer section, which explains the intricacies of analog to digital modems.

There are some pretty nifty options available for Internet access. A good deal of information is on the Web, so why not compare the numbers for yourself. Perhaps it is time to take the transfer-medium leap towards higher speed and quality. Contact your local cable and telephone companies and see what they have to offer.



All you ever wanted to know about cable modems, but were embarrassed to ask: Let the CATV CyberLab cater to your cable desires.

REID GOLDSBOROUGH

mailto: digitaldomain@gernsback.com

Reach Out and Touch With Technology

For the past four thousand years humans have relied on technology to communicate with one another over distance. Using papyrus, paper, smoke, drumbeats and electrons, we've exchanged messages about matters both mundane and profound.

During the "old" days of the online world (five years ago), the main choices for sharing knowledge or experiences and asking questions were somewhat limited. Some options were:

- Local bulletin-board systems run by individuals
- Discussion forums/chat rooms found on commercial services (e.g. CompuServe and America Online)
- E-mail based discussion groups
- Usenet newsgroups
- Internet Relay Chat

You can find all sorts of programs for jazzing up your e-mail at www.messagemedia.com.

All of those methods are still around, but they've been supplemented by services that can be useful for both business and recreation. The popularity of all those discussion services counters the notion that, above all else, people value content on the Internet.

According to Andrew Odlyzko, who heads an AT&T Labs information science research department, people most value communication. In his recent paper "Content Is Not King" (*www.research.att.com/~amo/doc/networks.html*), Odlyzko writes that people will be more likely to pay for tools that enhance communication than for text, music, movies, and other content.

Yet, aside from your hardware and Internet connection, most communications services are free—at least for consumers. On the other hand, discussion tools for businesses range from free to pricey.

VIRTUAL SOIREE

TalkCity (*www.talkcity.com*) is one of the best free Web-based discussion forums. It has fashioned itself into a full-fledged virtual community, with discussion-centered neighborhoods for people of various ages and interests, "real-time" chats, e-mail, private clubs, home pages, shopping, and special events.

If you have your own Web site, whether it's business or hobby related, you can create a discussion-centered community. In order for message boards and chat services to be effective, your site needs a significant amount of traffic. To minimize the effects of drive-by postings and angry debates ("flame wars"), you also need to actively manage discussions.

Discussion software that you run in-house ranges from the free *HyperNews* (*www.hypernews.org*) to the more sophisticated O'Reilly *WebBoard* at *webboard.oreilly.com*. The latter costs $1799.

Alternately, you can outsource your site's community features by using a free service such as Yahoo Clubs (*clubs.yahoo.com*) or more feature-laden tools such as those from Prospero Technologies at

Wireless hand-held technology finds a fun and affordable home at www.cybiko.com. *Chat or play games with friends up to 300 feet away.*

www.prosperotechnologies.com. The set-up fee for the latter starts at $5000 and monthly fees start at $500.

INSTANT MESSAGING

The Web isn't the only locale where new discussion developments have occurred. Free instant-messaging programs, such as *ICQ* (*web.icq.com*), have achieved widespread popularity, particularly among young people. Use the program to check if a "bud" is online, fire off a "Wassup," message, get a quick response, and rap away. There's no delayed gratification here.

Instant-messaging programs have also gotten down to business. Nowadays, they typically provide tools for collaborating with others on work projects, including working on the same document, sharing the same program, transferring files, and browsing the Web.

With instant-messaging programs, however, you have to control how accessible you are to prevent them from turning into a nuisance or a time sink. Security can also be a concern with business use. In response, fee-based programs such as Lotus *Sametime* (*www.lotus.com/sametime*) provide beefed-up features and in-house controls. Pricing for *Sametime* starts at $6028 for the server and $19 per user.

CHATTING ON THE RUN

Cutting the tether to your desktop PC is the latest rage in on-line communications. The Palm VII hand-held PC (*www.palm.com*) has led the way. It's priced at $449, with wireless Internet service starting at $9.99 per month.

A less expensive but more limited option in wireless communication is the new Cybiko handheld (*www.cybiko.com*). Priced at $129 and targeted primarily toward teenagers, it lets you carry out text-based conversations with other Cybiko users who are within 150 feet indoors or 300 feet outdoors.

PSYCHOLOGY AND CYBER CHAT

If you're in business, it's smart to pay heed to consumers who are heavily into digital communication. Active on-line users, or "e-fluentials," are thought to influence the attitudes and behavior of about eight other people. Off-line, a typical person influences just two others, according to a new study from Burson-Marsteller, a New York City public relations agency.

If you're a consumer, it's smart to keep in mind that on-line communication has its limitations. As pop psychologist Dr. Joyce Brothers told me once in a phone interview, "Computers can be used in positive ways to increase our contacts, friendships, and understanding. But they don't replace face-to-face contact, the touch of a hand."

THE FRESH "SENT" OF E-MAIL

We might not be able to hold hands with the PC, but in exchange we have...e-mail. Since the inception of e-mail, we have had the power to reach across the globe and connect. Unfortunately, some of the customs of "snail mail" were inherited by e-mail; so we have

(Continued on page 52)

POINT AND CLICK

Bacon's MediaSource
www.bacons.com

Cybiko
www.cybiko.com

Direct Contact Newswire
www.owt.com/dircon

HyperNews
www.hypernews.com

ICQ
web.icq.com

Lotus Sametime
www.lotus.com/sametime

Message Media
www.messagemedia.com

O'Reilly WebBoard
www.webboard.oreilly.com

Palm VII
www.palm.com

PostMasterDirect.com
www.postmasterdirect.com

Prospero Technologies
www.prosperotechnologies.com

TalkCity
www.talkcity.com

Yahoo Clubs
www.clubs.yahoo.com

TED NEEDLEMAN

mailto: computerbits@gernsback.com

More Power, Mr. Scott!

It might surprise you to learn that a good percentage of computer-related "glitches" are not really the fault of bad components, operating-system errors, or programming mistakes. Instead, they happen because of a momentary power interruption, brownout, or outright power failure.

While we live in one of the more technologically advanced countries, our power-delivery superstructure has unfortunately not kept pace with the need for lots of reliable power. Given how much we use and rely on sensitive electronic equipment these days, that's not an especially reassuring situation.

The sophisticated switching-power supplies in today's PCs can accept a pretty wide variation in input voltages. The brownouts that are increasingly familiar to most of us, especially during the summer months, don't always send your PC into a tailspin. Applications are also a lot better at automatically creating backup files and recovering them after an unexpected shutdown.

Even with those "safety nets," I've experienced more than my share of watching a shrinking dot of light on my CRT and the accompanying sinking feeling in my stomach after the lights suddenly went off.

POWER PROBLEM SOLVED

Several years ago, I decided enough was enough. I earn my living with my PC; and even if I don't lose important files due to a power failure, my time is better spent working than trying to recover backups. Although (or perhaps because) I live in a rapidly growing suburban area, power failures and summer brownouts are becoming more—rather than less—frequent.

The APC Back-Office Pro provides both USB and serial connections to your PC for an orderly shutdown of your applications.

My answer was to add an Uninterruptible Power Supply, or UPS, to every PC in the house. The UPS is very different from the popular "surge protector," though every UPS on the market also offers surge protection as an additional feature. Unlike a power-protection strip, which has its MOS (Metal Oxide Semiconductor) device to drain a very high voltage power spike to ground, a UPS is designed to supply a constant voltage to your equipment—regardless of what is happening at the AC power outlet.

With a UPS, if the voltage from the AC outlet drops below a predetermined level, the device disconnects the output outlets from the AC wall outlet. Then the UPS converts the DC voltage from a rechargeable lead-acid battery to the expected line voltage, powering the devices that are connected to protected outlets, such as PCs. Overvoltages and voltage dips on the power line are also adjusted for by Automatic-Voltage-Regulation (AVR) circuitry. The result is a generally clean 115-volt AC sine wave, regardless of how far out of spec or noisy the power-line voltage gets.

All of those functions are taken care of automatically. In fact, the difficulty involved in setting up a UPS is that the unit is generally delivered with one or both battery leads disconnected. Before you plug the unit into the wall, you usually have to open up the case and connect the battery lead.

SIZE MATTERS!

Picking the correct size UPS is probably the most challenging part of making the purchase. There are more than a half-dozen vendors of home-and office-oriented UPS systems, and many of them just put something like "good for Pentium III workstation" on the box. UPS ratings are generally provided in Volt-Amp (VA) capacity and/or watts. Common ratings for UPS systems sold in office-supply and computer stores run from 300 VA to more than 2000 VA.

How much capacity is enough? There is, unfortunately, no set answer. It really depends on what you have hooked up to the UPS and how long you'll need the system to run in a worst-case scenario. For small-office and home use, the purpose of a UPS is not to provide enough power to last through a bad blackout, but rather to allow you to finish what you are doing and shut down your applications and PC in an orderly manner.

A handy tool for determining

the capacity needed can be found on the Web site of American Power Conversion Corp, or APCC (*www.apcc.com*). An interactive UPS "sizer" asks what you will be connecting and how long you need the UPS to run during a power failure, and it will then suggest a model.

APCC and Belkin Components both have reputable track records in the UPS field. Triplight and Blackout Buster are other popular brands, though I have no personal experience with either one.

Two of the units we use are real monsters—the APCC Smart-UPS 1400 and Belkin's Regulator Pro NetUPS 1400. As you might guess from their monikers, both units have very hefty 1400-VA capacities and are really meant for network servers. The APCC Smart-UPS 1400 in my office has two complete PC systems (CPUs, monitors, and external Zip drive) plugged into it.

The other hefty UPS—the Belkin Regulator Pro NetUPS 1400—is attached to the second most heavily configured system in the house, which adds a scanner, speaker system, and a network hub.

Neither one of these devices is inexpensive; both cost in the neighborhood of $500–$600. The APCC Smart-UPS 1400 has an SNMP network card installed, so that any PC on my network can check the unit's status—a feature that bumps up the price a bit. On the upside, while Belkin and APCC rate this size unit as having a run time of between seven minutes and a half-hour at full and half load respectively, connecting a smaller-draw workstation to the UPS really boosts the run time. We connected a 600-MHz PC with a 145-watt power supply and 15-inch CRT monitor to each device, booted up a DVD movie, made sure the UPS batteries were fully charged, and then pulled the UPS plug out of the wall. The APCC Smart-UPS 1400 ran for an hour and twenty-nine minutes before giving up the ghost, while the Belkin Regulator Pro NetUPS 1400 ran for an hour and nine minutes before shutting down. That's not only enough time for an orderly shutdown, but also enough time to finish a payroll run if you're using the system for a business.

The Smart-UPS 1400 kept our test system running for almost an hour and a half.

Other PCs in the house are attached to somewhat less expensive UPS models. We have a mix of APCC BackOffice UPS-Pro 500s and Belkin Regulator Gold 500 models. Both of those models are in the $150 range, and both provide at least ten minutes of run time with most PC configurations that are connected to them. We usually have an inkjet printer plugged in as well, so we allow a maximum of five minutes before shutting down.

All of the UPS systems we use come with software and cables so the UPS can control the PC's shutdown. That's a good idea if you frequently run applications unattended. That way, the application is shut down systematically, even if you are not there.

SOURCE INFORMATION

American Power Conversion Company
132 Fairgrounds Rd.
West Kingston, RI 02892
800-800-4272
www.apcc.com
CIRCLE 100 ON FREE INFORMATION CARD

Belkin Components
501 West Walnut St.
Compton, CA 90220
800-2-BELKIN
www.belkin.com
CIRCLE 101 ON FREE INFORMATION CARD

DON'T BE CAUGHT UNPREPARED

Most UPS vendors make a big deal about how their units also provide surge protection against lightning strikes. Most of the major players in this market, including APCC and Belkin, boast that they will pay up to $100,000 to replace any equipment that's damaged by a lightning strike when connected to one of their units.

This sounds great, but I've also heard horror stories about connected equipment that's been fried by a spike from a telephone line or even by an EMP picked up by a long network-cable run. I don't know if these are just "urban legends," but common sense dictates good backup procedures even when your PCs are attached to a UPS.

SOMETHING TO PONDER

UPS systems really make a lot of sense regardless of how you use your PC. They don't have to be as hefty and expensive as the ones I use. APCC and other vendors make inexpensive units in the shape of a fat power strip in the $50 to $60 range. That's about twice what a decent surge protector costs, but a UPS gives you a lot more power protection for the money and at least a couple of minutes to perform a routine shut down of your applications and PC in the event of a power failure.

However, don't be tempted to skimp on a UPS. I've seen them on sale for as little as $40. At that price, you aren't really getting much in the way of either features or capacity. Spend a bit more and get a lot more, especially in the area of confidence, even in areas with poor and unreliable power. Like everything else in the computer industry, you not only get what you pay for, you *don't* get what you *don't* pay for. P

TED NEEDLEMAN

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Super Duper Scanners

Along with getting ever easier to use, each new generation of flatbed scanner gets better. Simple product design and the graphical nature of computer applications are two variables making a scanner a "must-have" peripheral.

This time around, we'll look at a trio of scanners with very different capabilities, feature sets, and prices. None of the three, however, is priced out of reach of a serious user.

SCANNERS 101

Before we get to the specifics, it's probably a good idea to review some basics. All flatbed scanners work the same way, at least conceptually. A glass platen is used to position an original document facing towards the interior scan mechanism. This arrangement allows the scanning of a bound original, such as a page in a book or magazine.

During the scan process, a beam of light is bounced off the document and reflected onto a sensing array. Depending on the construction of the scanner, there is either a mirror or a light source and/or sensor array mounted on the moving platform that is propelled by a stepper motor down the glass platen. Sensor elements may be either CCDs (Charge-Coupled Device) or CISs (Contact-Image Sensor), and the light source can be either cold-cathode fluorescent tubes or LEDs. The combination of a fluorescent-light source and CCD sensor still provides the best color fidelity, while LED/CMOS-based scanners use less power and can be very thin units.

Scans are processed in the three primary colors (red, blue, and green) for each imaged pixel. The number of imaging sensors per inch in the scan array determines the horizontal imaging resolution, while the ability of the stepper motor to move the scan vertically in small increments determines the vertical resolution. The combination of those two factors is the scanner's actual optical resolution. Today's scanners range from 300 × 300 to 1200 × 2400 dpi in optical resolution. Increased resolution, helpful for scanning small objects (like 35mm slides) and making enlargements, uses a software technique called *interpolation*. This technique involves making an educated guess about the pixels that lie between imaging sensors, based on the color of the actual imaged pixels surrounding the unknown pixel.

Epson's Perfection 1640SU offers the highest optical resolution in its price class.

Finally, in addition to the scanner's resolution, it's also important to consider the unit's color depth and interface. *Color depth* is a measure of how accurately a scanner can resolve color differences. At a minimum, a scanner will offer 24-bit color depth, which is actually 8 bits of data for each pixel for each of the primary colors (red, blue, and green). Color resolution and accuracy are directly proportional.

Be aware, however, that even a scanner with 48-bit color resolution passes only 24-bits of color data to most applications. Those are the most significant 24 bits; the bits the scanner electronics are most sure about. The remaining bits are discarded. All the scanners reviewed here have 42-bit color depth, and all of them pass on the most significant 24 bits.

Common scanner interfaces include USB, parallel port, and SCSI. Many scanners that have USB and/or SCSI can be used with either a PC or Apple Mac.

CANON N1220U

With an estimated street price of $199, the Canon N1220U offers only a USB interface. The USB not only makes data transfers fast (an important consideration when the optical resolution is as high as 1200 × 2400 dpi), but it also eliminates the need for an AC power transformer. The scanner, which uses an LED light source and CIS array, draws so little power that it's easily powered by the USB interface itself. The N1220U is a perfect accompaniment to a laptop computer, because you can scan even when you're not near an AC outlet.

The Microtek ScanMaker V6USL offers the consumer scanning of legal-size document, as well as a transparency adapter for scanning slides.

Unlike some of the first Canon scanners to use this type of sensor and light source, our test scanner produced scans that were dead-on accurate and showed none of the slight color drift of the earlier CIS models. The N1220U offers 1200- × 2400-dpi optical resolution.

Finally, the N1220U is great looking! It stands just over an inch high and has an unusual (but very cool-looking) metallic finish that Canon calls "Champagne." Canon includes lots of software; most of that is PC oriented. These include the ScanGear's *CS-U* TWAIN driver, ArcSoft's *PhotoStudio 2000* and *PhotoBase*, ScanSoft's *OmniPage OCR*, and a copy of Adobe *Photoshop 5.0 LE*. For Mac users, there's the Canon Plug-in Module CS-U for the Mac Operating System.

EPSON PERFECTION 1640SU

The Epson Perfection 1640SU bumps the price up a bit to $299. This scanner is also available in two more expensive models, the 1640SU Photo, which costs $399 and includes a transparency unit, and the 1640SU OFFICE, which costs $499 and substitutes an automatic document feeder for the transparency unit.

That sounds like a lot of money, but the Perfection 1640SU has the highest optical resolution in its class—an amazing 1600 × 3200 dpi. It accomplishes that resolution by incorporating a CCD sensor array with 1600 elements per inch and a specially designed stepper motor that Epson calls a "Microstep Drive." Keep in mind, however, that taking advantage of this resolution means really large image file sizes. We scanned several 3.5- × 5- and 4- × 6-inch photos at the highest optical resolution and filled several hundred megabytes of hard disk space. That's not really a problem with the huge 20 GB and larger hard disks that many users now have, and a CD-R/RW disc can still hold a number of images, even at this resolution. It does, however, have a direct impact on how long the image takes to load into an application such as *Photoshop*. Resampling or adjusting the size and resolution of a 100-MB image takes quite a while, even on a high-end PC.

The Perfection has dual interfaces. Most users will take advantage of the USB interface, as it offers easy plug-and-play installation. Others, such as graphics professionals and many Macintosh users, will appreciate the SCSI interface that's also offered.

SOURCE INFORMATION

Canon Computer Systems, Inc.
2995 Red Hill Ave.
Costa Mesa, CA 92626
800-OK-CANON
www.ccsi.canon.com
CIRCLE 110 ON FREE INFORMATION CARD

Epson America, Inc.
301 Edgewater Pl. #120
Wakefield, MA 01880
800-463-7766
www.epson.com
CIRCLE 111 ON FREE INFORMATION CARD

Microtek Lab, Inc.
3715 Doolittle Dr.
Redondo Beach, CA 90278
800-654-4160
www.microtekusa.com
CIRCLE 112 ON FREE INFORMATION CARD

For all of its high-end features, the Perfection 1640SU is really easy to use. Epson has a TWAIN driver, and there's a scan button on the front lip of the scanner that can also launch the scan utility.

As with most scanners these days, the Perfection comes with a bundle of software. The bundle includes Adobe's *PhotoDeluxe* and *Photoshop LE*, ScanSoft's *TextBridge Pro OCR*, and ArcSoft's *PhotoPrinter*, which allows you to print various combinations of print sizes.

MICROTEK SCANMAKER V6USL

The least expensive of the trio at $149, the ScanMaker V6USL also has the lowest optical resolution, at 1200 × 600 dpi. Although that seems somewhat low when compared to the Epson Perfection's 1600- × 3200-dpi resolution, we found the ScanMaker V6USL's resolution just fine for most uses. Microtek throws in a transparency adapter, which the company calls a "LightLid 35." This is actually a small bar that contains an addi-

(Continued on page 36)

Filtering Electronics Circuits Against EMI/RFI

JOSEPH J. CARR

Electromagnetic and radio-frequency interference may keep electronic devices from performing properly. In many instances, adding simple filter circuits can fix the problems. Here are some techniques you need to know about.

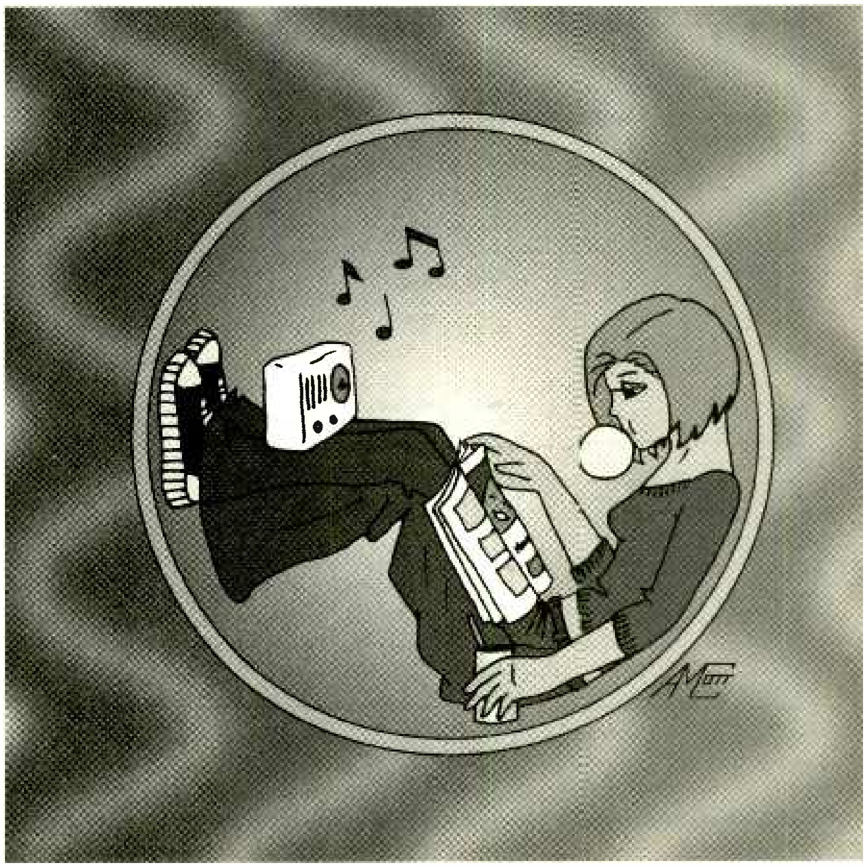
Electronic circuits must perform two different functions at the same time—they must respond to desired signals, and they must reject undesired signals. Unfortunately, today's world is full of a variety of interfering signals, all grouped under the headings *electromagnetic interference* (EMI) or *radio-frequency interference* (RFI). These interference sources can ruin the performance of—or even destroy—otherwise well-functioning electronic circuits. Most circuits are designed so that they do respond properly to desired signals. Nevertheless, many devices fail miserably, because they also respond to undesired signals in an inappropriate manner. Let's take a look at some of the techniques that you can use to EMI/RFI-proof your electronic devices and circuitry.

Shielding Is Not Enough. The first step in protecting against EMI/RFI is to shield the circuitry. The most common method is to place the entire circuit inside a metallic enclosure that prevents both external EMI/RFI fields from interacting with the internal circuits and internal fields from doing the opposite. However, even with a well-shielded circuit, power and signal leads must still enter and/or leave the enclosure. As a result, the shield is not perfect and some sort of filtering is needed.

Basic Types of Filters. Filters come in various types, but perhaps the most useful way of categorizing them is by passband: low-pass, high-pass, bandpass, and notch filters are the four basic classes.

Low-pass filters (LPF)—The low-pass frequency response shown in Fig. 1A passes all frequencies below a critical preselected cut-off frequency (F_C), and attenuates those above F_C. The cut-off frequency is usually defined as the point at which the gain falls off –3 dB from the mid-band response or (if the response is uneven) the response at a defined frequency. The cut-off is not abrupt, but rather will fall off at a given slope. This roll-off above F_C is usually defined in terms of decibels per decade (a 10:1 frequency change) or decibels per octave (a 2:1 frequency change). Low-pass filters that produce this kind of response curve are used to attenuate EMI/RFI signals above F_C.

High-pass filters (HPF)—The high-pass response shown in Fig. 1B is exactly the opposite of the low-pass response. This kind of filter passes frequencies above F_C, but attenuates those frequencies below F_C. Again,



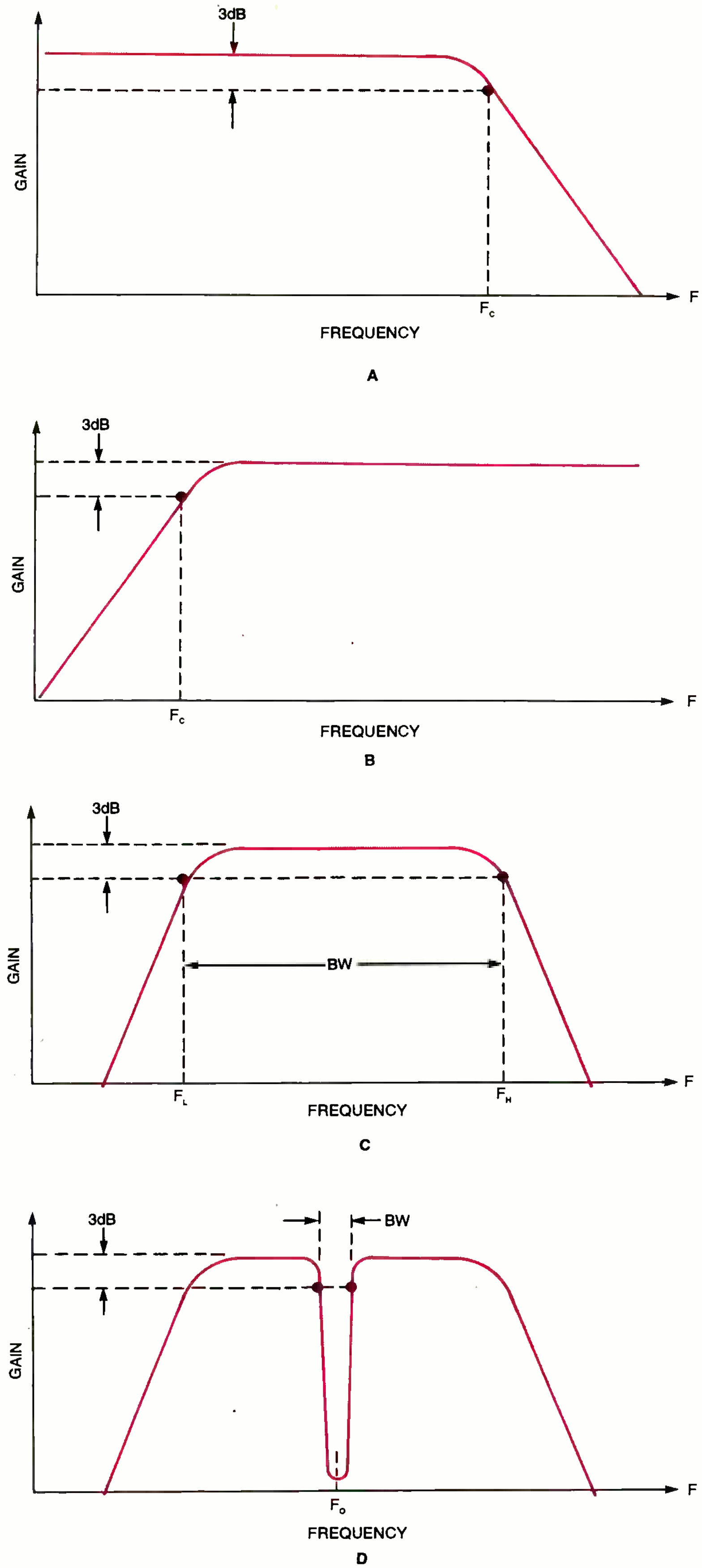


Fig. 1. Here are the filter-response characteristics for low-pass (A), high-pass (B), bandpass (C), and notch (D) filters.

there is a roll-off slope below F_C.

Bandpass filters (BPF)—The bandpass-filter response shown in Fig. 1C is essentially overlaid LPF and HPF responses. There are two cut-off frequencies: a lower limit (F_L) and an upper limit (F_H), both of which are defined at -3-dB points. The bandwidth (BW) of the BPF is defined as the difference between -3 dB points:

$$BW = F_H - F_L$$

In most cases, the BPF will have a center frequency (F_O) specified. The "Q" or "quality factor" of the BPF is defined as the ratio of the center frequency to bandwidth, or:

$$Q = F_O/BW$$

where Q is dimensionless, and the two other terms are expressed in the same units.

Notch Filter—The notch filter response shown in Fig. 1D has a very high attenuation at a specific frequency within the circuit's passband, but passes the other frequencies. In Fig. 1D, the notch is superimposed over a BPF response, although it may also be found with LPF, HPF, or wideband (flat) responses. The notch filter is used to take out a specific interfering frequency. For example, if 60-Hz AC power-line interference is terribly bothersome, then a notch filter might be used.

Filter Circuits for EMI/RFI. Filter circuits can be active or passive, but in this article, we are going to look only at the passive varieties. Such filters are made of combinations of resistors, capacitors, and inductors. Those combinations include RC, LC, and RLC varities.

Figure 2 shows simple resistor-capacitor (RC) networks in both low-pass and high-pass filter configurations. Note that the two circuits are similar except for the reversal of the two types of components. The cut-off frequency of these circuits is found from:

$$F_C = 1/2\pi RC$$

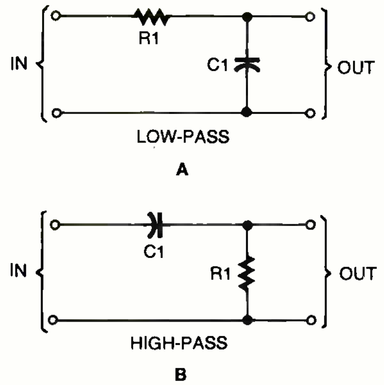


Fig. 2. Resistor-capacitor (RC) low-pass and high-pass filter circuits look similar; only their elements are reversed.

where F_C is the cut-off frequency in Hertz (Hz), R is the resistance in ohms, and C is the capacitance in farads. These circuits provide a frequency roll-off beyond F_C of –6 dB per octave, although a sharper roll-off can be obtained by cascading two or more sections of the same circuit.

Figure 3 shows four different Chebychev filters (two LPF and two HPF). These filters include low-pass and high-pass "Pi" configurations (Figs. 3A and 3C) and low-pass and high-pass "Tee" configurations (Figs. 3B and 3D). Note how the circuits got their characteristic names: schematically, they look like the Greek symbol π or the letter "T."

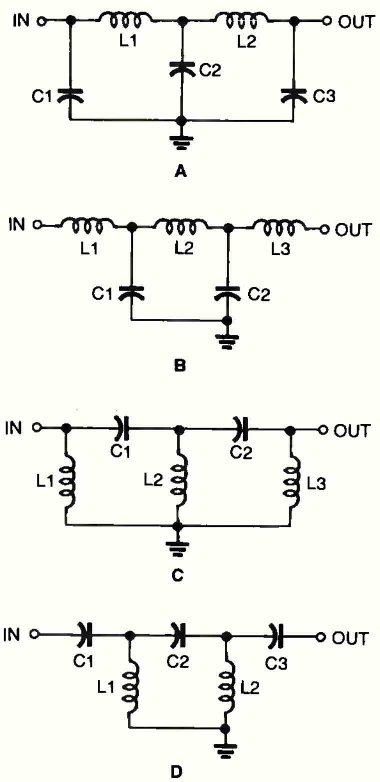


Fig. 3. Including an inductor in a filter circuit yields four basic combinations: a low-pass pi configuration (A), a low-pass tee configuration (B), a high-pass pi-configuration (C), and a high-pass tee configuration (D).

Each of these filter circuits is a "five-element" circuit; i.e. they each have five L or C components. Fewer (e.g. three-element) and greater (e.g. seven- and nine-element) numbers of elements are also used. Fewer elements deliver a poorer frequency roll-off, while more elements produce a sharper roll-off. Sets of component values are given for each circuit in Tables 1 through 4. Those component values are normalized for a 1-MHz cutoff frequency. To find the required values for any other frequency, divide those values by the desired frequency in megahertz. For example, to make a high-pass Tee-configuration filter for, say, 4.5 MHz, take the values of Table 4 (for Fig. 3D) and divide by 4.5 MHz:

L1 = 5.8 mH/4.5 MHz = 1.29 mH
L2 = L1
C1 = 2776 pF/4.5 MHz = 617 pF
C2 = 1612 pF/4.5 MHz = 358 pF
C3 = C1

If the desired frequency is less than 1 MHz, then it must still be expressed in MHz: 100 kHz = 0.1 MHz and 10 kHz = 0.01 MHz.

TABLE 1
1-MHZ VALUES FOR FIG. 3A

L1	10.9 µH
L2	10.9 µH
C1	3650 pF
C2	6287 pF
C3	3650 pF

TABLE 2
1-MHZ VALUES FOR FIG. 3B

L1	9.12 µH
L2	15.7 µH
L3	9.12 µH
C1	4365 pF
C2	4365 pF

TABLE 3
1-MHZ VALUES FOR FIG. 3C

L1	6.94 µH
L2	4.03 µH
L3	6.94 µH
C1	2321 pF
C2	2321 pF

TABLE 4
1-MHZ VALUES FOR FIG. 3D

L1	5.8 µH
L2	5.8 µH
C1	2776 pF
C2	1612 pF
C3	2776 pF

RC EMI/RFI Protection. Some circuits—especially those that operate at low frequencies—use RC low-pass filtering for EMI/RFI protection. Consider the differential amplifier shown in Fig. 4. This circuit is representative of a number of scientific- and medical-instrument amplifier-input networks. A medical electrocardiogram (ECG) amplifier, for example, is basically a differential amplifier with a high gain (1000 to 2000) and a low-frequency response (0.05 to 100 Hz). It picks up the human heart's electrical activity from skin electrodes on the surface.

Some circuits—especially those that operate at low frequencies—use RC low-pass filtering for EMI/RFI protection.

A number of problems affect the ECG's recording, other than the obvious 60-Hz problem. The ECG is often used in the presence of strong radio-frequency (RF) fields from electrosurgery machines (as discussed in the November 2000 issue of **Poptronics**). These "electronic scalpels" produce very strong fields at fre-quencies between 500 kHz and 3 MHz. The ECG circuit must also survive high-voltage DC jolts from a charge from a defibrillator machine if a patient's heart goes into *ventricular fibrillation* (a fatal type of arrhythmia, or irregular heartbeat). The defibrillator machine "jump starts" the heart

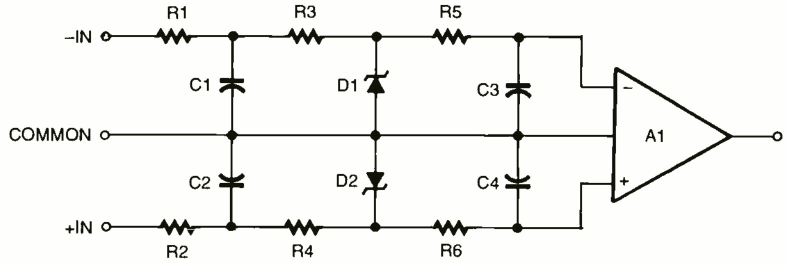


Fig. 4. The right combination of RC filtering and high-voltage protection provide excellent protection for low-frequency circuits such as electrocardiogram (ECG) amplifiers.

with a set of short-duration voltage spikes ranging from hundreds of volts to several kilovolts, depending on the particular waveform design and energy setting. Those potentials might be applied directly across the ECG amplifier, placing it at risk.

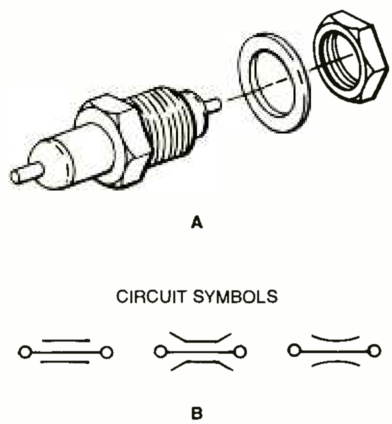


Fig. 5. A feedthrough capacitor passes an AC signal through a shielded enclosure.

Figure 4 contains both RF filtering and a means for limiting the defibrillator jolt. The resistors and capacitors form a three-stage cascade RC filter, one for each input of the differential amplifier. Those components will filter the RF component. Typical values range from 100,000 ohms to 1 megohm for the resistors, and 100 pF to 0.01 µF for the capacitors. High-voltage protection is provided by a combination of the input resistors and a pair of Zener diodes (D1 and D2) shunting the signal and common lines. In some older ECG amplifiers, NE-2 neon lamps were used in place of the Zener diodes.

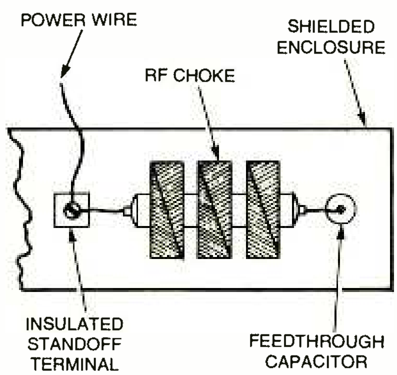


Fig. 6. In this example, an external RF choke is mounted outside a shielded enclosure; the feedthrough capacitor passes the signal to the inner circuit.

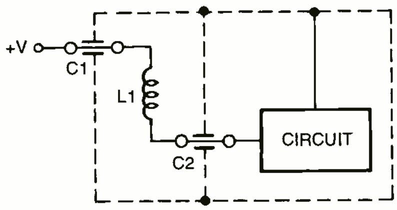


Fig. 7. If you have an extra-sensitive circuit, you can use a secondary shield within the main shield. Feedthrough capacitors pass the signal through the shields.

Feedthrough Capacitors. One efficient way to reduce the effects of EMI/RFI that pass into a shielded

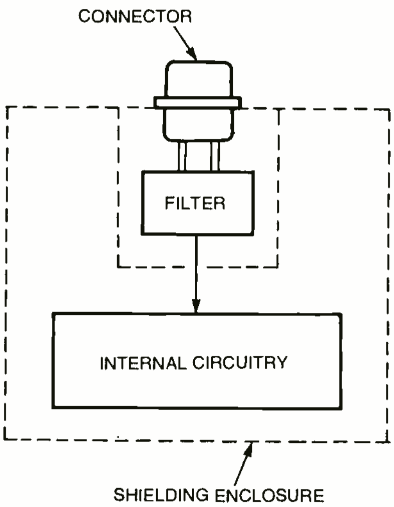


Fig. 8. Commercially-available connector/EMI-filter combinations are readily available, reducing parts count, design time, and troubleshooting.

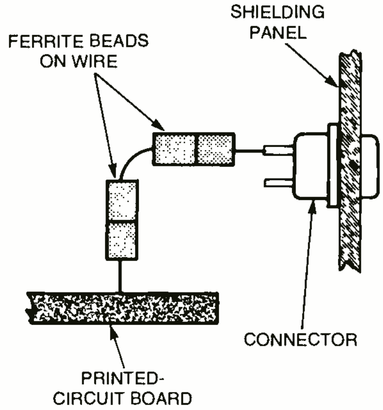


Fig. 9. Ferrite beads can act as an RF choke to protect circuits from interference picked up by connector pins.

compartment via power and signal lines is to use a feedthrough capacitor (see Fig. 5). Such capacitors typically come in 500-pF, 1000-pF, and 2000-pF values. Both solder-on and screw-on (see Fig. 5A) versions are available. In some catalogs, those capacitors are referred to as "EMI filters" rather than "feedthrough capacitors." I may be a cynic, but the "EMI" designation seems to add considerably to the price without any apparent advantage over straight feedthrough capacitors. Figure 5B shows several different forms of circuit symbols used for feedthrough capacitors in circuit diagrams.

FILTER CALCULATOR

If you are interested in designing filter circuits with specific responses, an Excel spreadsheet is available to assist you with the math. The basic filters shown in Fig. 3 are modeled up to nine elements. Point your browser to *ftp.gernsback.com/pub/pop/filter_tables.xls* to download.

There are several different ways to use a feedthrough capacitor. One is to simply pass it through the shielded compartment wall and attach the wires to each side. In other cases, additional resistors or inductors are used to form a low-pass filter. Figure 6 shows one approach in which a radio-frequency choke (RFC) is mounted outside the shielded compartment. This method is often used for TV and cable-box tuners. One end of the RFC is connected to the feed-through capacitor; the other

(Continued on page 48)

Programmable-Logic Devices are a snap to "burn" with *THE ALTA PRO 2000 PLD PROGRAMMER*

Frustrated that you can't build that latest "cool" project because you lack a PLD programmer? Sweat not, for this easy-to-build device is the answer to your prayers!

ROBERT G. BROWN

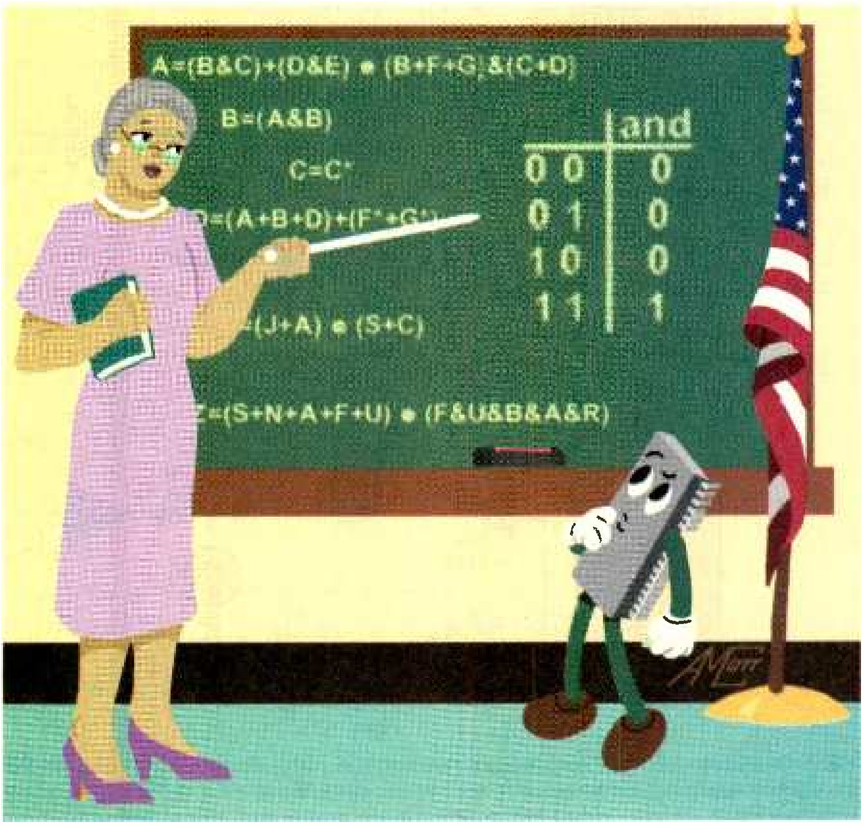
Back in May 1994, **Electronics Now** published my construction article on *p*rogram*m*able-*l*ogic *d*evices (PLDs). Since then, I've gotten feedback from hundreds of readers and still get requests—almost seven years later—for kits. Of course, time moves on, and the old programmer is showing its age and limitations.

Those two reasons alone make it high time to update the "old gal." Therefore, I'm pleased to present a new PLD programmer, the *Alta Pro 2000*. This next-generation programmer is designed to be more flexible than the old unit and can program many more devices. The hardware has the capability to program both 5-volt and 3.3-volt devices (although no 3.3-volt devices have companion support—yet!). At this writing, it can program the following devices from Lattice, National Semiconductor, SGS Thomson, Atmel, and ICT:

- GAL16V8A/B/C/D
- GAL20V8A/B/C/D
- GAL22V10/A/B/C/D
- ATF16V0B/C
- ATF20V8B
- ATF22V10B/C
- PEEL22CV10A+

Of course, that list may be added to from time to time. Check for the latest device list at *www.alta-engineering.com*. I've also posted the interface specification for the Alta Pro 2000 so others can create programs to handle different devices. Unfortunately, I've had to sign non-disclosure agreements with the PLD manufacturers in developing the Alta Pro 2000's software, so I can *not* publish source code or give out programming algorithms. If you're wondering why a semiconductor manufacturer would want to apparently prevent potential buyers from programming and using their devices, you'll have to ask them.

Theory Of Operation. Most programmable devices require one or more "super voltages"—a voltage (often referred to as V_{pp}) used to



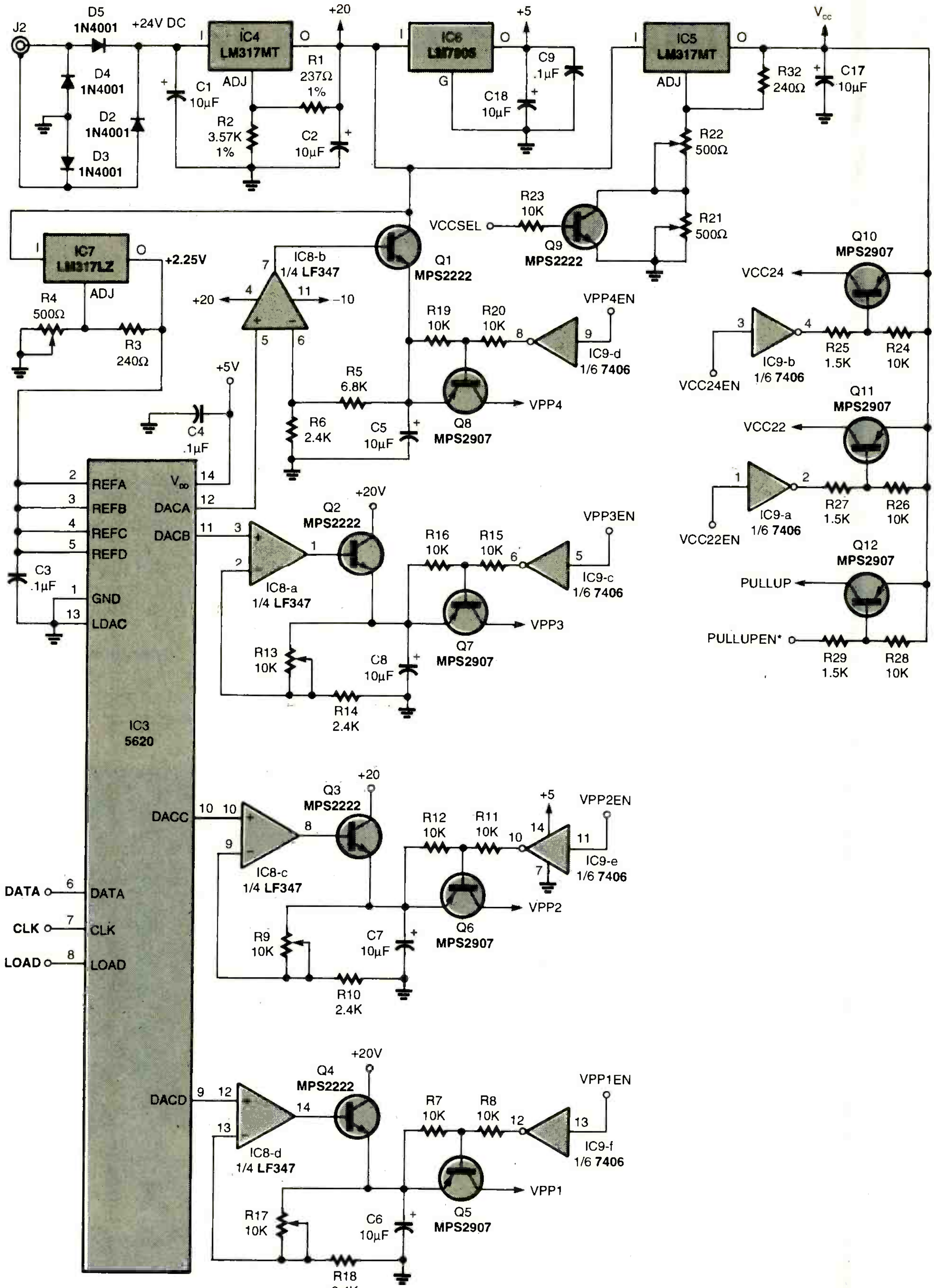


Fig. 1. The Alta Pro 2000 PLD programmer is designed for flexibility and non-obsolescence. Besides the different supply voltages generated by the various voltage regulators, a digital-to-analog converter can create any programming voltage needed by any device—past, present, or future.

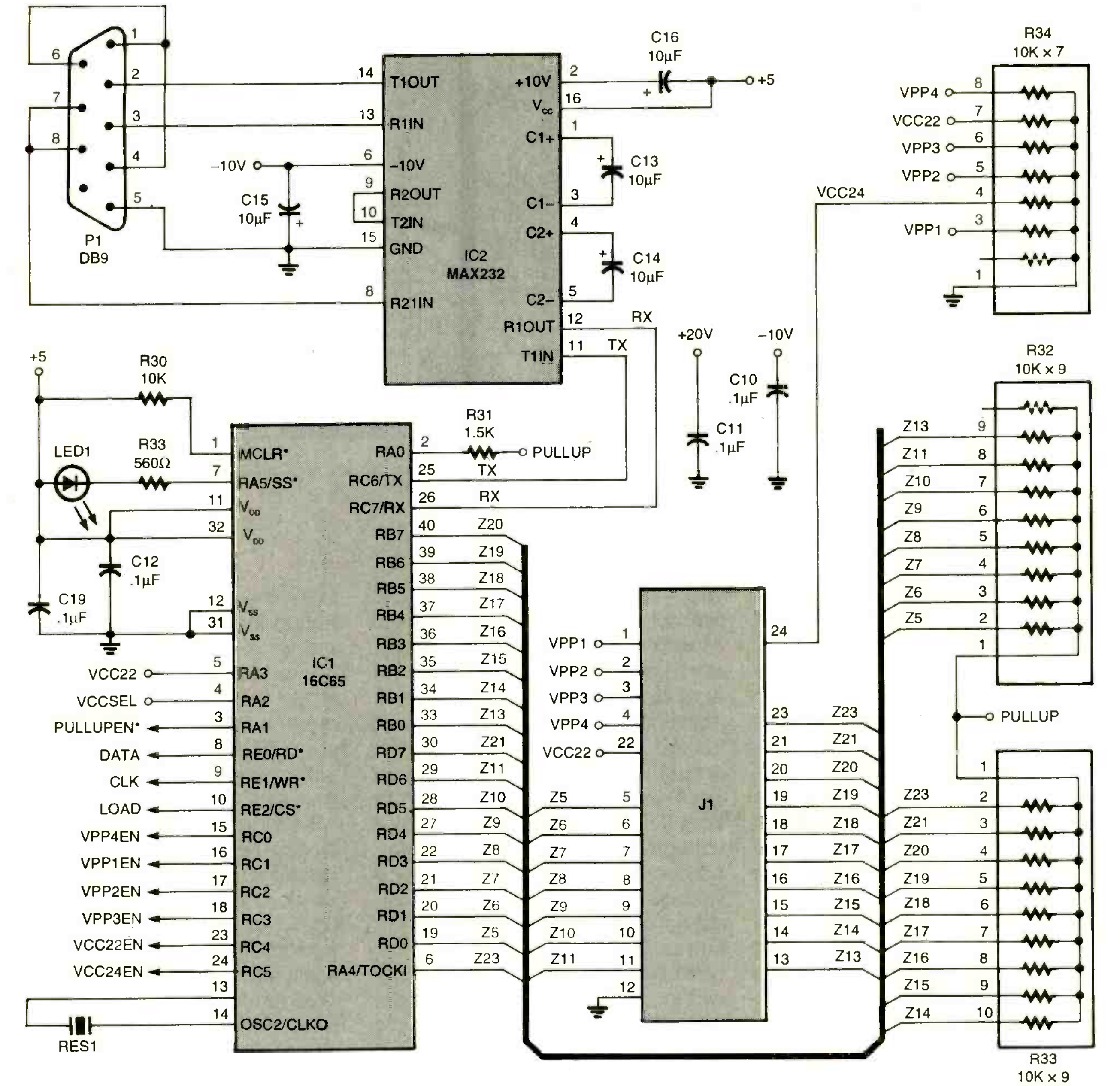


Fig. 2. The on-board PIC microcontroller takes commands from a host PC and manipulates the signals going to a ZIF socket holding the PLD being programmed.

put the chip into a "programming mode" or to store an electrical charge during the programming process. That voltage is usually higher than the device's normal operating voltage. For example, a standard 5-volt GAL22V10 requires a V_{pp} in the range of 10 to 16.5 volts on pin 2 during programming. In addition to controlling the super voltage, the device programmer must have precise control over the power (V_{ee}) and the logic-level signals supplied to the device.

Let's take a closer look at the Alta Pro 2000's circuitry; the schematic diagram can be found in Figs. 1 and 2. The unit has the capability of generating four simultaneous V_{pp} signals on pins 1, 2, 3 and 4 of the ZIF socket, J1. The voltage on each of those pins can be varied from zero to 17 volts. Generation of the super voltages starts with IC3, a TLC5620 quad 8-bit serial digital-to-analog converter (DAC).

As the name implies, the TLC5620 contains four DACs and uses a serial rather than a parallel interface. The use of a serial interface reduces the pin count and allows for a smaller package. The TLC5620 requires a reference voltage for each DAC; pin 2 is the reference voltage for DAC "A," pin 3 for DAC "B," pin 4 for DAC "C," and pin 5 for DAC "D." In this design, all of the DACs use the same reference voltage—about 2.25 volts as set by IC7. The TLC5620 has a built-in buffer amplifier for each DAC. The amplifier has a selectable gain of either one or two. When the gain is one, the buffered DAC output has a range of zero up to the reference voltage. When the gain is two, the DAC output can reach two times the reference voltage. The Alta Pro 2000 always uses

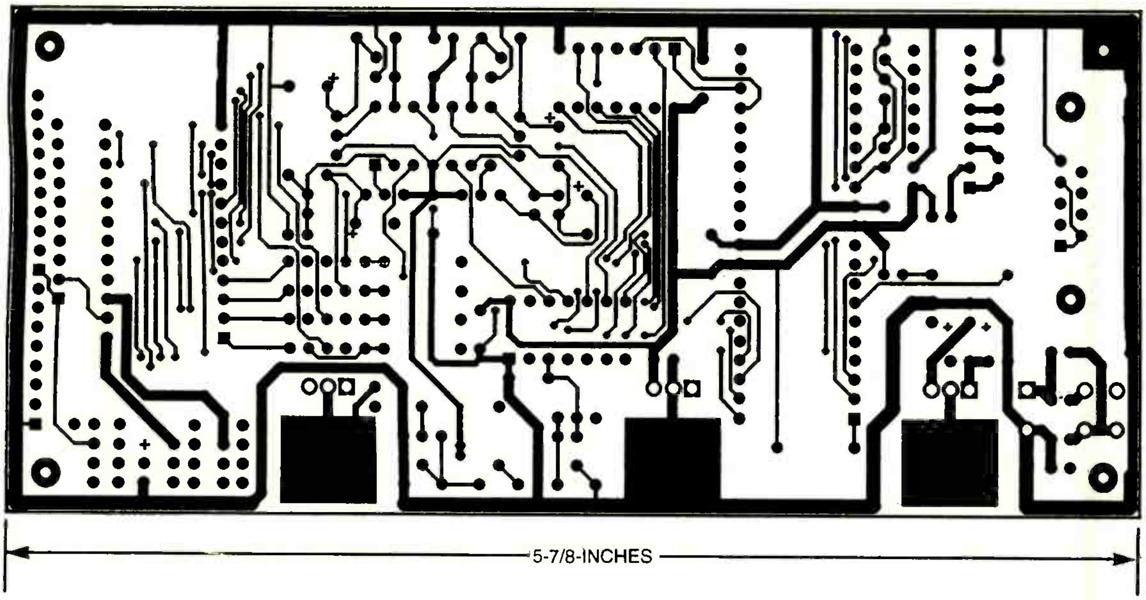


Fig. 3. The Alta Pro 2000 is best built on a PC board. Here is the foil pattern for the component side of such a board.

the 2X range.

Three pins are used for writing to the TLC5620: pin 6 is the data pin, pin 7 is the clock, and pin 8 is the load pin. To write to the DAC, an 11-bit command is clocked into the TLC5620 one bit at a time. The TLC5620 accepts each bit from the data line on the falling edge of the clock line. The first two bits select the DAC—00 for DAC A, 01 for B, 10 for C, and 11 for D. The third bit selects the range (buffer-amp gain)—0 for a gain of one and 1 for a gain of two. The final eight bits are the value to be written to the DAC, most significant bit first. After the 11 bits are clocked into the TLC5620, the load signal is pulsed low and the DAC output is updated.

Since the DAC output only goes up to about 4.5 volts on a gain setting of 2, we must amplify the voltage further to get a valid super voltage. I'll only describe the amplifier circuit for DAC A; note from Fig. 1 that the other three amplifiers are similar. The output of DAC A (IC3 pin 12) is fed into pin 5 of IC8-b, which is the non-inverting input of an LF347 quad op-amp. The op-amp is configured in a very standard non-inverting configuration with the addition of pass transistor Q1 on its output. The pass transistor has no effect on the gain of the circuit, but increases the op-amp's output-current ability. In effect, this part of the circuit is a voltage regulator—the output voltage is controlled by the input to the op-amp. As with any standard non-inverting op-amp circuit, the voltage gain is equal to the value of the feedback resistor (R5) divided by the value of the input resistor (R6) plus 1. In this case, the gain is about 3.8. With an input voltage of about 4.5 volts from DAC A, the maximum output voltage is about 17 volts. During calibration, the DAC reference voltage (supplied by IC7) is adjusted with R4 to give 17.0 volts at the output of IC8-b.

Transistor Q8 acts as a simple switch. When the enable signal (VPP4EN) at pin 9 of IC9-d is a logic high, the inverter's output (pin 8) goes low. Grounding the base of Q8 turns it on and connects the super voltage to pin 4 of the ZIF socket, J1. Otherwise, the voltage on pin 4 of J1 is pulled down to ground by one of the 10K resistors in resistor network R34 (see Fig. 2).

The outputs of the other three DACs are all handled in basically the same manner as the output of DAC A. The one difference is that the feedback resistor in the non-inverting op-amp circuit is variable. This allows each circuit to be adjusted individually, compensating for component tolerances and matching the 17-volt maximum output among all four DACs.

Power Supply. The Alta Pro 2000's power-input circuit was designed around the output of a 24-volt AC wall transformer connected to J2. Diodes D2–D5 form a full-wave bridge rectifier; any ripple is smoothed by C1. You could substitute a DC supply without affecting performance as long as there is a 24-volt DC level at the input of IC4.

The input voltage is regulated by IC4 to 20 volts. That voltage is used directly by some of the analog circuits in addition to voltage regulators IC5–IC7. The only fixed-voltage regulator, IC6, supplies 5 volts for the digital-logic components. Variable-voltage regulator IC5 provides either 3.3 or 5 volts to the device in the programming socket. The VCCSEL signal, when high, turns Q9 on, effectively shorting R21. The voltage output of IC5 is then set by R32 and R22. That potentiometer is adjusted for a 3.3-volt output. When VCCSEL is low, R21 is in series with R22, increasing the output voltage (as adjusted by R22) to 5 volts. We've already discussed the role of IC7's output and how it is adjusted by R4.

The Alta Pro 2000 communicates with a PC using an RS-232 serial port. A MAX232 level translator, IC2, handles the voltage shift needed when working with the RS-232 protocol. The reason I'm mentioning the serial interface chip in this section is that it takes power from the 5-volt supply and, using two internal charge pumps, creates +10

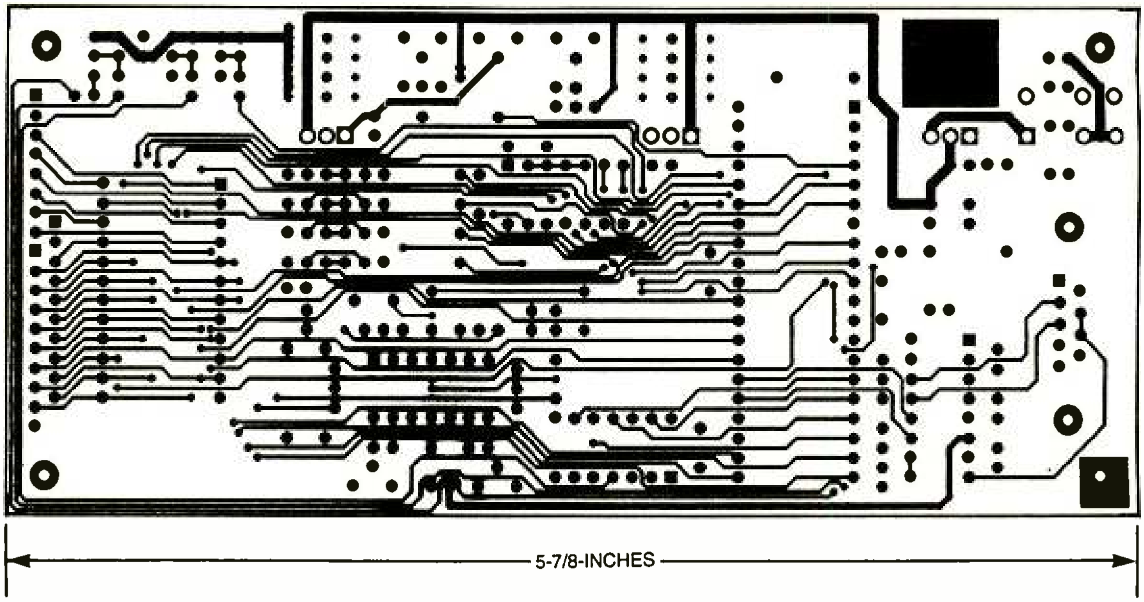


Fig. 4. The board design for the Alta Pro 2000 is double-sided. Getting this solder-side pattern to align with the component-side pattern will test the mettle of any seasoned hobbyist.

and –10 volts from the 5-volt supply. The chip produces the proper RS-232 signal levels using those voltages. In addition, the –10-volt supply produced by IC2 is used for the negative supply of IC8; the LF347 op-amp works best with a split-type power supply.

The Central "Brain." The on-board intelligence of the Alta Pro 2000 is in IC1, a PIC16C65A microcontroller. This is an expanded 40-pin version of the smaller PIC processors featured in many projects. The PIC16C65A has a built in UART for serial communications and 33 I/O (input/output) pins divided among five ports (designated PORT A through PORT E). Two of the I/O pins from PORT C (bits 6 and 7 on pins 25 and 26) are used for the serial port transmit and receive signals. The PIC's software takes commands from a host PC to configure, read, and write data among the rest of the I/O pins. We'll take a look at each pin's function on a port-by-port basis.

Port E—Three bits are used to control IC3. All of the pins for port E are configured as outputs. The functions of these three signals were previously covered.

Port C—Bits 6 and 7 of this eight-bit port carry the transmit and receive signals to and from IC2. The remaining six bits are all configured to be outputs. Bits 0 through 3 are used to enable the various V_{PP} signals to pins 1, 2, 3, and 4 of J1. Bit 4 is the VCC22EN signal that enables the supply voltage to pin 22 of J1. When this signal is a logic high at pin 1 of IC9, the output at pin 2 is low, which turns on Q11 and connects the supply voltage (either 3.3 or 5 volts) to pin 22 of J1. Bit 5 is the VCC24EN signal that works the same way for pin 24 of J1.

Port A—Bit 5 of this six-bit port lights LED1 when it is low. Bit 2 supplies the VCCSEL signal. When low, the supply voltage for J1 is 5 volts; a logic high changes the supply voltage to 3.3 volts. Bit 3, configured as an input, reads the logic level on pin 22 of J1. Bit 1 controls the PULLUPEN* signal. When PULLUPEN* is low, it turns on Q12. The switched voltage from Q12 (the V_{CC} voltage as determined by VCCSEL) is applied to the common pin of resistor networks R35 and R36. This provides a pull-up to the correct voltage on pins 5–11, 13–21, and 23 of J1. When not at a low logic level, bit 1 is "tri-stated" (no voltage level whatsoever), which turns off Q12 and removes the pull-up voltage. Bit 0 is connected to the PULLUP signal through R31. When the pull up on J1 is disabled, this bit can be set to a logic low level to provide a pull down on the aforementioned J1 pins. When not active, bit 0 is tri-stated so it doesn't interfere with the pull-up signals.

Note that I haven't mentioned Bit 4's function, because that will bring us to...

Ports B and D—Together with bit 4 of port A, ports B and D are used to provide logic-level control and status for pins 5–11, 13–21, and 23 of J1. Since the Alta Pro 2000 has the ability to program both 5-volt and 3.3-volt devices, it must be capable of working with either 5 or 3.3 volts for a logic-high level. For that reason, those signals are either configured individually to a logic-low level or tri-stated; they are never set to a logic-high level. If a logic-high level is needed on a pin, that bit is tri-stated and the pull-up resistors in R35 or R36 pull the pin up to the proper voltage level. The status of any J1 pin can be read by reading the port.

Communications. A protocol defines the communication between the PC and the Alta Pro 2000. There are commands that the PC can send to control all of the signals coming from the PIC16C65A, which, in turn, controls everything else on the board. For example, the PC can send either the command "5E" (hexidecimal notation) that tells the PIC to turn on the LED or "5F" that tells the PIC to turn off the LED.

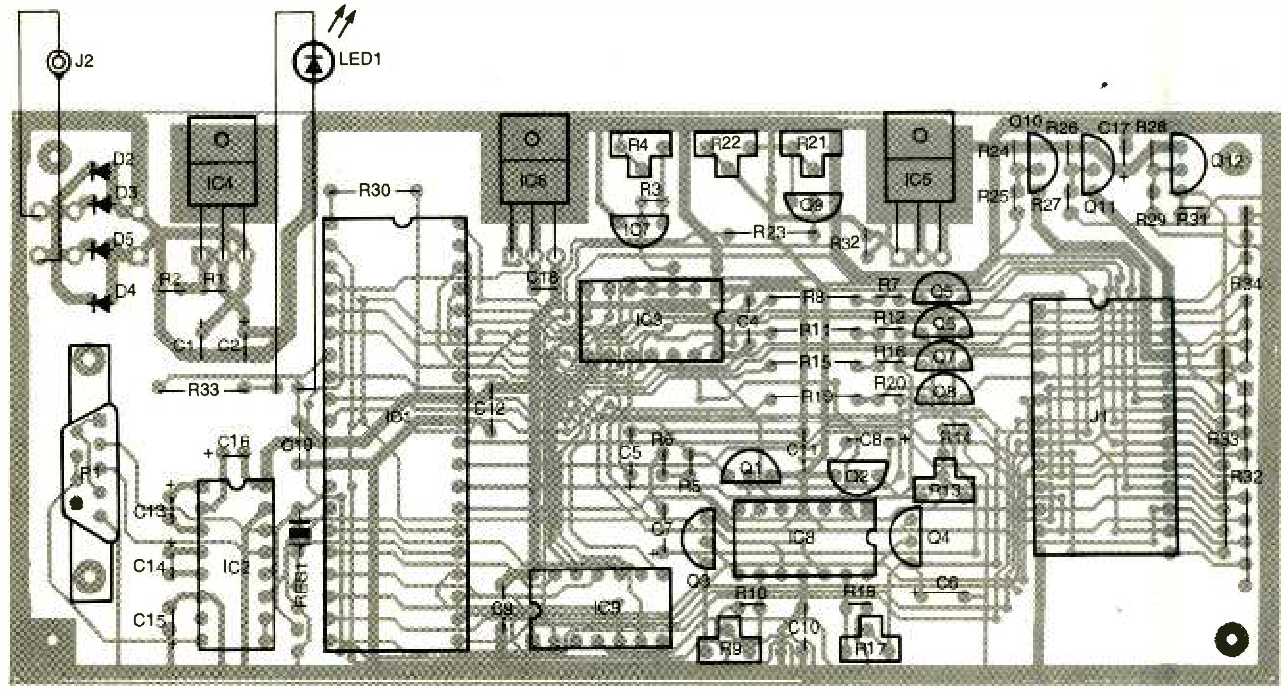


Fig. 5. Once you have an etched board, this parts-placement diagram will guide you in locating the components. Due to its compact size, many axial components are mounted vertically.

Other commands are more than one byte because they include data as part of the command. For example, the command 34 followed by the data byte FF tells the Alta Pro 2000 to write the value FF to the VPP4 DAC.

If you are interested in the complete protocol, it is defined in the file APPROCOL.TXT. That file is available for download from the Gernsback FTP site as part of the complete Alta Pro 2000 software package; more on that later.

Building The Alta Pro 2000. It is best to build the Alta Pro 2000 on a double-sided PC board with plated-through holes. Since the board is quite dense, a professionally made board with a solder mask and silk screen might be easier. A PC board is available from the source given in the Parts List. For those that would like to make their own board, foil patterns are shown in Figs. 3 (component side) and 4 (solder side).

You should use a clean, low-wattage soldering iron with a fine point. Assembling the board works best if you start with the resistors that lie flat on the board (such as R8, RII, R15, R19, etc.) and work your way through the components that stand higher off the board. Note that most of the resistors—as well as the diodes—must be installed standing up. Use sockets for all of the ICs and J1. We'll plug the ICs into their sockets as we test the board to prevent any defective parts or construction errors from destroying the semiconductors. Similarily, we'll plug the ZIF socket used for J1 into a standard 24-pin DIP socket to prevent damaging one of the most expensive components in the Alta Pro 2000.

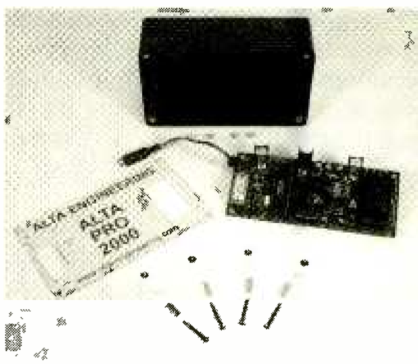
Note that a horizontal, or "laydown," style of potentiometer is recommended for R13. Using that style will make later adjustments easier.

When installing IC6, use a clip-on heatsink. The voltage regulator should be mounted so that the heatsink hangs about ½ inch over the board edge. The other regulators (IC4 and IC5) use bolt-on heatsinks. They should be mounted the same way—the heatsinks touching the board with a ½-inch overhang.

If you want, you can solder the leads from the 24-volt power source directly to the board. However, a coaxial connector that matches the plug on the end of the transformer makes using and transporting the Alta Pro 2000 easier. If you are using a DC supply, keep in mind that you don't have to worry about voltage polarity; the diode bridge will handle that chore.

Once everything is assembled, carefully inspect the board for construction errors such as bad solder joints or solder bridges. Inspection is a very important step since there are many different voltages on the board. A solder bridge from a higher-voltage to a lower-voltage signal can easily destroy a component—and I speak from experience!

Testing Your Handiwork. You should carefully bring up the board in the step-by-step manner described here. Start with all of the IC sockets empty and adjust all of the trim pots to their center position. First, check the supply voltages. Turn on



The Alta Pro 2000's PC board is mounted to the lid of the case using screws and spacers. You might need an additional IC socket to raise the ZIF socket to the proper height.

(or plug in) the power. Looking at the board with the DB9 connector on the left and, using the DC volts setting on your meter, measure the voltage at the rightmost pin on IC4 (referenced to ground). It should read in the range of 24 to 30 volts. Next, check the voltage at the center pin of IC4; it should read about 20 volts. You should also find 20 volts on pin 4 of IC8. The following locations should read 5 volts between them:

- IC1 pins 32 and 31
- IC1 pins 11 and 12
- IC2 pins 16 and 15
- IC3 pins 14 and 1
- IC9 pins 14 and 7

The voltage at pins 2, 3, 4, and 5 of IC3 should all be the same and read about 2.5 volts. Adjust R4 to get a reading of about 2.25 volts on those pins. Set the voltage at the center pin of IC5 to about 3 volts using R22 and, if needed, R21. Finally, test the LED by running a jumper from IC1 pin 7 to ground. The LED should light. If all of those tests pass, then you should power down. If not, you should correct the problem before going ahead.

Install IC2 into its socket and turn on the power. Check the voltage at IC8 pin 11. Iit should be at about –6 to –11 volts. If it isn't, check the circuit around IC2. Power down the unit.

You're now ready to install IC1. However, it must be programmed with the PIC software from the Alta Pro 2000 software package. You can download that package from the Gernsback FTP site; the URL is *ftp.gernsback.com/pub/pop/alta pro_2000.zip*. Unzip the file and "burn" the PIC software into IC1 using an appropriate PIC programmer. The software package includes a "packing list" text file describing the contents and purpose of each file in the package.

When IC1 has been programmed, install it and IC9 in their respective sockets. Connect the system to a convenient COM port on your PC. Turn on the unit, and from a DOS

The completed Alta Pro 2000 is ready to program any mainstream PLD. With knowledge of the Alta Pro 2000's interface protocol, programming requirements of a particular PLD, and a little skill in writing programs for the PC, the Alta Pro 2000 will never become obsolete...at least, not for a good long time.

window on your PC (you must have Windows95 or later) run the *apdiag* program followed by the COM port number you are using:

APDIAG <com port number (1-4)>

Although the host programs (the ones run on the PC) are DOS-based, they require a 32-bit operating system. If you try to use an older version of MS-DOS, you will simply be greeted by the error mes-

PARTS LIST FOR THE ALTA PRO 2000

SEMICONDUCTORS

IC1—16C65A microcontroller, integrated circuit
IC2—MAX232CPE or MAX232ACPE RS-232 translator, integrated circuit
IC3—TLC5620CN quad digital-to-analog converter, integrated circuit
IC4, IC5—LM317MT adjustable voltage regulator, integrated circuit
IC6—LM7805 5-volt fixed voltage regulator, integrated circuit
IC7—LM317LZ adjustable voltage regulator, integrated circuit
IC8—LF347 quad op-amp, integrated circuit
IC9—7406 open-collector hex inverter, integrated circuit
Q1–Q4, Q9—PN2222 NPN silicon transistor
Q5–Q8, Q10–Q12—PN2907 PNP silicon transistor
LED1—Light-emitting diode, any color
D1—Not used
D2–D5—1N4001 silicon rectifier diode

RESISTORS

(All resistors are ¼-watt, 5% units unless otherwise noted.)
R1—237-ohm, 1%
R2—3570-ohm, 1%
R3, R32—240-ohm
R4, R21, R22—500-ohm potentiometer, PC-mount
R5—6800-ohm
R6, R10, R14, R18—2400-ohm
R7, R8, R11, R12, R15, R16, R19, R20, R23, R24, R26, R28, R30—10,000-ohm
R9, R17—10,000-ohm potentiometer, vertical PC mount
R13—10,000-ohm potentiometer, horizontal PC mount
R25, R27, R29, R31—1500-ohm
R33—560-ohm
R34—10,000-ohm, 7-element resistor network, common return
R35, R36—10,000-ohm, 9-element resistor network, common return

CAPACITORS

C1, C2, C5–C8—10-µF, 25-WVDC, electrolytic
C3, C4, C9–C12, C19—0.1-µF, ceramic-disc
C13–C16—10-µF, 16-WVDC, electrolytic
C17, C18—10-µF, 6-WVDC, tantalum electrolytic

ADDITIONAL PARTS AND MATERIALS

J1—24-pin IC socket
J2—Coaxial power connector, cable-mount
P1—DB9 male connector, PC-mount
RES1—10-MHz ceramic resonator
Heatsinks (clip-on for IC6, bolt-on for IC4 and IC5), 24-pin zero-insertion-force (ZIF) socket, 24-volt AC or DC, 400-mA wall-mounted transformer, DB9 female-to-female cable, case, hardware, wire, etc.

Note: The following items are available from Alta Engineering, 58 Cedar Lane, New Hartford, CT 06057-2905; 860-489-8003; *alta@ieee.org*; *www.alta-engineering.com*: Software on 3½-inch disk, $10; Blank PC board, $35; Kit of board, all PC-mounted components, and software, $109; Kit of board, components, software, and case, $139; Kit of board, components, software, case, power supply, and cable (US only), $159. If you reuse the ZIF socket from the old Alta Engineering PLD programmer, save $20 on any of the complete kits. Please include $5 for shipping and handling in the US; $10 shipping and handling outside the U.S. CT residents must add appropriate sales tax. VISA/MC accepted.

sage, "This program requires 32-bit Windows."

If you have specified the correct COM port number and the program has established communications with the Alta Pro 2000, you will see a menu displayed. If the program can not establish communication with the programmer, you will get an error message. You will need to turn off the Alta Pro 2000 and check the cabling, verify the COM port number, and so on until you've corrected the problem.

Once you have communications with the Alta Pro 2000, you'll need to run several tests. First, using menu options 1 and 2, verify that you can turn the LED on and off. Next, select menu option 3, follow the instructions, and check and set the V_{CC} supplies. After that, select option 5 (skip option 4 for now) and follow the instructions for the port test (Ports A, B, and D refer to the ports on the 16C65A). Note that the tests for Port B and Port D are automated. If any of the test fail, you will need to solve the problem before continuing. You can use the low-level tests from option 6 to help with your troubleshooting.

If you've passed all the tests so far, power down the Alta Pro 2000, exit the *apdiag* program, and insert the last two ICs, IC3 (TLC5620CN) and IC8 (LF347).

Power up the Alta Pro 2000 and start the *apdiag* program again. Repeat the tests from above. Assuming that they all pass, select option 4 and follow the instructions for setting up the programming voltages (V_{PP}). If there are problems, you will need to track them down and correct them by following the signal path from the DAC output through to J1. If everything is OK, the Alta Pro 2000 is ready for use.

Install the unit in a suitable case. I mounted mine on the lid rather than at the bottom using screws, nuts, and long spacers. If you are using a metal case, be sure that the heatsinks for IC4 and IC5 do *not* touch the panel. The heatsink for IC6 should lay flat against the board and will press up against the panel. Use nylon washers between the board and the nuts so that the nuts do not short any of the traces on the bottom of the board.

A zero-insertion-force socket mounts in J1. You might find that a second 24-pin IC socket is needed between the ZIF socket and J1 so that the ZIF socket clears the panel.

Programming PLDs. To use the programmer, connect the unit to a serial port on your PC, power up the PC, power up the Alta Pro 2000, and start the program from a Windows95 or later DOS window with the command

altapro <x>

where x is the com port number connected to the Alta Pro 2000. A simple menu will be displayed. Before placing a chip in the ZIF socket, select the device type using menu option 1 (not having the correct device selected could burn out the chip).

The remaining menu selections should be self-explanatory. They allow you to read/write JEDEC files and load, program, and verify devices. If the device has a User Electronic Signature (UES), it is displayed for both the main and verify buffer in ASCII format.

That covers the details of the Alta Pro 2000. If you are new to programmable-logic devices, you should read some introductory articles such as the one that I wrote in the May 1994 issue of **Electronics Now**. Be sure to visit my Web site at *www.alta-engineering.com* for the latest information on the Alta Pro 2000, including an updated device list and any last-minute changes or additions. There are also links to PLD manufacturers so you can get data sheets and free development tools. If you have questions, you can reach me by e-mail at *alta@ieee.org*. P

PEAK COMPUTING

(continued from page 24)

tional light source. You mount the slide or filmstrip to the LightLid 35, place it on the scan platen, and set the TWAIN driver for transparent media rather than reflective. Then the ScanMaker V6USL will let you scan slides and film as well as paper originals.

To be honest, the quality of the scans when used in this mode, while acceptable, is not as good as using a specialized film scanner. At the same time, this feature comes free with a scanner that is, in other respects, an excellent value.

Like the Epson, the ScanMaker V6USL provides both USB and SCSI interfaces, making it usable with both PCs and Macs. A "Go" button offers single-touch scanning, and the scanner comes with a very nice bundle of software including *Photoshop LE, OmniPage LE OCR, PageKeeper* document-management software, and Microtek's easy-to-use *ScanWizard* TWAIN driver. Just to make the V6USL an even better value, it will scan documents up to legal size (8.5 × 14 inches).

TOO MANY FEATURES?

The three scanners presented here are all upscale models. You can get a basic scanner with 600- × 300-dpi resolution, for as little as $50 after a mail-in rebate. If you haven't used a flatbed scanner before, starting with one of these inexpensive models may be the best way to get your feet wet. Then, after you have some experience, you may be in a better position to decide exactly what features you really want and need. P

Capture voltages for easy measurement with the ANALOG MEMORY MODULE

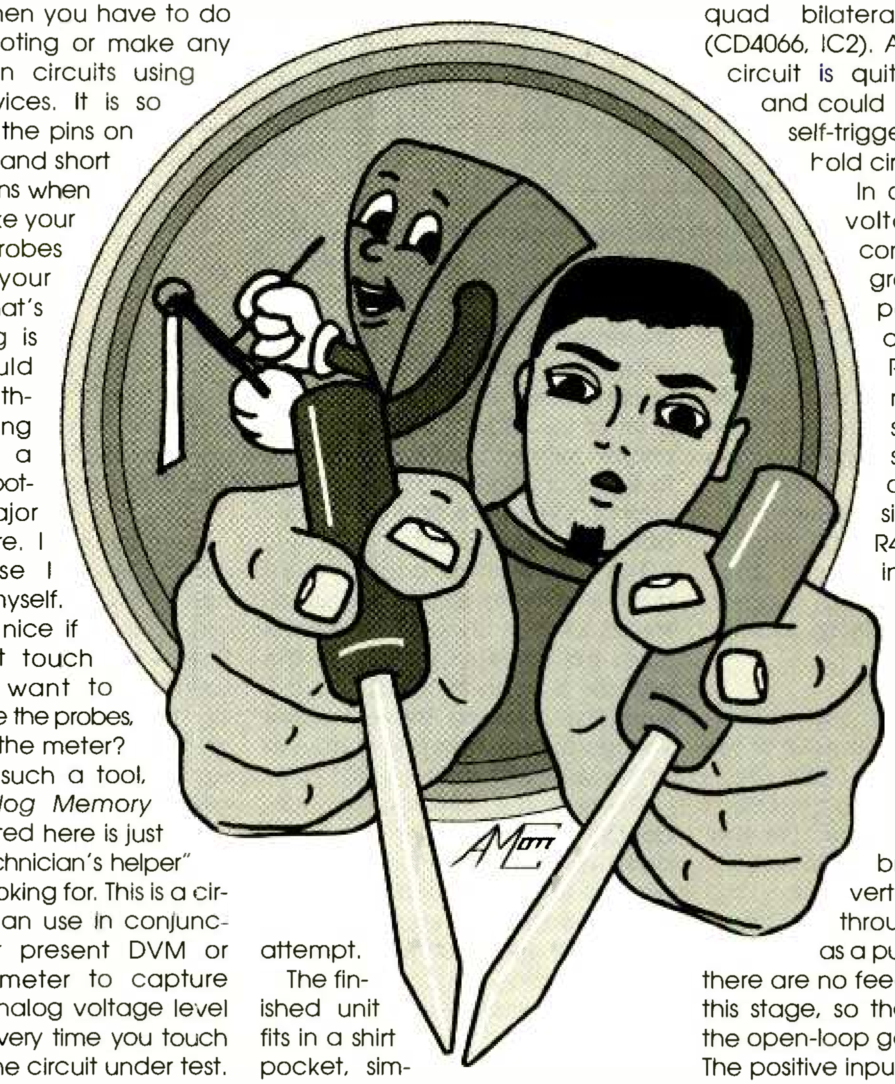
Having difficulty keeping your eyes on your probe tips and meter at the same time? An "extra set of eyes" is on the way!

STANLEY J. YORK

Do you work with SMDs, SOICs, or other surface-mount components? Do you have to troubleshoot these circuits down to component level because of their small size?

If you do, then chances are you get nervous when you have to do any troubleshooting or make any adjustments on circuits using those tiny devices. It is so easy to slip off the pins on those small ICs and short out adjacent pins when you have to take your eyes off the probes to look at your voltmeter. What's more frustrating is that you could damage an otherwise functioning part, making a simple troubleshooting task a major rebuilding chore. I know, because I have done it myself. Wouldn't it be nice if you could just touch the pins you want to measure, remove the probes, and then read the meter?

If you need such a tool, then the *Analog Memory Module* presented here is just the add-on "technician's helper" you've been looking for. This is a circuit that you can use in conjunction with your present DVM or Simpson-type meter to capture and hold an analog voltage level automatically every time you touch the probes to the circuit under test. You can then remove the probes and read your meter in safety. As a bonus, you don't need a third hand to press a "sample" button. In addition to analog-voltage retention, the circuit also captures pulse-amplitude readings without the need for you to go to the bother of dragging out your oscilloscope (if you have one) and try to set it up to catch the pulse on the first attempt.



The finished unit fits in a shirt pocket, simplifying the juggling of test equipment should you have to work in a confined area.

Circuit Description. The Analog Memory Module's schematic diagram is shown in Fig. 1; refer to it during the following discussion. The circuit is built around two commonly available ICs, a quad op-amp (LM324, IC1) and one section of a quad bilateral CMOS switch (CD4066, IC2). As you will see, the circuit is quite straightforward and could be described as a self-triggering sample-and-hold circuit.

In operation, the two voltage probes are connected to circuit ground (J1) and one point of the resistor-divider string (R1, R2, and R3) to reduce the input signal level to a safe value for the op-amp. The input signal is then fed via R4 to the non-inverting input of IC1-a. That op-amp acts as a unity-gain buffer for the following stages. The output from IC1-a is then split three ways:

Branch 1—The first branch feeds the inverting input of IC1-b through R5, which acts as a pulse generator. Note there are no feedback elements in this stage, so the gain is equal to the open-loop gain of the op-amp. The positive input is tied to approximately one volt above ground via resistor divider R6 and R7. Op-amp IC1-b thus serves as a comparator, generating an output pulse each time pin 6 rises above pin 5. These

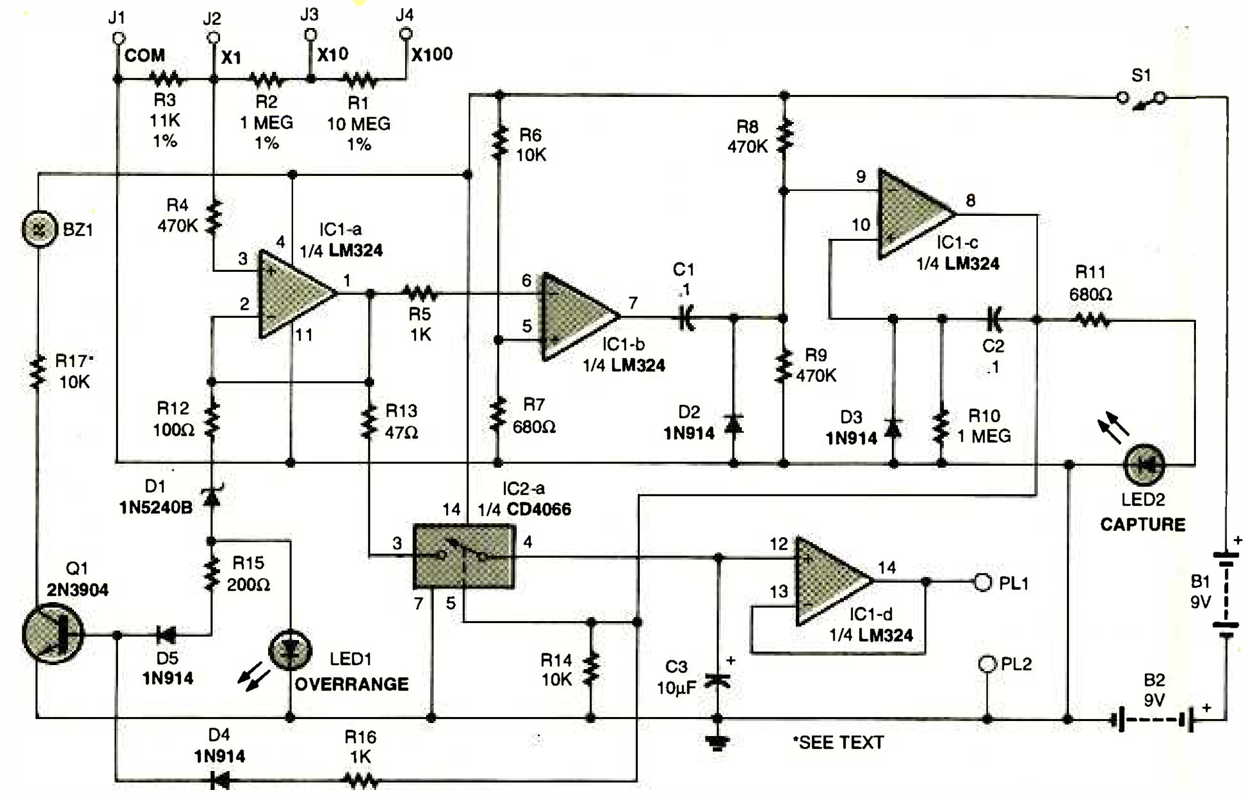


Fig. 1. The Analog Memory module is a basic self-triggering sample-and-hold circuit that can measure and capture DC voltages up to 1000 volts.

pulses are then AC coupled through C1 to the inverting input of IC1-c, which is wired as a simple one-shot monostable multivibrator. Diode D2 clips the negative-going portion of the pulse, preventing IC1-c's input from latching up. Resistor R10, along with C2, sets the time constant for the one shot. Each time the one-shot triggers, LED2 will emit a brief flash, indicating a signal capture.

Branch 2—The second branch from IC1-a goes to one input of the CMOS bilateral switch (IC2), which (in its untriggered state) presents a very high impedance (several megohm) to the signal. When the gate is triggered by IC1-c and the switch closes, the impedance across the device drops quickly to a very low value—typically a few tens of ohms. That lets capacitor C3 charge rapidly through R13 to the value of the incoming signal. When the one-shot times out, the CMOS switch opens again, preventing the charge on C3 from leaking off. The charge on the capacitor is then buffered by IC1-d before being presented to output terminal PL1. A convenient ground reference, PL2, accompanies PL1. The time constant of the R13/C3 combination is chosen for the fastest response time to signal change and best voltage retention. Here, the time constant is about one millisecond.

The time that the capture "window" is open to allow the capacitor to charge should be several times this value. In this circuit, the window is open for about 50 milliseconds, allowing the capacitor voltage to get within a few millivolts of the voltage on pin 1 of IC1-a.

At the same time that the window is open and LED2 is flashing, a pulse will also be driven into the base of Q1 via D4 and R16. When Q1 conducts, BZ1 sounds a short beep. The end result is that whenever a reading is successfully captured, the circuit will give both an audible and visual indication.

Branch 3—The third branch from IC1-a drives Q1 via R12, D1, R15, and D7. This branch will not do anything for a normal reading, but will become active only if the signal presented to IC1-a is too high, and therefore out of range. If that signal is over about 11 volts, Zener diode D1 will conduct. The current flow will light LED1 and turn Q1 on, sounding the buzzer.

How can you tell if the buzzer is alerting you to a successful capture of an overvoltage condition if you can't look at the LEDs? Simple—if the buzzer emits a long sound when trying to take a reading, then the signal is out of range and the voltage at PL1 is probably wrong; a short chirp means a successful capture.

With two 9-volt batteries powering the Analog Memory Module, full-range readings are accurate in the normal 0–10-, 0–100-, or 0–1000-volt ranges. The LM324 output can go within a volt or so of the supply rails, suggesting that the reading range could be extended beyond those presented here. Neverthe-less, it was decided to limit the output range to something convenient and to be in line with commonly available instruments.

Construction. Before you start construction, look at the Parts List to make sure you have everything you need. It is very frustrating to find half way through a project that a certain part is the wrong size or value. Also, at this stage, make sure that the components you are using will fit on the board and inside the case you have selected. If you have to use a part different than those specified, you should allow for changes on the board before you start construction, which might be difficult or impossible after assembly has started.

The prototype Analog Memory Module was built on a piece of RadioShack perfboard with special copper-trace patterns etched on one side. The following instructions relate to that method of construction. If you wish, you may certainly build the unit on a printed-circuit board. However, designing such a board is beyond the scope of this article and is left up to the reader.

The suggested component layout is shown in Fig. 2, with the wire interconnects shown in Figs. 3 and 4. Note how some components are mounted vertically while others are mounted horizontally. The diagram indicates which way to place the bodies of the vertical components. Most of the signal diodes are mounted vertically; they are mounted with their bands (cathode end) pointing up, away from the board.

One construction method is to install and solder the wires and small components first, working your way up to the larger devices. That way allows you to press the board down on a piece of soft foam rubber during soldering. That holds the components flat to the board while you solder them in place, resulting in professional-looking workmanship.

You could also install all components, "clinching" (folding over) and trimming their leads so that they lock into the board. You can then install the jumper wires without the occasional aggravation of undoing a connection that was soldered too early.

However you decide to build your board, check your work when you are done for the "usual suspects" of poor workmanship: bad solder joints, solder "bridges," missing components, incorrect values, polarized components installed backwards, and so on. It's usually a good idea to do this check after you've rested for a while. Any experienced electronics hobbyist can tell stories of looking over their work the next day and wondering, "How could I have been that sloppy?"

(Editor's note—Since it is a CMOS device, good design practice dictates that you should also ground all of IC2's unused input pins. Although the author's prototype works as advertised, it is always better to err on the side of safety.)

Once you are satisfied with your work, put a dab of RTV silicone insulation on R1's leads and solder connections. This resistor might see 1000 volts; the extra insulation will minimize the possibility of high-voltage creep or arc-over on the surface of the board.

Case Preparation. If you use both the board and plastic box recommended in the Parts List, you should have no problem fitting one inside the other. However, if you chose a different box or used different components, you should check to make sure that you have enough room to install the board, buzzer, batteries, and terminals.

Prepare the case while the RTV on the board is curing. On the author's prototype, the LEDs, S1, and the circuit board were mounted on the lid; the various jacks were placed on the ends. You can see the general layout in Fig. 5. When marking the holes for the circuit board, try to keep the board as far to one end as you can without the board interfering with the lip of the case and lid. You should also mount the board over the batteries, leaving room for S1's body at the "empty" side of the case.

A drilling guide for the terminals is

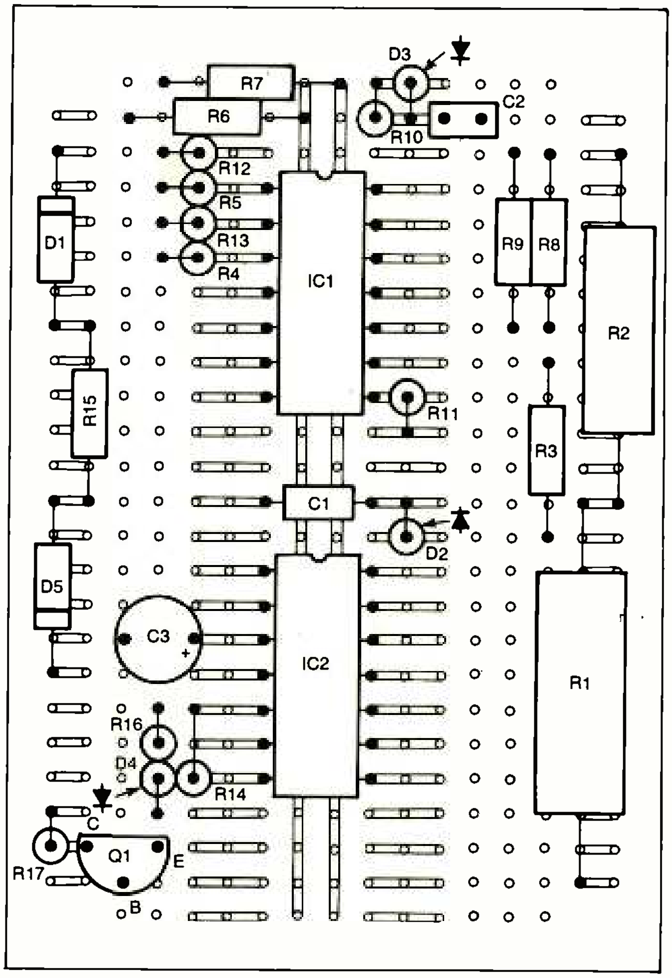


Fig. 2. The Analog Memory Module uses a plain experimenter's perfboard.

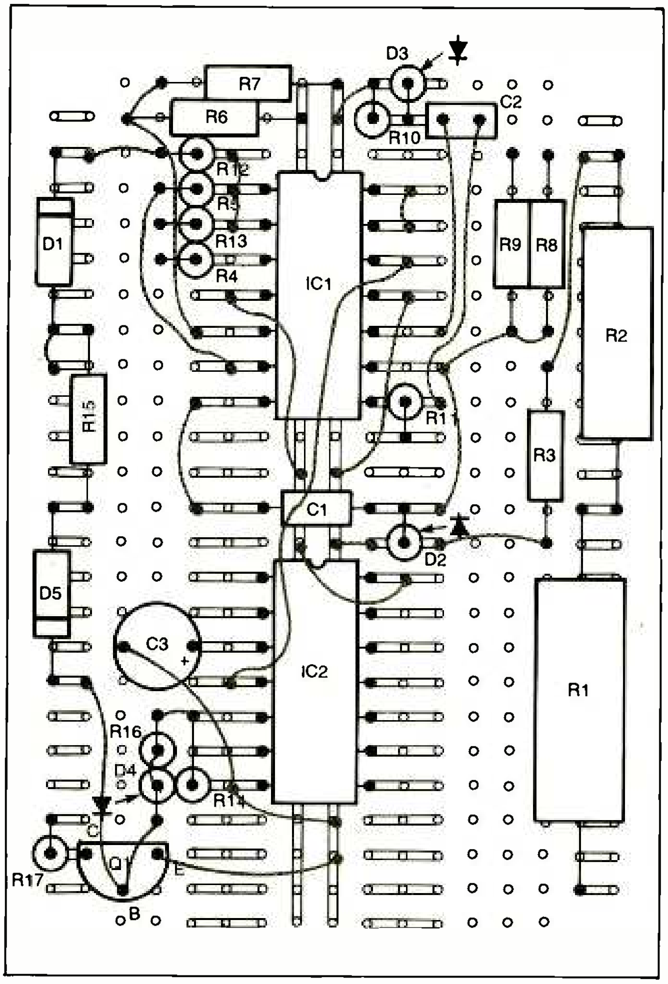


Fig. 3. Adding jumpers to the perfboard is as easy as "connecting the dots."

shown in Fig 6. Those jacks mount on the ends of the case. You might have to adjust the hole size to the particular jacks that you're using. Remember, J4 could potentially go up to 1000 volts, so try to allow as much space as you can around that terminal. Finish the outside of the case by applying press-on lettering to identify the terminals and LEDs.

The battery clips are mounted on a piece of plastic that measures 1½ × ⅜ × ¾-inch in size. Drill and tap three 4-40 holes through the block as shown in Fig 7. Mount the battery clips on one side of the block using short 4-40 screws. Place the assembly in the bottom of the box as shown in Fig. 5 and use another short screw through the small hole to hold the block in place at the end of the box.

Install the probe terminals next with solder lugs underneath the nuts. If you are careful and choose the right drill size, the LEDs can be press fit in place; a small dab of RTV can act as a "safety net."

The buzzer is small enough that it can be glued in the bottom of the case. Placing the buzzer near J1 is a good spot, leaving plenty of room to get the batteries in and out.

Mount the board to the top of the box using nylon screws only and test fit in the box to make sure you have adequate clearance around the high-voltage terminals. The use of nylon screws here cannot be overemphasized since the high-voltage end of R1 is very close to one of the nuts that hold the board in place.

Finish up the final assembly by installing all the wiring to the various switches, connectors, and battery clips (see Fig. 8). Use heatshrink tubing on all the terminals. As an extra precaution, the wire carrying the high voltage from J4 to the board should have a length of heatshrink tubing around it as well.

Testing And Calibration. To test the unit, you will only need a regular DVM or Simpson-type moving-coil meter.

Begin testing the board by installing one of the batteries and only *one* pole of the other battery; use your meter (set to a low-current range) to complete the circuit and measure current draw. Switch the unit on.

You might hear a short beep from the buzzer and one of the LEDs might briefly flash. After a couple of seconds, the current draw should be less than about 10 mA (in my units, typical current draw at this stage was about 5 mA with no LEDs on). There should be no LEDs illuminated, and the buzzer should be quiet. If you see much more current than this, you should turn the unit off and investigate. There might be a diode installed backwards or a wrong resistor value somewhere. Also, make sure that there are no solder bridges or other short circuits.

If everything checks out, turn the unit off, remove the meter probes, and connect the batteries properly. Insert the meter probes into J1 (black) and J2 (red). Set the DVM to the ten-volt range and plug the Analog Memory Module into the DVM (PL2 goes to the common input and PL1 goes to V_{in}) Turn the unit on.

The green "capture" LED may briefly flash, and the buzzer may emit a short beep. The DVM should be indicating no voltage or, at least, very little. If you see a high reading or if the voltage slowly rises on the meter, you may have a leaky CMOS switch or a bad op-amp. Replace those parts as needed before you go any further.

Touch the red test probe to the positive end of B1. The green "capture" LED should glow for about 50 milliseconds or so, and the buzzer should beep. The DVM should read the battery voltage (about 9 volts, depending on the health of the Analog Memory Modules batteries). The red "overrange" LED should remain off.

Now touch the red probe to the

PARTS LIST FOR THE ANALOG MEMORY MODULE

SEMICONDUCTORS

IC1—LM324 quad op-amp, integrated circuit
IC2—CD4066 quad CMOS bilateral switch, integrated circuit
Q1—2N3904 NPN silicon transistor
LED1—Light-emitting diode, red
LED2—Light-emitting diode, green
D1—1N5240B 10-volt, ½-watt Zener diode
D2–D5—1N914 silicon switching diode

RESISTORS

(All resistors are ¼-watt, 5% units unless otherwise noted.)
R1—10-megohm, 1%, 2-watt
R2—1-megohm, 1%, 1-watt
R3—111,000-ohm, 1%
R4, R8, R9—470,000-ohm
R5, R16—1000-ohm
R6, R14—10,000-ohm
R7, R11—680-ohm
R10—1-megohm
R12—100-ohm
R13—47-ohm
R15—200-ohm
R17—10,000-ohm (see text)

CAPACITORS

C1, C2—0.1-µF, ceramic-disc
C3—10-µF, 25-WVDC, electrolytic

ADDITIONAL PARTS AND MATERIALS

J1–J4—Banana jacks (to suit voltage probes)
PL1, PL2—Banana plugs (to fit meter)
S1—Single-pole, single-throw toggle switch
BZ1—Buzzer (RadioShack 273-059 or similar)
B1, B2—9-volt battery
Battery holders (RadioShack 270-326 or similar), battery connectors (RadioShack 270-325 or similar), plastic enclosure (RadioShack 270-222 or similar), perfboard (RadioShack 276-150 or similar), wire, meter probes, 14-pin IC sockets, 4-40 × ¼-inch spacers, 4-40 flat-head nylon screws, 4-40 nuts, etc.

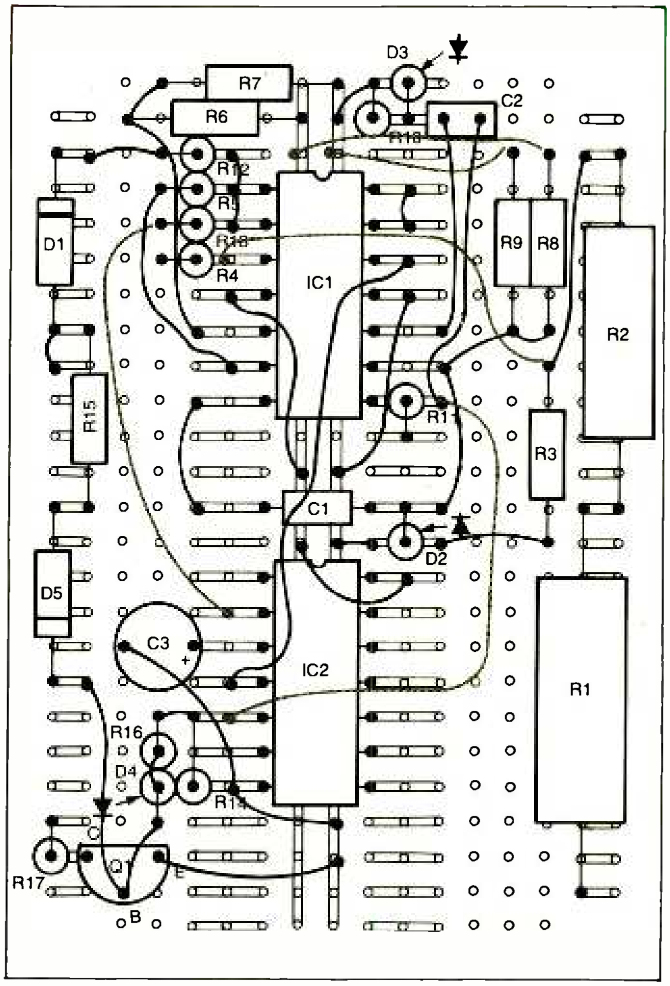


Fig. 4. Here are the rest of the jumper locations. You might want to ground the unused inputs on IC2 for added circuit stability.

positive end of B2. This time, in addition to the green "capture" LED, the red "overrange" LED and buzzer also come on and stay on as long as the probe is trying to read an 18-volt level. Touch the red probe to the previous test point and notice once again that the green LED comes on, but not the red one, and that the reading on the DVM returns to 9 volts or so. Move the red test probe to J3 (X10 position) and try the 18-volt test again. You should now obtain a normal reading without the overrange indication; the meter should read about 18 volts (1.8 × 10).

If you have access to a pulse generator, you can test the pulse-capture feature. Keep in mind that pulses must be longer than the 50 millisecond capture window designed into the circuit. Set up the pulse generator for a 100-millisecond single shot and the peak amplitude to some known level. Connect the pulse generator's output to the appropriate input jacks on the Analog Memory Module and your DVM to the module's outputs. Turn everything on and trigger the pulse generator. The Analog Memory Module should capture the pulse and display the amplitude on your DVM. Adjusting the pulse amplitude and triggering another pulse should capture and display the new value. Let's see you do that without the Analog Memory Module!

One final test before closing up the case is to compare the indicated voltage with the actual input voltage. A 3½-digit DVM is adequate for this test. If you use a Simpson-type meter, you should try to use the lowest voltage range available that will cover about 9 volts.

Measure and note—as accurately as you can—B2's voltage with the meter. Measure the voltage with the Analog Memory Module on the X1 range and compare the two readings. They should be identical (within a few millivolts, anyway). Any large difference should be investigated. You might have a bad op-

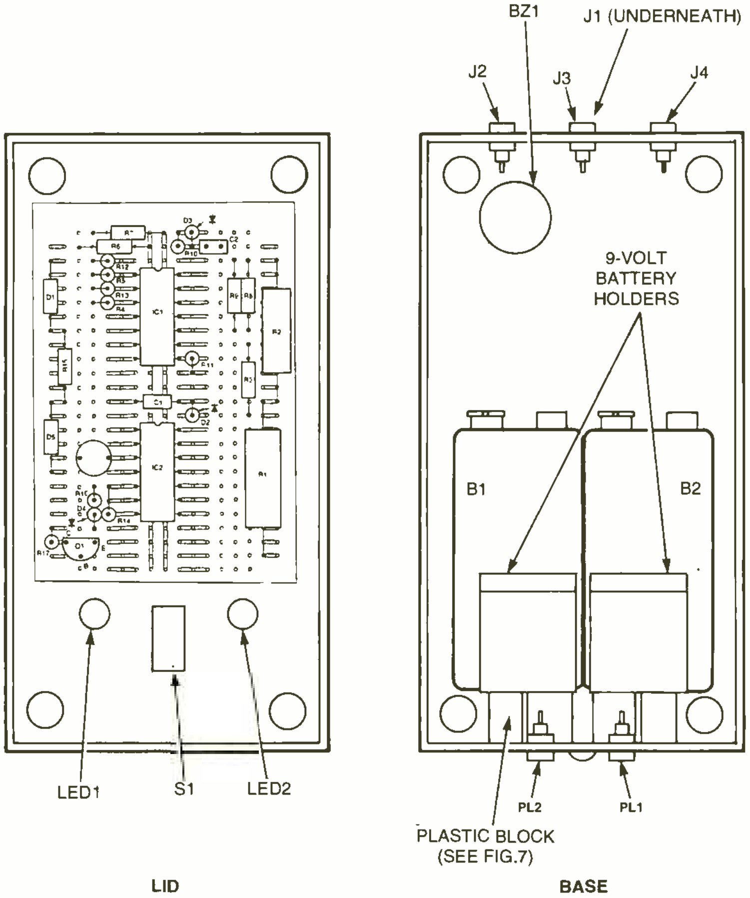


Fig. 5. The circuit board mounts on the case lid along with the controls and indicators. The main part of the case is reserved for bulky items like batteries and buzzers.

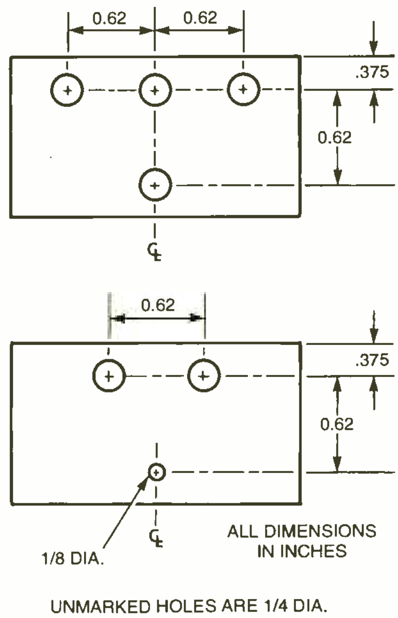


Fig. 6. The author's prototype has the connectors mounted on the ends of the case. One end is for the input jacks; the other is for the outputs (and for mounting the battery clips).

amp, a leaky CMOS switch or capacitor, or you may have a wiring error or wrong resistor value somewhere. If the readings are the same, switch to the X10 range and repeat the test, using both batteries.

If your unit passes this test OK, then you can go ahead and close it up. Make sure, when you do the final assembly, that you have adequate clearance around high-voltage resistor R1 and that the batteries cannot slip and touch the input or output terminals.

The completed Analog Memory Module is ready to make your life easier.

Using The Module. This device is good only on DC voltages within the range of 0–1000 volts, which should cover most situations likely to occur in your garage or hobby shop. There are, however, some suggested modifications at the end of this article that might extend the usefulness of the device.

In normal day-to-day use, you need only to connect your test probes to the input terminals and connect your DVM (set to the 10-volt range) to the output terminals. Each time you touch the test probes to a test point, the one-shot in the module is triggered and updates the reading on your DVM regardless of whether it is higher or lower than the previous reading. I found on one of my units that I sometimes had to stab the probe twice to get an accurate reading. If you find that you are getting inaccurate readings, it is probably because the timing is not exactly right between the CMOS gate opening and the charge building up on the capacitor. You may want to try stabbing the probe twice to see if your final reading is closer.

You don't necessarily have to connect the DVM to the device until after you take the reading. If you are in a cramped position—the back of a TV set, for example—you can take the reading with just the Analog Memory Module, go back to your workbench, and plug in your DVM. The unit has quite a

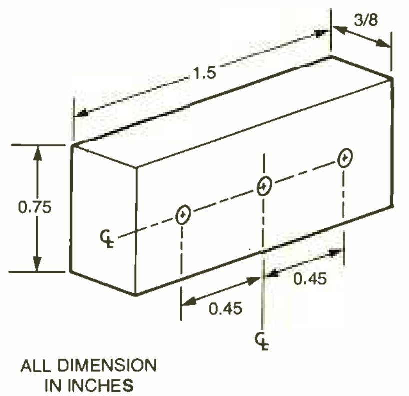


Fig. 7. This small plastic block holds the battery clips.

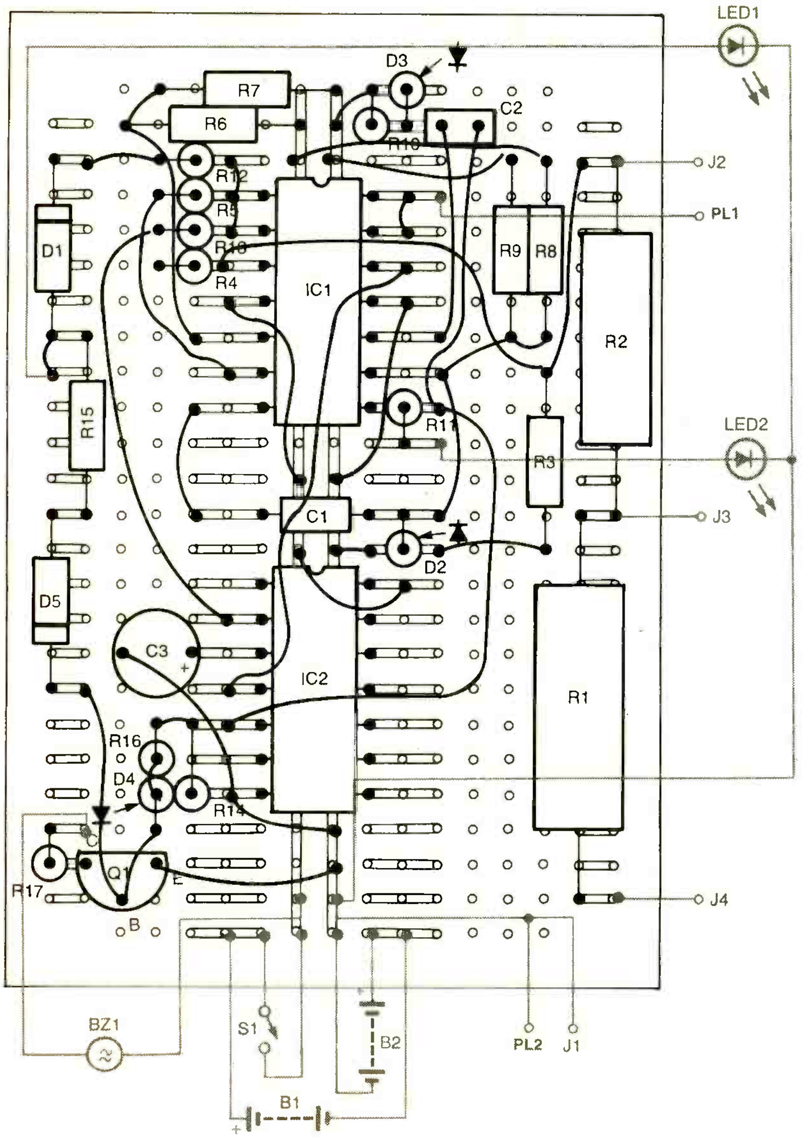


Fig. 8. When everything is mounted in the case, make the final wiring connections as shown here.

memory, and should retain the last reading for a couple of minutes if you were careful when building it and used good quality components.

Modifications And Suggestions. Although the Analog Memory Module is a valuable addition to your tool box, there are a few modifications you may want to consider.

To capture a fast or narrow pulse, it will be necessary to reduce the sample-and-hold circuit's time constant (IC2 and associated components) and the capture-window opening time. To do that, reduce the value of R13 or C3 to give the circuit a fast timing cycle and reduce the gate time on the CMOS switch by changing the values of R10 and C2 in the one-shot circuit. In any event, the window opening time must be shorter than the expected pulse width. Be careful when experimenting with these values, because they also affect the memory-retention time.

To make the unit a universal AC/DC module, some means of converting the AC signal to a DC level equal to the RMS value must be devised—a modification that is beyond the scope of this article. However, you could experiment with a different attenuator string and a rectifier arrangement or perhaps a precision-rectifier circuit using an op-amp. That would require more input terminals or an AC/DC switch.

A word on the buzzer: You might find that the suggested buzzer is too loud. That is why R17 is in the circuit—to tone the buzzer down. You may adjust the value of R17 to give the buzzer a comfortable sound level.

I have built several units for myself and friends. We've used them with everything from old Simpson meters to the latest digital offerings. Once you start to use the Analog Memory Module, you'll find that troubleshooting those SOICs or SMDs is not so bad after all. P

NEW LITERATURE
(continued from page 7)

Reprinted from *QST*, these collected columns are full of helpful tips on all ham subjects, from hand-held transceivers to antennas, from batteries to computers, and from digital modes to microphones. There are hundreds of ideas, projects, and techniques that will help readers solve problems, improve skills, and have more fun on the air.

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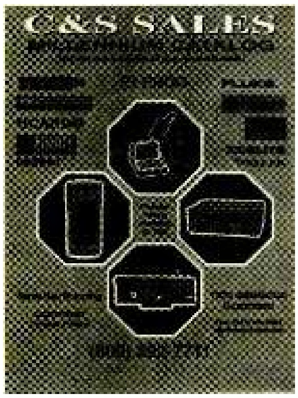
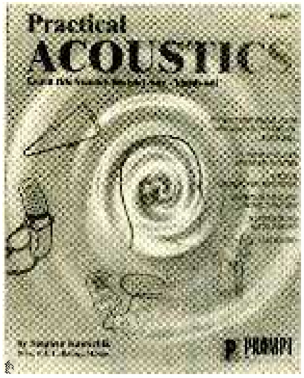


This 62-page full-color catalog includes products from Fluke, Elenco, Hitachi, and B&K Precision, among others. A color photo, full specs, description, and price information accompany each product.

It offers an extensive selection of capacitance meters, function generators, multimeters, oscilloscopes, power supplies, soldering irons, and hand tools, among other products. There are numerous kits: educational, robotic, solar, and solderless, as well as books and videotapes.

Practical Acoustics
by Stephen Kamichik
Prompt Publications
Howard W. Sams & Company
2647 Waterfront Parkway, East Drive
Indianapolis, IN 46214-2041
800-428-7267
www.hwsams.com
$29.95

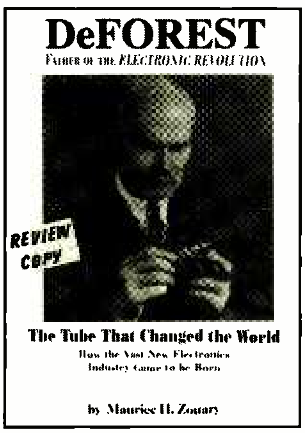


A full understanding of acoustics—the physics of sound—requires learning about both theory and practice. The book is a two-part in-depth study of the science of acoustics. The first part covers the theory, from acoustical waves and decibels to speakers and underwater acoustics. The second part contains eight chapters of projects, including speaker enclosures and a graphic equalizer.

It is a useful learning tool for the beginner, a resource for anyone who wants to refresh and update their knowledge, and a handy reference for anyone in the field.

DeForest: Father of the Electronics Revolution
by Maurice H. Zouary
1st Book Library
2511 West Third St., Suite 1
Bloomington, IN 47404
800-839-8640 (or-email pat@1stbooks.com)
www.1stbooks.com
$14.14 plus S&H (discount price through Web site only, higher price at bookstores and amazon.com)

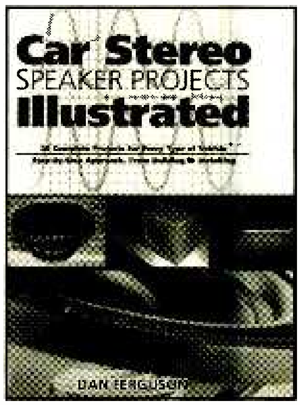
This 400-page "documentary in print and graphics" explores the beginnings of the electronics industry—how Lee



DeForest's invention of the Electron Tube Amplifier in 1906 changed the world. This book takes readers into his early research career—his failures, successes, and breakthroughs, looking at his pioneering in wireless telegraphy and his groundbreaking inventions.

The author owned and operated a library of stock footage of rare film starting from 1898, including early vintage films with soundtracks. After thorough and painstaking investigation, he discovered that those sound-on-film productions were the original production negatives of DeForest Phonofilms, produced between 1920 and 1927. (Exclusive examples of original DeForest sound-on-film productions in 35-mm blow-ups are included in the book.) This discovery led him to delve into DeForest's life and work and to his conclusion that Dr. DeForest should be recognized as the Father of Modern Electronics.

Car Stereo Speaker Projects Illustrated
by Dan Ferguson
McGraw-Hill
2 Penn Plaza, 12th Floor
New York, NY 10121
800-2MCGRAW
www.books.mcgraw-hill.com
$29.95



Speakers are the pivotal ingredients in any sound system. This heavily illustrated, step-by-step guide puts leading-edge auto speakers within anyone's grasp, with 20 complete speaker projects for all kinds of vehicles.

Using up-to-date designs and techniques, the author explains how to build and install speakers that put recording-

(Continued on page 56)

Changing Of The Guard

Q *Why are YOU the new moderator of the "Q & A" column?—D.H., Harviell, MO*

A I was wondering the same thing. I may still be wondering next year. Let's make that the first question this month.

After a great "term of office" by Michael Covington, I'll be taking the reins of the "Q&A" column beginning this month. I'm going to have to read the columns I write to find out why Larry Steckler and Joseph Suda selected me as the person to succeed Mike.

A hobbyist since 1960 (when I was in the fifth grade), I made electronics my profession—first as a technician and then as a teacher. Between the U.S. Navy and Tektronix, Inc., I spent 12 years on the bench as a test-equipment-repair and calibration technician. I began teaching electronics in 1982 at the Francis Tuttle Vo-Tech Center (now the Bruce Gray Technology Center) in Oklahoma City. After 15 years there, I moved to a teaching position in southeast Missouri.

My hobby started when I used a wood-burning iron to resurrect a three-transistor radio that I'd found in the trash. Over the years, I built a series of Knight-Kit and Heathkit test instruments and communications gear. I also built one of the first MITS Altair 8800 computers introduced in **Popular Electronics** back in January 1974. I love finding an application that can be satisfied with an electronic circuit and then designing, building, and testing that circuit.

I'm a stickler for the appearance of the finished product. Over the past several years, I've been finding great enjoyment in the restoration of antique radios and test equipment.

If I have one major fault, it would be that I'm frugal when it comes to my projects. Because I have a huge stock of TTL ICs and discrete semiconductors, I'll design a circuit using those components rather than using a microprocessor of some kind. The acme of this frugality came when I built a "Tektronix" 212 handheld oscilloscope and a 465DM44 portable scope, both constructed completely from discarded, defective circuit boards.

Binary-to-Bargraph Converter

Q *Is there an IC that converts a binary input into a bargraph-like output? It would be similar to a 3-to-8 decoder except that the output of lower order would stay low as the binary input is increased in value. A binary 111 would cause all of the outputs to go low.—A. G., Ann Arbor, MI*

A In a follow-up e-mail, A.G. independently came up with a solution identical to ours, as shown in Fig. 1. A cascading AND-gate structure at the output of a standard decoder gives us the bargraph display we need. If the binary input is 011, IC1-d will go low, disabling every AND gate under it and causing the respective LEDs to remain on. A four-bit circuit would require a 74154 and three 7408 AND-gate ICs. At that point, one might instead consider programming a pair of EPROMs for the proper logic and, depending upon the application, buffering the outputs.

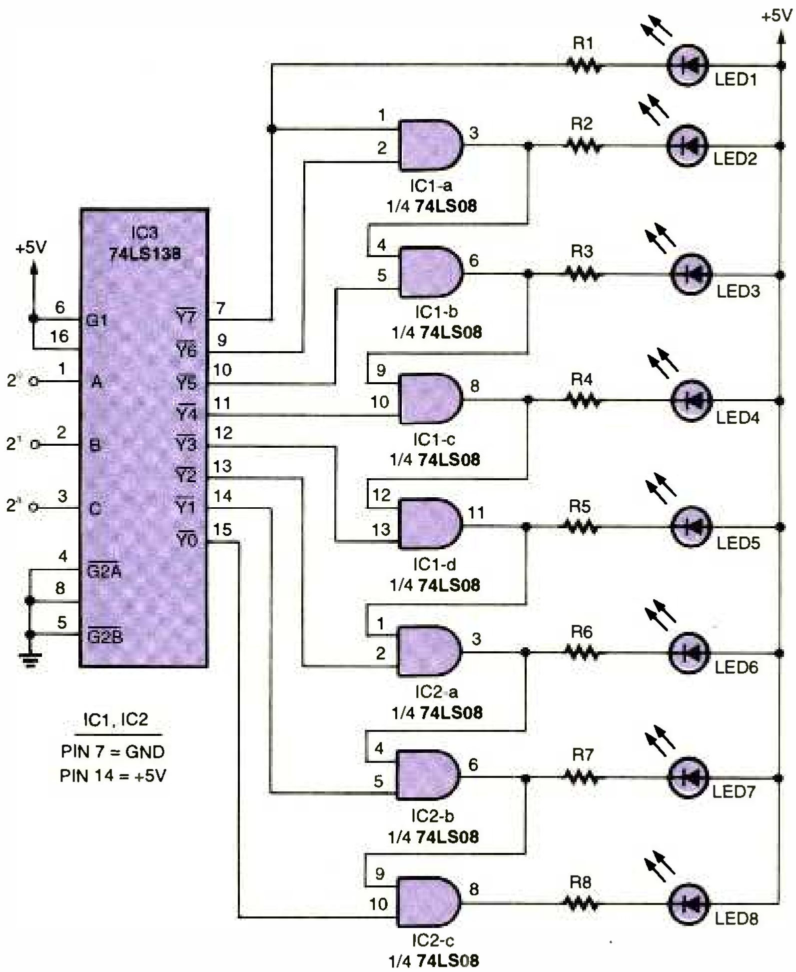


Fig. 1. This binary-to-bargraph decoder uses cascading AND gates. The circuit is easy to expand by continuing the obvious scheme with a larger decoder such as a 74LS154 and more gates or by using an EPROM as suggested in the text.

A DMM On A Car Battery

Q *How could I get to use my DMM on a car? The idea seemed simple enough, using a 12- to 9-volt adapter to connect my meter to the cigarette-lighter socket. When I try to do that, my DVM display shows "1" when I ground the negative lead and check a power line on the car's electrical system. What's going on?—M.H., Toronto, Ontario*

A The manufacturer of a line-operated digital multimeter (DMM) designs the instrument with the input leads isolated from the power supply and earth ground so that they can be reversed with no ill effects.

The hand-held DMM has inherent isolation in a plastic box. However, when you open up the battery compartment and connect the DMM right to the auto's electrical system, no longer is there any isolation between meter and the device under test—the car. Since you don't know how the supply and measurement section are interconnected internally, it's very possible that you are subjecting the DMM to the electrical equivalent of the mythical snake eating itself tail-first. In fact, I wouldn't be surprised if the display went a little nuts if you connected only one of the leads to ground or the hot wire. Moral of the story: drop $3 on a decent 9-volt alkaline battery and keep the car out of the innards of the meter. With the new battery installed, you might check the meter for any damage that may have occurred.

Finding Manuals

Q *You're my last resort. I was given a 1608A Impedance Bridge and a 1900A Wave Analyzer, both from General Radio, but I have no manuals or schematics. Where do you look for manuals? Are the instruments worth keeping and of what use would they be to a ham?—L.M., Eden Prairie, MN*

A Top-notch, lab-grade test equipment has been hitting the surplus shelves at bargain-basement prices over the past several years. However, manuals are rarely supplied with them, leaving a hobbyist without operating or maintenance information for some really complex instruments. There are several Internet resources for test equipment manuals. For less popular instruments, such as the GR brand, you have to search them all. For purchase, the 1608A manual can be found at *Manual Man* and the 1900A at *A.G. Tannenbaum*; both are available for rent from W.J. Ford. The manuals will explain how these instruments can be used in ham radio for your specific situation.

INTERNET RESOURCES FOR MANUALS AND INSTRUCTION SHEETS

bama.sbc.edu (downloadable—vintage equipment)
w7fg.com
www.acadia.net/guest/michelle (consumer electronics)
www.agtannenbaum.com/catalog.html
www.circuitarchive.co.uk/hewath.htm (downloadable Heathkit manuals and schematics)
www.columbiaelectronics.com/index.htm (military communications)
www.falls.igs.net/~testequipment/manuals.html (rental)
www.hi-manuals.com
www.manualman.com
www.manualsplus.com
www.nostalgiaair.org/NostalgiaAir/schematics/tel (downloadable—antique electronics)
www.one-electron.com/filing_cab.html (specific links to schematics)
www.sarrio.com/sarrio/rsfinal1.html
www.surplussales.com
www.tiac.net/users/mgasman (audio and video)
www.treasurechestcorp.com (consumer electronics)
www.vacuumtube.com/schemati.htm (vintage hi-fi)
www.vacuumtubes.com/manuals.html (tube testers)

The "How to Get Information" sidebar that accompanies each "Q&A" column is only a starting point. Many of our readers might be interested in a more comprehensive list of Internet sites, where you can find manuals and schematics for nearly anything having to do with test equipment, consumer electronics, communications, or antique electronics. I've listed some of those resources in the accompanying sidebar. Most have their manuals for sale; a few dealing with antique electronics are downloadable; and one has manuals that you can rent for a short time, copy, and return.

Readers, let us know if you have other manual sources.

What happened to C.R.E.I.?

Q *In the May 2000 issue, you answered a letter regarding the current location of National Technical Schools. I graduated from "CREI" (Capitol Radio Electronics Institute) in 1949 and have made my way in electronics through all the changes for 50 years. Not only did CREI teach me the state of the art in electronics as of 1949, but, more important, they taught me how to teach myself. Whatever happened to CREI? They also advertised in your magazine.—E.F., Macon, GA*

A CREI, located in the Washington, DC, area, not only had on-campus educational facilities, but they had the finest electronics-correspondence curriculum in the industry. While most correspondence schools pushed the test equipment and television kits that came with their courses, CREI was minimal on "hardware" and emphasized their detailed electronics-technology curriculum.

Capitol Radio Engineering Institute, like most institutions with "radio" in their names, realigned with current technology in the late 1970s and changed their name to Capitol College. They are now located at 11301 Springfield Road, Laurel, MD 20708; *www.capitol-college.edu.*

Dueling Radios

Q *I'm in a situation where I'm forced to reside in a very confined area, and the men in this place all have problems that we have termed "Riding the Radio." There are a lot of radios within this confined area, each with an external antenna attachment. In such close proximity, the radios tend to rebel at our feeble attempts to pick up any station other than the local one. It seems that at approximately every 10 MHz, we get interference that literally locks out all reception. If one person wants to listen to 102.3 and someone else close by wants to listen to 92.5, then we are constantly at war with each other over our stations. What is the cause of this interference? Can it be stopped? Can I scavenge parts from another radio to fix the problem?—K.K., Tennessee Colony, TX*

A Most inexpensive AM and FM radios have a local oscillator that is offset from the incoming station's frequency by 10.7 MHz (FM) or 455 kHz (AM). This local oscillator is like a little radio station in itself, mixing with the incoming carrier to form sum and difference frequencies. When one radio is in close proximity to another, these signals can be stronger than that of the radio station you're trying to receive. You'll notice that the two stations in question are offset by approximately the 10.7 MHz offset mentioned earlier. The automatic-frequency control of an FM radio tends to pull the tuning over to the stronger signal, and there goes your reception.

One possible solution is to turn off the AFC if you have control of that. If your neighbors are listening to FM, you can switch to AM and probably take care of the immediate problem. Of course, if there are a lot of folks on AM in close confinement, you will have similar trouble. Relocating the radio on a different wall and/or with a different orientation might help. Wrapping the radios in aluminum foil and grounding the foil to a cold-water pipe also may help, although you need to be careful doing that if the radio is a "hot-chassis" type with exposed metal parts. Switching to a modern synthesized radio could be the end of your problems, but that may also be an unreasonable solution. Beyond that, how about listening to cassettes?

Obviously, the solution cannot involve any "contraband" items, of which the aluminum foil may be one. Maybe some of our readers have some solutions to the "dormitory" radio duels.

HOW TO GET INFORMATION ABOUT ELECTRONICS

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

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

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

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

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

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

Copies of past articles: Copies of past articles in **Electronics Now, Popular Electronics** (post 1996 only) and **Poptronics** are available from our Claggk, Inc., Reprint Department, P.O Box 12162, Hauppauge, NY 11788; Tel: 631-592-6721.

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

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

Manuals for older test equipment and ham radio gear are available from Hi Manuals, PO Box 802, Council Bluffs, IA 51502, and Manuals Plus, 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; (*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.

Power-Supply Connections

Q *I have a Deltron RF20-1.5S power supply and would like to know what the symbols on the rear panel for the remote control mean.—S. G., San Leandro, CA*

A Todd Reichenbach of Deltron was kind enough to fax some data for the RP series, which is similar. "B–" is the negative output and "S–" is the negative sense; these are normally linked together. "V–" is the voltage programming. "B+" is the positive output, "S+" is the positive sense, and "V+" is the voltmeter positive; these three are normally linked together. "N" and "I" are for current programming and are normally linked together. "G" is chassis ground.

Power supplies with "sense" inputs can be used to deliver the intended voltage directly to the load, compensating for any IR drop in the connecting leads—especially important with long wires carrying high current. In this case, instead of running just two wires from the supply to the load, you would break the connection between the "B–" and "S–" and the "B+" and "S+" at the supply and connect the load with four wires. The far ends of the "B+" and "S+" wires would be connected together at the positive side of the load; the same is done to the far ends of the "B–" and "S–" wires at the negative side of the load. The actual current-carrying conductors on the "B–" and "B+" terminals need to be heavier to minimize voltage drop. The two voltage sensing conductors on the "S–" and "S+" terminals can be of a smaller gauge since they don't carry the load current.

In this remote-sensing configuration, the power supply adjusts its voltage so that the output voltage you select will appear at the load. The voltage at the supply output itself will be higher to compensate for the IR drop on the lines. If you want the programming information or manual, contact Deltron, Inc., P.O. Box 1369, North Wales, PA 19454; *sales@deltroninc.com*.

2360 JRC?

Q *I have a Smith-Corona 5A-1 typewriter with two blown ICs in the power supply. Those eight-pin DIPs are marked "2360D JRC." I haven't been able to find anything on them through catalogs or the Internet. Can you or other readers help?—B.M., Greensboro, NC*

A JRC may be the giveaway here, standing for Japan Radio Company. Their 2360 and 2360A are DC-to-DC converters in eight-pin DIP packages. You can find them at *www.njr.com/products*.

And Are These FETs?

Q *I have a serial interface with two transistors that I can't identify even after searching dozens of stores, Web sites, and catalogs. The manufacturer's logo makes me think that Harris Semiconductor is the manufacturer. The part number of the first is VN0610L; the other is VP0808L. Any help or cross-references would be great.—E. E., Clermont, FL*

A We immediately recognized the "VN" from VN10KN FETs. You have a couple of enhancement-mode MOSFETs there, and you can find the data on them on Siliconix's site at *www.vishay.com/brands/siliconix/*.

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, 275 G Marcus Blvd., Hauppauge, NY 11788, 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.

ELECTRONIC CIRCUITS

(continued from page 28)

goes to some other point in the external circuit. A stand-off insulator is shown here—a common method on TV/cable tuners—but other approaches are used as well. It is very important to keep the RFC-to-feedthrough-capacitor lead length as short as possible to limit additional pick-up beyond the filtering components.

Another approach is shown in Fig. 7. This method uses a separate shielded compartment inside the main shielded enclosure. Feedthrough capacitors C1 and C2 carry the signal (DC or a low-frequency signal) into and out of the filter compartment. An inductor, L1, is part of the filtering, so the combination L1-C1-C2 forms a low-pass pi-configuration filter. The inductor may also be an RF choke, but the effect is the same.

One caution is in order: if LC filters are used on both input and output signal lines of a circuit, make sure they resonate on different frequencies. This will prevent them from forming a tuned-input/tuned-output oscillator if the circuit being protected has sufficient gain at the filter's resonant frequency.

Connectors with built-in filtering (Fig. 8) are also available. These products are usually described as *EMI-filtering connectors*. Although most of them are designed to work with 120/220-volt AC power lines, others are available that work at higher frequencies.

One last approach is shown in Fig. 9. This application is a little harder to see because the "filtering" is performed by using a set of one or more ferrite beads slipped over the wire from the connector pin to the circuit board. Ferrite beads surrounding a wire act like a small value RF choke, so they will filter (typically) VHF/UHF frequencies. It is common to see these beads on RF equipment, but they are also found on digital devices as well.

General Guidelines. Thus far, we've looked at a number of different filtering approaches to protecting equipment. Now let's consider the general guidelines:

Always shield the circuit—A circuit that is not shielded cannot be adequately protected by filtering. There is simply too much chance of direct pick-up of the EMI/RFI source by the components and wires of the circuit. In addition, filtering of EMI/RFI generators (such as transmitters) will not help much if the device is not shielded.

Apply filtering to the DC power lines—Power-supply lines entering or leaving the circuit's shielded enclosure are virtual invitations for stray signals to enter your device and "crash the party."

Use the minimum filtering necessary—Overkill is not necessary for accomplishing the level of protection required. It does no good to add one more section of filtering when the job is done properly, but does add cost, complexity, and opportunities for failed components (which will keep the service technician busy, if nothing else).

Use the minimum values of capacitance or inductance—If it is necessary to filter signal-input and -output lines, choose values that are consistent with the degree of protection needed. Keep the cut-off frequency well away from the frequencies the circuit normally uses. The filtering will affect those frequencies as well as the undesired frequencies, so it is necessary to select values that minimize the effect on desired frequencies while maximizing the effect on undesired frequencies.

Final Notes. Filtering the DC power and signal lines entering or leaving a shielded circuit will go a long way towards eliminating any EMI/RFI problems that occur. There are, other active-filter techniques that can be used, but that subject can (and does) take up entire books. After all, the KISS principle—keeping it simple and stupid—increases reliability in the ling run. Isn't that what we set out to accomplish in this article?

mailto: amazingscience@gernsback.com

JOHN IOVINE

Fuel Cells

We're going to start a short series on fuel cells. This month, we'll look at the status of fuel-cell technology, and we'll discuss how to construct a few different types of fuel cells in later columns.

Fuel cells came into public awareness in the early 1960s when NASA determined that fuel cells would be an ideal power source for America's spacecraft. Not only did fuel cells generate electric power, their waste product was drinkable water for the astronauts. The American space program, starting with Gemini series of spacecraft, had fuels cells as an integral part of the power supply.

That connection with space flight certainly promoted a high-technology aura around fuel cells. The truth of the matter is that fuel cells are not new devices. William Grove constructed the first electric-power-generating fuel cell back in the 1830s.

A Short History

The history of the fuel cell actually begins in 1786 when Galvani (an Italian anatomist) discovered that a dead frog's leg would twitch when touched with two different metals at the same time.

In 1800, Alessandro Volta replaced the frog legs with a cloth soaked with salt water. He placed alternating discs of zinc and silver separated by a wet salt-soaked cloth and created the first battery (Volta's "pile"). Within a few weeks of this discovery, the English scientists William Nicholson and Sir Anthony Carlisle performed the first electrolysis demonstration, breaking water down into oxygen and hydrogen.

The next step occurred in 1838, when William Grove demonstrated that the electrochemical dissociation of water is reversible. Grove trapped hydrogen and oxygen in an electrolytic cell in a way that the gases remained in contact with the solution and the platinum gas-generating electrodes. After electrolysing the water, Grove disconnected the battery. A meter connected to the two electrodes showed an electrical potential of about one volt.

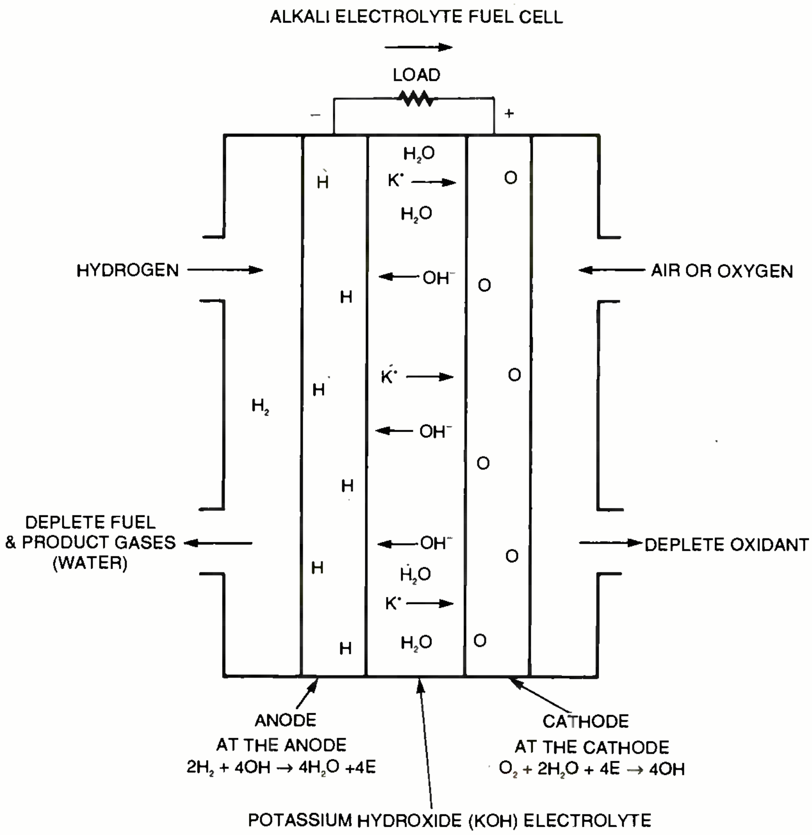


Fig. 1. Here is a cross-section of a typical fuel cell.

Batteries With A Fuel Tank

Fuel cells and batteries are both electrochemical devices that convert chemical energy into electrical energy. In a battery, the chemical reactants are stored internally. When the reactants are exhausted, the battery is replaced (or in some cases recharged). Fuels cells use reactants (fuel) stored externally. As long as there is fuel, a fuel cell will (in theory at least) continue to generate electricity.

Figure 1 is the schematic of an alkali fuel cell. We'll be building such a cell when we're ready to "get our hands dirty." This is the type of fuel cell used in U.S. spacecraft. The first oddity that you might notice is that the anode is labeled "–" and the cathode is labeled "+!" When I first started looking at fuel cell schematics, I found this confusing. Actually, I though it was a mistake, but after looking at a few dozen schematics with the same error, I realized it couldn't be a mistake. Accordingly, I checked the definition of cathode in Oxford's Dictionary of Current English. It reads in part:

Cathode—1. negative electrode in an electrolytic cell. 2. positive terminal of a battery.

I only bring this up so that you don't become confused when studying other schematics of fuel cells, since all the schematics I've seen so far follow this convention.

We'll go over the actual electrochemical mechanism involved in generating electricity when we build this fuel cell.

Fuel-Conversion Efficiency

The internal-combustion engine—ubiquitous in our culture and civilization—is a common measuring stick of fuel efficiency. Something that uses fuel more efficiently than an internal combustion engine is good, something less efficient is bad.

Here is where fuel cells shine. They have efficiency that is two to three times greater than the internal-combustion engine. Why is a fuel cell so much more efficient? An internal-combustion engine burns fuel, so the fuel is first converted into heat, and then into mechanical energy. The thermodynamics efficiency of a heat engine is given by the *Carnot cycle*, which states that even under ideal conditions, a heat engine can not convert all the supplied heat energy into mechanical force.

A fuel cell chemically converts the reactants into electricity without any intermediate heat-to-mechanical energy step. That's the fuel cell's "ace in the hole," yielding efficiencies that exceed the Carnot limit. A fuel-cell car will get much better mileage per "gallon" of hydrocarbon as compared to an internal-combustion engine.

Fuel cells are also more environmentally friendly than traditional fuel burners. When using hydrogen and oxygen as fuel, the fuel cell produces electricity, water, and heat.

The Electric Car

Many people assume that rechargeable batteries will be the power source for electric vehicles (EV). Fuel cells, however, are better candidates. Rechargeable batteries are heavy and require a substantial amount of recharging time. Fuel cells, on the other hand, are smaller and lighter; they generate electricity as long as they are supplied with fuel.

When a fuel cell starts running low, it can be simply refilled with fuel, much like today's automobile. A fuel-cell-powered vehicle will be able to get back on the road quickly as compared to waiting for batteries to recharge.

Fuel-cell technology is at the forefront of the technology for the new "zero-emission" cars that soon will be required by some states. For example, ten percent of all the new vehicles sold in California after 2003 must be zero-emission vehicles.

I've Seen the Future...Is it Hydrogen?

The vast majority of fuel cells are hydrogen/oxygen based. The hydrogen can be a pure gas, a liquid, or a gaseous hydrocarbon. Hydrocarbons are more energy dense than pure hydrogen and provide longer run times. Some examples of liquid hydrocarbons are methanol, ethanol, and gasoline. Examples of gaseous hydrocarbons are methane and propane.

The argument against using hydrogen gas is the storage difficulty due to the tank size needed for reasonable run times or trip distances between refills. Alternatives to large storage tanks may be found in *hydrides*, materials that can absorb, store, and release large quantities of hydrogen gas. More work and development needs to be performed with hydrides before they are of practical use.

Using Energy-Dense Hydrocarbons

I've already mentioned hydrocarbons as an alternative fuel-cell fuel. The trick is in releasing the hydrogen from the fuel. One way is *reforming* the fuel to release hydrogen gas from the hydrocarbon. Steam and high temperatures, for instance, reform natural gas.

A new gasoline-based fuel processor and fuel cell was developed under a partnership that included the U.S. Department of Energy, Arthur D. Little, Plug Power L.L.C., Los Alamos National Laboratory, and Ballard Power Systems. The advantage of this new system is that it can use the existing gasoline-station infrastructure for fuel distribution. The fuel cell runs 100 times cleaner than a conventional engine with 50% less greenhouse-gas emissions and doubled fuel efficiency. This technology is being held back because high-volume manufacturing technologies still need to be developed to reduce overall cost. In addition, performance and durability tests remain to be completed. What good is a clean engine if you need a new one every few months?

The other alternative is to use the hydrocarbon directly in the fuel cell. Ray Gorte, head of chemical engineering at the University of Pennsylvania, recently developed an experimental solid-oxide fuel cell. This new fuel cell only delivers about one-tenth the power of a hydrogen-oxygen cell and is sensitive to sulfur. Sulfur essentially poisons the cell, so gasoline would need another cleaning step to reduce its sulfur content.

Other Applications

Fuel cells have other uses than the automotive field. For example, fuel cells can supplement power stations. The need for an additional 1.7 trillion kilowatt-hours of electric power is forecast over the next 20 years. Hopefully, the higher efficiency of fuel cells over traditional "burned" fuels will help meet those needs in a more environmentally friendly way.

Other power-generation uses include remote site power and backup and primary power generation for industrial buildings, hospitals, and possibly private homes. Because the fuel cell is more efficient than traditional burned fuels, reliance on imported energy can be reduced.

We can "think small" with fuel cells as well. Just about anything that uses a battery can benefit from fuel-cell technology. A few applications already in the works are an aluminum/air fuel cell for cellular phones and a fuel cell for laptop computers.

If Not Now, When?

With all the wonderful attributes of fuel cells, where are they? Why don't we see them in our laptop computers, video cameras, and cell phones? While fuel-cell technology has improved much over the last decade, they still are not competitive (read: cost-effective) with existing technologies.

One of the more advanced fuel-cell designs uses a membrane material from DuPont call *Nafion*. The raw material costs about $100 per square foot. Reducing existing membrane cost and developing other membrane materials are on a high-priority list for creating competitive fuel cells. Additionally, fuel-cell electrodes are typically coated or plated with platinum—an expensive metal.

We'll start seeing fuel-cell technology in the automotive industry. All of the major automobile companies have ongoing fuel-cell research and development programs. The list of industrial companies working on fuel-cell technology reads like a "Who's Who" of science research. There is much enthusiasm and support for continued research and development of fuel cells. Recently, President Clinton and Congress allocated $100 million for the continued development of fuel-cell technology.

With this basic knowledge under our belt, we can start building different types of fuel cells. We will also build a bug battery. The bug battery is really a fuel cell that uses microorganisms to generate fuel for the fuel cell.

See you then. P

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Berwyn, IL 60402

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Mt. Prospect, IL 60056

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DIGITAL DOMAIN

(continued from page 20)

"luxuries" such as bulk mailing and chain letters. In addition, new hazards are among us. Never before had little Johnny been afraid to open his birthday card and become infected by a virus. Nowadays, one false move while checking your e-mail could set off The Apocalypse—just kidding.

I WOULD NOT EAT TEN "MEGS" OF SPAM

If you're on line, you've undoubtedly received "spam"—unsolicited, untargeted bulk e-mail. Typically they are ads for illegal "Make Money Fast" pyramid schemes, pornographic pay Web sites, quack healthcare remedies, or other come-ons of interest only to the gullible or desperate.

Spam, which conjures up images of fatty, low-cost luncheon meat (a trademark of Hormel, Inc.) and Monty Python skits, is nearly universally reviled, the most notable exceptions being the marketers who must manage to snag at least a few unwitting victims to make their seamy endeavors appear worthwhile.

Unlike postal junk mail, spam places most of the cost burden on recipients and the larger infrastructure. That's why it has long been a violation of Internet norms and why respectable businesses refrain from it. Spam has been the focus of court cases that have been hugely expensive for spamsters caught in the act and the subject of proposed federal legislation.

E-MARKETS

You might therefore think that e-mail is the last tool you should use for marketing and public relations. Not necessarily.

Using e-mail, organizations can reach out to prospects, and organizations as well as individuals can reach out to the media, without incurring the wrath of those you're trying to influence. You just have to know what you're doing.

With e-mailing marketing, the golden rule is receiving permission: You need recipients' permission to use their e-mail in-boxes.

You can do this yourself by offering visitors to your Web site the option of receiving e-mailings from you. To entice people to receive—and continue to receive—your commercial messages, you should provide useful, noncommercial content along with your marketing material

Another option is to contract with an "opt-in" bulk e-mail company. Opt-in companies compile lists of people who have opted to receive e-mail about specific types of products or services. These companies will rent their lists to you or carry out an entire marketing campaign for you.

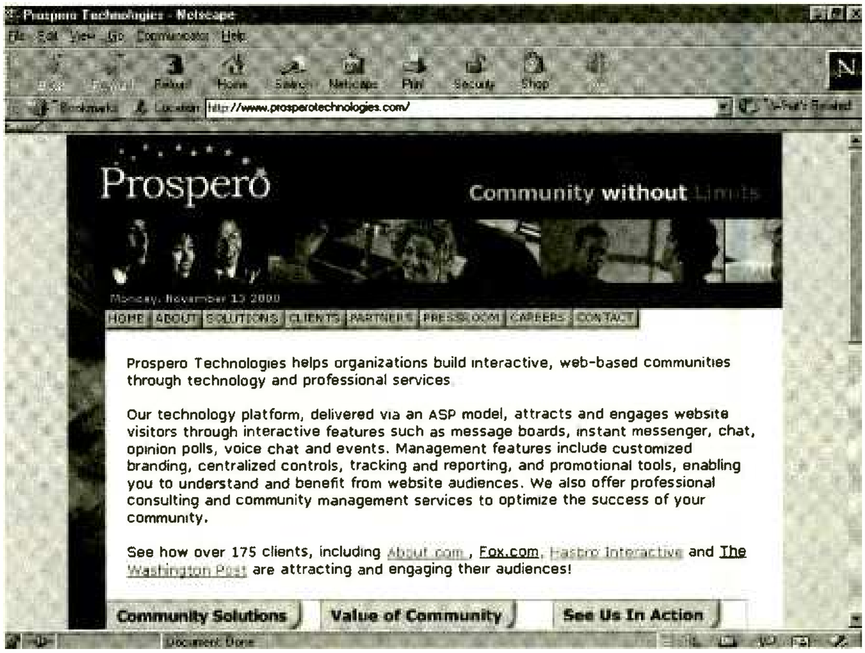
nonprofit organization, or community.

Just as with advertising-oriented e-mail, you have to be careful with public relations e-mail. Many journalists are already overwhelmed with e-mail from readers, sources, colleagues, and spamsters.

The trick here is to send your e-mail to only those journalists who can use it and to design it for their purposes.

KEEPING TABS IN A VIRTUAL WORLD

Though it can be time-consuming, the best way to compile a list of journalists' e-mail addresses is manually. A number of companies



Let the experts at Prospero Technologies help you design your very own virtual community.

PostMasterDirect.com, at *www.postmasterdirect.com*, is the largest opt-in service, with more than 3000 lists, from accounting to woodworking. It creates its lists from visitors to Web sites it has partnered with, such as CNET and CBS Sportsline. It charges 10 to 30 cents per name, which includes e-mail delivery, with a $1000 minimum.

MEET THE PRESS... IN DIGITAL

You can also use e-mail to get publicity through newspapers, magazines, radio, and television, whether it's about your new product or a development involving your school,

can provide lists for you, however, which you can search through for journalists covering your area.

The best low-cost option is Direct Contact Newswire, at *www.owt.com/dircon*. The service used to rent out its lists of journalists' e-mail addresses but stopped after receiving complaints that too many messages journalists received were poorly targeted and irrelevant.

Direct Contact Newswire handles the entire process for you, including choosing the most relevant media targets. The cost is 10 cents per name with a $50 minimum. The service can also send press releases by fax and write the release for you.

The best high-end option is Bacon's MediaSource, at *www. bacons.com.* This is a list of comprehensive information about 65,000 media outlets and 450,000 editorial contacts, 75 percent of which have e-mail addresses.

You can rent the list through Bacon's Web site, where it's updated daily, or on CD-ROM, where it's updated quarterly. The cost for either option is $1895 for an annual subscription. Bacon's will also carry out an e-mail media campaign for you for a fee of 55 cents per name with a $50 minimum.

Whether you're e-mailing to prospects or media targets, you're better off using specialized software than your regular e-mail program; especially if you're doing the work yourself and contacting more than a couple of dozen recipients. Programs such as MailKing and UnityMail, both found at *www.messagemedia.com,* automate the process of getting your message out.

IT'S A SMALL WORLD

PCs have offered portals of communication to anyone fortunate enough to obtain one. We can all dream of what the future holds for human interaction via electronic medium. Today we see the emergence of technologies—such as fiber-optic and satellite-link networks—that will revolutionize communications. Who knows? Today we have the Internet, and years from now we may indeed have an Inter-planetary net.

LETTERS

(continued from page 4)

These trapped flux lines can either be dragged through the superconductor, or they can break away and possibly be expelled or trapped in another region. The combination provides an unusual and possibly useful frictional system.

An important experiment that could be performed with the magnet and superconductor is to tie a string to the magnet along with a mass about ten times that of the magnet. Make it into a pendulum where the magnet swings over the superconductor (not yet cooled below the transition temperature) with about a ⅛-inch clearance. While the pendulum swings, cool the superconductor below transition temperature and watch the magnet stop. The added mass prevents the magnet from floating. Compare this with replacing the superconductor with a piece of copper and observe the difference in motion due to eddy currents at both room and liquid nitrogen temperatures.

DOUG KIRVEN, Ph.D.
Durham, NC

Flux pinning was described in Part I of the superconductor article (**Poptronics**, July 2000). Fluxing pinning, as explained in Part I, is responsible for the rare earth magnet being held levitating above the superconductor without flipping off the superconductor. An enhanced flux pinning superconductor was described that will also suspend a rare earth magnet below the superconductor, in addition to levitating a rare earth magnet above itself.

Regarding the demonstration of the frictionless magnetic bearing, though I think flux pinning may indeed produce some minuscule drag on a rotating magnet, I don't believe it is an appreciable force. I feel the pendulum experiment you described is flawed if you try to use it to demonstrate rotational drag. Here's why. The force needed either to stop the magnet pendulum (in your experiment) or just to hold the rare earth magnet levitating (Meissner Effect) above the superconductor (horizontal or tilted) is appreciable. If this appreciable force were converted to "generate drag" on the magnet levitating above the superconductor, it would become difficult to rotate the magnet at all. In essence, the levitating rare earth magnet would resist any rotation. But this is not the case. It is very easy to rotate the magnet, and once the magnet begins rotating, it rotates for quite a long time. My conclusion is that if flux-pinning force were creating a rotational drag as you described, the magnet would not rotate so readily or do so for so long.

Literature I read on superconductors describes the magnetic bearing experiment as frictionless. If there were an appreciable drag generated by flux pinning, I would have expected to encounter some mention of it in superconductor literature.

The pendulum experiment you described demonstrates the flux-pinning force. I do not see any rotational drag coefficient demonstrated.

As for the eddy currents, I don't see the relevance.

In closing, if you could point to any literature that mentions rotation drag created by flux pinning or if you have another potential experiment, I will be happy to look into it and revise my ideas, if necessary.

JOHN IOVINE

Seeing Stars

I enjoyed Ted Needleman's "Computer Bits" column about NexStar 5 in the November issue. As a veteran amateur astronomer and relatively new owner of a Meade LX-200, I too am enjoying computerized astronomy.

What Ted learned, of course, is that just as a binoculars doesn't make you a bird watcher, a telescope doesn't make you an astronomer. I tell people they "must" learn their way around the sky with the unaided eye or with binoculars before purchasing any kind of telescope; otherwise it's impossible to know if the telescope is set up correctly. Also, it's vital to understand that telescopic views are very different from space-probe photos.

Two books I particularly recommend are *365 Starry Nights* by Chet Raymo and *The Backyard Astronomer's Guide* by Dickinson and Dyer. Clear skies.

MICHAEL A. COVINGTON
via e-mail

mailto: serviceclinic@gernsback.com

SAM GOLDWASSER

VCR Audio Problems

This month, we're going to look into audio problems, so let's dig right in.

Silent Movies

Has this happened to you? It's a rainy day and you decide to sit home and watch a favorite movie, perhaps an old copy of *Fritz the Cat*, but after pressing play on your VCR you notice there is something wrong with the audio track. Many of us have experienced the nuisance of missing or corrupted audio on VHS playback. The following are some troubleshooting tips for repairing audio problems inherent to some VHS systems.

Can you hear anything? If *all* audio is missing, visually check the external connections—particularly if you use RCA jacks. Also, try switching between channels 3 and 4 if you use the VCR's RF output. Adjusting the fine-tuning control (if any) on your TV can sometimes remedy a minor audio problem. Are all the cables connected correctly? Are all the switches properly set? Simple operator errors are the bane of many a technician.

Does the audio problem happen only during playback? If you know that the tape is in good condition and the audio is good, carefully touch each of the terminals on the audio/control (A/C) head with the tip of a small screwdriver (**CAUTION**: Insulate all except the tip of the screwdriver to prevent shorts). The A/C head is the stationary head to the right of the video drum, near the location where tape re-enters the cassette. If the audio circuits are working, the audio-head terminal should produce a buzz from the speaker. A constant buzz during playback may be indicative of a dirty A/C head. The A/C head can be cleaned with an alcohol-moistened cotton swab gently rubbed near the top where the audio tracks are located. DON'T touch the video heads with alcohol. Other possible causes of degraded audio include debris within or misalignment of the tape path. These ailments can promote a loss of contact between the tape and the audio head in the vicinity of audio tracks. If there was no initial buzz during the circuit test, then something in the audio circuit is most probably bad. Double-check that there is no audio switch or a mode-select toggle that might be wrong. Mechanical switches can often be flipped back and forth a couple of times in order to clean the contacts. Beyond this, additional testing will be needed requiring a service manual with schematic.


Carefully clean the tape path with an alcohol-moistened cotton swab. Do not touch the video heads with alcohol.

Poor Audio on Hi-Fidelity Systems

There can be several non-electronic causes for poor quality sound during playback. Periodically, the audio head needs to be cleaned. Cleaning tapes may not always be effective tools. It is more effective to use cotton swabs and isopropyl alcohol or head-cleaning solution for head cleaning. You might as well clean the tape guides while you are at it—a speck of dirt can cause the tape to wander and produce erratic sound.

There are cases when the audio/control head needs to be aligned. Usually an azimuth adjustment (the angle the head gap makes with respect to the direction of the tape's long axis) can cure an audio glitch. You can make this adjustment if you are so inclined. Before you adjust the azimuth, a test for proper alignment would be to record and then play back a tape on this machine—regardless of how far off the azimuth adjustment may be. The recording should sound good, at least as good as one can expect from the linear audio track.

Sometimes, the audio head (and other parts) needs to be degaussed. An inexpensive audiotape head demagnetizer can be purchased at your local electronics store. Turn on the demagnetizer and move it slowly near all metallic parts that the tape contacts (e.g., the guides, levers, erase and audio/control head). Stay away from the video heads because some demagnetizers are powerful enough to damage heads. Make sure the demagnetizer you use has no sharp ends to damage anything. You can cover the tool with electrical tape if in doubt.

The audio head could be worn. If the poor sound quality really bugs you, audio heads can be easily replaced. New heads are not cheap because generic replacements are rarely available. After the head install, an alignment will be needed. Another possibility is that tape-path problems can cause bad tape versus head contact. Make sure the path is clean and free of foreign objects.

Expectations for audio quality on the linear audio tracks on non-high fidelity VCRs should be realistic. The worst sound quality often stems from a stereo VCR in EP mode. This poor rendition is due partly to the stereo tracks being less than half as wide as non-stereo tracks. Best results can be achieved with a combination of SP tape speed and a non-stereo signal. Even this solution yields comparatively poor music quality.

What's the Buzz?

Do you hear an annoying hum or buzz on your one-channel deck? Performing the following "screwdriver and short tests" can help to narrow down a one-channel low audio problem:

You should be able to locate the L and R channels by the buzz resulting from signal pickup from the screwdriver-test mentioned previously. If the bad

Take time to familiarize yourself with the patch panel of your VCR. Inspect connectors and switches for cleanliness and proper functioning.

channel doesn't respond at about the same level as the good one, there is probably an electronics problem present rather than need for an A/C head alignment (though a bad A/C head coil is still possible).

If you can locate the signal ground for the A/C head, then CAREFULLY short the output pin of the bad channel head to ground. The hum/buzz should disappear when the short is induced if there is a head or alignment problem. If the hum is not cancelled, there is an electronics problem for that channel.

Does Your Audio Flutter?

While the general quality of VHS linear audio is almost always mediocre, there should not be excessive flutter resulting in a wavering pitch. Certainly, it should not be noticeable for vocal on audio tracks. How bad music sounds will depend on your expectations as well. Here are some possible causes for flutter:

- Dirty/gummed-up stationary guides or A/C head
- Lack of lubrication of the capstan or roller guides
- Excessively tight idler or other clutch
- Bad capstan motor, especially if direct drive type, or motor driver
- Bad pinch roller/bearing
- Video head drum (upper cylinder) that is mounted off-center or that has excessive run out or wobble
- Servo-system problems
- Power-supply problems
- 'Stiction' between tape and lower cylinder
- Unrealistic expectations of linear audio quality

Hey, My New Tape Has No Audio!

Have you just produced a recorded tape and are wondering why the non-Hi-Fidelity audio is not working? Have pre-recorded tapes or tapes recorded on this VCR worked prior to the problem developing? Do the new recordings have no sound whatsoever? Let's examine some possible faults.

Make sure your tape isn't bad. Yes, I know, this is unlikely, but very old tapes tend to lose oxide along the edges where the linear audio goes. If the previous audio is erased but you now have silence, the problem could be that the erase function is working but no new audio is being recorded on the tape. Check any audio-mode or dubbing switches for proper settings. If you are using the RF input, see if the RCA connectors are firmly inserted into the jacks. Sometimes, dirt or bad connections on the RCA inputs will trick the VCR into thinking you really want to use those instead of the RF. Pushing an RCA plug in and out a few times might clean the jack.

If you are using the RCA inputs, make sure the audio cable is plugged into the proper jack on the VCR and that there is an audio signal from the source (plug into an amplifier or another VCR to test).

Don't be afraid to take a close look inside your VCR.

Has Anyone Seen My Audio?

Sometimes tapes play fine, but audio is missing to the TV and/or when making recordings using the VCR's tuner. If this is your dilemma ask yourself, "How is the TV connected?" Is it through the RF/antenna input? If it is connected through the RCA jacks, it could be a TV/cable problem. Bypass the VCR and check for sound. As for the RF connection, this could be caused by many factors.

There may either be an incorrect source-select or dubbing-mode setting. There may even be a dirty set of contacts on a related switch. Check your instruction manual, and cycle and/or clean the contacts of any suspect switches. Unplug the VCR for a few minutes to reset the controller—it may be in a weird mode. Dirty contacts on the RCA audio in jack may be guilty—some decks automatically assume you want to record from there if anything is plugged in. Maybe a device, like a CD player, was left plugged into the jack several months ago when you last used it! Usually, inserting an RCA plug into the jack a couple of times will clean the contacts at least well enough to confirm whether or not this is the problem. There is often a separate cable for both audio and video between the tuner and the main board inside a VCR deck. Reseat this board and test it. If the problem stems from an electronic fault resulting in the circuit not selecting the audio the maintenance will require a schematic.

"Out, Out, Damn Audio..."

If the old audio track is unchanged when rerecording on a previously recorded tape, i.e., you get the new video but old audio, first check that any dubbing switches are set correctly. Do you get a mixture of old and new audio? There could be a problem with the audio-erase head (part of the A/C head stack) or its circuitry. Clean the audio/control head. Check for dirt or tape oxide on or around the audio/control head. Beyond these procedures, testing will probably require a schematic. However, if you can locate the connections to the audio-erase head, use an ohmmeter to test for continuity of the coil. If you have access to an oscilloscope, check for the high-frequency erase signal during record.

Why Does My VCR Squeal Like A Stuck Pig?

The most common cause for a squealing noise is a tired or weak belt that is slipping. The need for lubrication is less likely. If a squeal is heard (along with the VCR perhaps aborting the operation) when entering play or record mode, a slipping loading belt is the usual cause. If a squeal is heard during fast-forward or rewind, then the drive belt may be slipping. A squeal or whine during play or record (perhaps intermittently when the video-head drum is spinning) could be the warning sign of a worn video-head drum bearing or a dirty and/or improperly positioned static brush (more on this in a moment). It may be time for a good cleaning, rubber parts replacement, and lubrication.

Whining or buzzing from the audio during playback of tapes not recorded on the troubled VCR may indicate a badly misadjusted A/C head. The linear audio heads are picking up the ends of the video tracks due to the A/C head being too low. A whine from the audio (of the TV) while using the VCR may indicate bad grounding of the internal shields, or other bad connections due to electronic problems.

High Pitched Whine From Inside A VCR

Your first thoughts are probably of an expensive repair to a motor bearing or replacement lower cylinder. If there is a high-pitched whine coming from inside the VCR when in play, record, or other mode, which spins the video heads, you may simply have a dirty or improperly positioned antistatic brush. There is usually a metal strip with a carbon contact pressing against the center of the video-drum spindle either above or below the deck. In rare instances, the brush may be *between* the upper and lower cylinders, requiring more disassembly. Gently press on this strip or lift it off of the spindle while you hear the sound. If the whine disappears, cleaning and slight repositioning of the strip should be all you need to do. Do not remove this strip—it is needed to ground the rotating drum to prevent static buildup and video noise problems. You may find that if you measure the resistance between the brush to the chassis that it is far from zero ohms—perhaps in the tens or hundreds of thousands or higher. This is perfectly normal (as long as it isn't infinity!) because static doesn't take much current flow to be eliminated.

VCRs Need TLC

With a little tender loving care and some basic preventive maintenance, you and your VCR should enjoy a pleasant auditory experience. Remember, when troubleshooting any device, first start off with a thorough visual inspection. Look for the obvious "no brainers," like cable connections and switch settings, and if the problem still persists continue troubleshooting in a routine manner. **P**

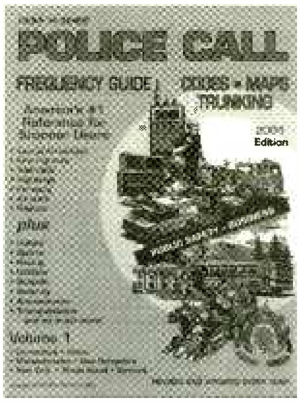
NEW LITERATURE

(continued from page 44)

studio-quality sound on the road. Construction techniques for a subwoofer filter, simple crossover strategies, and ways to squeeze peak performance from the sound system are covered. Design tools—including spreadsheets, Thiele-Small parameter measurement techniques, and shareware—are also explained.

Police Call: 2001 Edition

by Gene Hughes
Hollins Radio Data
P.O. Box 35002
Los Angeles, CA 90035
www.policecall.com
$12.99 plus S&H



Considered "the scanner user's bible," the 2001 edition is the largest ever and is also available on CD-ROM. The nine regional volumes contain over 35,000 frequencies. Volume I, pictured here, covers New York and New England.

In addition to emergency agencies such as Police and Fire, the books list two-way frequencies for aircraft, federal government, transportation, sports, entertainment, and more. Scanner enthusiasts will find that the first chapter, "Listener's Guide," is packed with helpful information. **P**

mailto: basiccircuitry@gernsback.com

CHARLES D. RAKES

Closing In On More Proximity Circuits

Last month, we were on the circuit train in the middle of a proximity-sensor-circuit odyssey. Before we could complete our adventure, we ran out of time and space. Now that we have a full head of steam, let's race down the "high irons" in the search of more fun proximity circuits.

Noise As A "Good Thing"

Our first entry this visit is a proximity-sensor circuit (Fig. 1) that puts to use the nasty noise and AC trash that's all around us. A 741 op-amp IC is the master operating component in this circuit. The amplifier's gain is set to near maximum with a 10-megohm feedback resistor connected between the negative input at pin 2 and the amp's output at pin 6. The metal pick-up sensor is connected to the input at pin 2 and must be located very close to the IC circuitry.

The amp's output feeds a detector/rectifier circuit, which supplies a positive drive voltage to the base of the 2N3904 NPN transistor. The transistor lights the LED when an object is detected. A sensor for this type of noise pick-up circuit need not be any larger than a half-dollar coin. If the pick-up is too large, the ambient noise can cause false triggering.

To activate this circuit, simply place a finger on or very near the sensor. Of course, if you try to use this circuit in an area where no electrical power is present, it will most likely fail to operate.

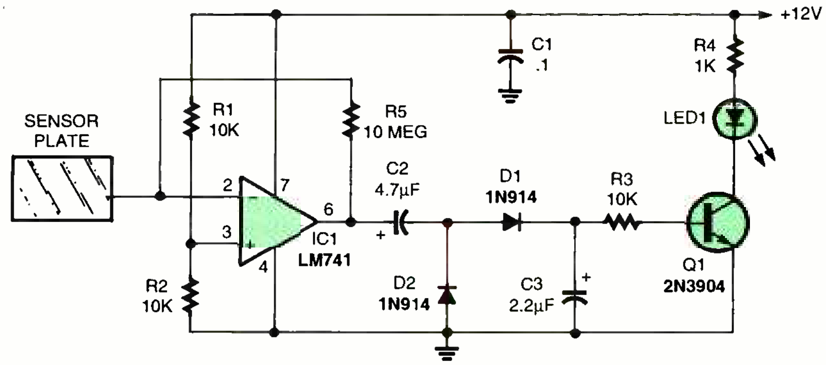


Fig. 1. This circuit, using an LM741 op-amp, works the same way as last month's LM567-based circuit.

PARTS LIST FOR THE NOISE-TRIGGERED SENSOR (FIG. 1)

SEMICONDUCTORS
IC1—LM741 op-amp, integrated circuit
Q1—2N3904 NPN silicon transistor
LED1—Light-emitting diode, any color
D1, D2—1N914 silicon signal diode

RESISTORS
(All resistors are ¼-watt, 5% units.)
R1–R3—10,000-ohm
R4—1000-ohm
R5—10-megohm

CAPACITORS
C1—0.1-µF, ceramic-disc
C2—4.7-µF, 25-WVDC, electrolytic
C3—2.2-µF, 25-WVDC, electrolytic

ADDITIONAL PARTS AND MATERIALS
Sensor plate, wire, hardware, etc.

Cut The Noise

We can also use the same 741 op-amp in a circuit that does not require any outside signal source. This somewhat unusual proximity-sensor circuit (Fig. 2) places the 741 op-amp in a high-frequency oscillator circuit that is operating near its maximum frequency. The 741 op-amp has an internal feedback capacitor that limits its maximum operation frequency. As the frequency increases, the op-amp's gain decreases until it reaches a gain figure that is just slightly greater than one.

If we crank up the frequency to that limit, the feedback path becomes very load sensitive—exactly what is needed in any load-type proximity-sensor circuit.

The oscillator's frequency-determinate components are C1, C3, R6, and R7. Feedback resistors R5 and R9 set the gain. The op-amp's bias is set, with R2 and R3, to produce a DC output on pin 6 at one-half the supply voltage, with the advantage of being independent of the actual supply voltage. Operating the output at one-half supply lets us use the maximum available output-voltage swing. Supply voltages between 9 and 16 volts will do.

The oscillator's output at pin 6 feeds the rectifier circuit made up of D1, D2, C4, and C6. The rectifier's positive output turns Q1 on and lights the LED.

For maximum sensitivity, adjust R9 to the point where the LED just begins to glow. A 4- by 6-inch metal sensor plate, isolated from surrounding objects, can easily detect your hand at a distance of two to three inches. Larger plates will detect larger objects at greater distances. The size of the sensor plate is limited to the maximum surface area that allows circuit oscillation. Sensor objects that are too large or too close to a ground mass can keep the circuit from oscillating. The sensor's negative supply should

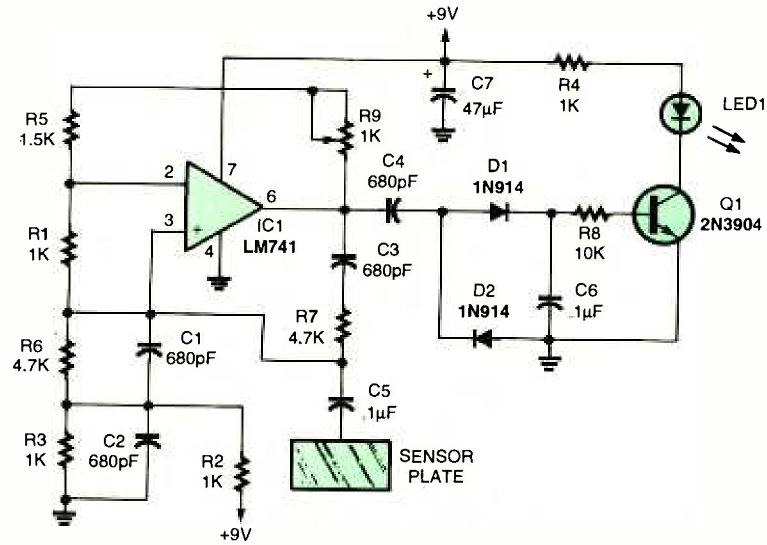


Fig. 2. This circuit senses changes in the background noise, only it provides its own noise.

PARTS LIST FOR THE "NOISELESS" PROXIMITY SENSOR (FIG. 2)

SEMICONDUCTORS

IC1—LM741 op-amp, integrated circuit
D1, D2—1N914 silicon signal diode
Q1—2N3904 NPN silicon transistor
LED1—Light-emitting diode, any color or size

RESISTORS

(All resistors are ¼-watt, 5% units unless otherwise noted.)
R1–R4—1000-ohm
R5—1500-ohm
R6, R7—4700-ohm
R8—10,000-ohm
R9—1000-ohm potentiometer

CAPACITORS

C1–C4—680-pF, ceramic-disc
C5, C6—0.1-µF, ceramic-disc
C7—47-µF, 25-WVDC, electrolytic

ADDITIONAL PARTS AND MATERIALS

Pickup plate material, IC socket, etc.

be connected to ground or to any large metal object that offers capacitance to ground.

FET-based Systems

Our next stop takes us to another load-sensitive proximity-sensor circuit (Fig. 3), which uses a 2N3819 N-type FET as the active device. This is a very stable and sensitive proximity-sensor circuit, suitable for alarm systems and commercial applications. The circuit is a Hartley oscillator with a variable-feedback gain control.

The RC frequency-determinate components used in our previous sensor are replaced with a hand-wound inductor. The oscillator's frequency is determined by the inductance of L1, its internal capacitance, and the load capacitance of the sensor plate. The feedback gain needed to obtain and sustain oscillation is set with R5. The oscillator's output signal is coupled through C5 to a rectifier circuit that supplies a positive bias to turn Q2 on, lighting the LED. The circuit's set-up procedure is very similar to our previous circuit. With R5 set to its maximum resistance value, slowly rotate the potentiometer until the LED just begins to glow. That is the sensor's most sensitive setting.

Any center-tapped inductor with an inductance value between 0.1 mH and 100 mH will work in the circuit. The coil used in our circuit was "jumble wound" on a 1-inch plastic tube with about 120 turns of 28-gauge enamel-covered copper wire. At the 60th turn, make a tap and continue winding for another 60 turns. Since the actual inductance value isn't critical, any similar size tubing will do for the form; the wire size can vary as well.

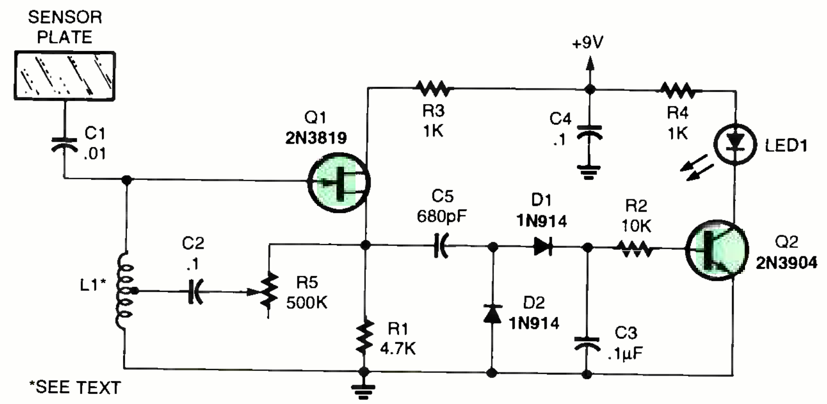


Fig. 3. By replacing the op-amps of Fig. 2 with a field-effect transistor and coil, we have a Hartley-oscillator-based sensing circuit. See the text for details on winding L1.

PARTS LIST FOR THE FET-BASED SENSOR CIRCUIT (FIG. 3)

SEMICONDUCTORS

Q1—2N3819 N-type field-effect transistor
Q2—2N3904 NPN silicon transistor
LED1—Light-emitting diode, any type or color
D1, D2—1N914 silicon diode

RESISTORS

(All resistors are ¼-watt, 5% units unless otherwise noted.)
R1—4700-ohm
R2—10,000-ohm
R3, R4—1000-ohm
R5—500,000-ohm potentiometer

CAPACITORS

C1—0.01-µF, ceramic-disc
C2–C4—0.1-µF, ceramic-disc
C5—680-pF, ceramic-disc

ADDITIONAL PARTS AND MATERIALS

1-inch plastic-coil form, 28-gauge enameled copper wire, etc.

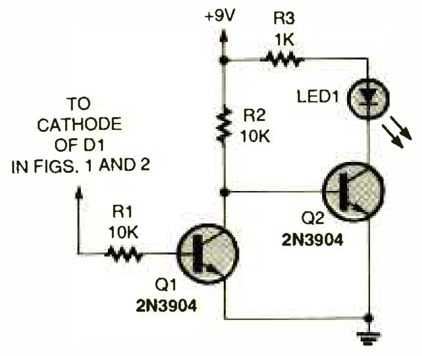


Fig. 4. If you need to invert the output of the previous two circuits, this simple add-on circuit will do the job.

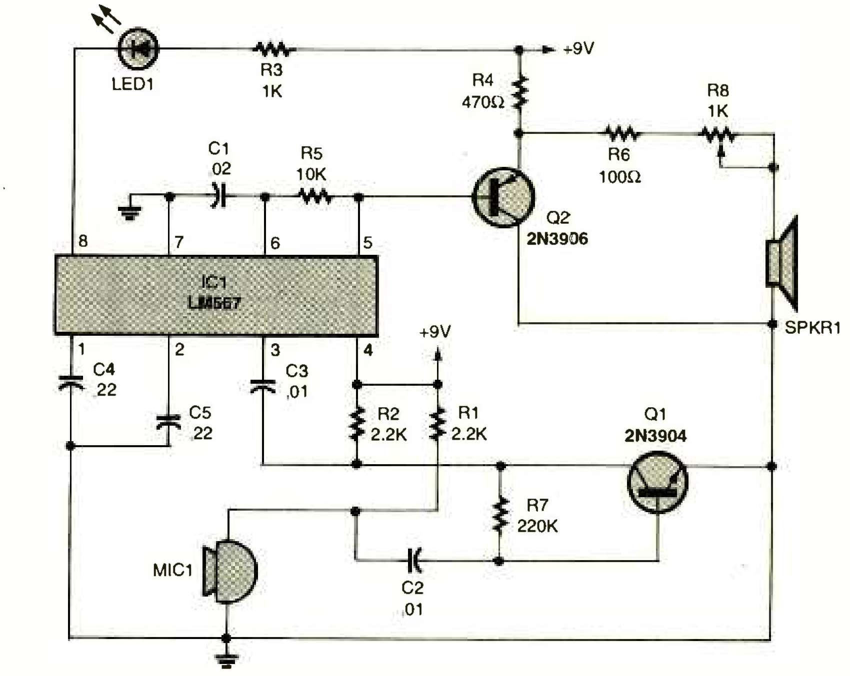


Fig. 5. Similar to radar or sonar, this circuit bounces an ultrasonic signal off the object being detected. If you don't mind the shrieking whistle, you can use audio-frequency tones for detection.

PARTS LIST FOR THE OUTPUT INVERTER (FIG. 4)

SEMICONDUCTORS

Q1, Q2—2N3904 NPN silicon transistor

LED1—Light-emitting diode, any type or color

RESISTORS

(All resistors are ¼-watt, 5% units.)

R1, R2—10,000-ohm

R3—1000-ohm

PARTS LIST FOR THE SOUND-BASED SENSOR (FIG. 5)

SEMICONDUCTORS

IC1—LM567 tone-decoder, integrated circuit

Q1—2N3904 NPN silicon transistor

Q2—2N3906 PNP silicon transistor

LED1—Light-emitting diode, any type or color

RESISTORS

(All resistors are ¼-watt, 5% units unless otherwise noted.)

R1, R2—2200-ohm

R3—1000-ohm

R4—470-ohm

R5—10,000-ohm

R6—100-ohm

R7—220,000-ohm

R8—1000-ohm potentiometer

CAPACITORS

C1—0.02-µF, ceramic-disc

C2, C3—0.01-µF, ceramic-disc

C4, C5—0.22-µ, ceramic-disc

ADDITIONAL PARTS AND MATERIALS

Piezo speaker (RadioShack 40-1383 or similar), electret microphone element (RadioShack 270-090 or similar), IC socket, etc.

Inversions I snoisrevnI

Our next entry, see Fig. 4, allows our previous two circuits to operate with an inverted output function. Rather than have the LED turn off when an object is detected, this circuit inverts the output so that the LED turns on. The inverter circuit connects to the cathode of D1 in either of the previous two circuits. The positive output at D1 turns Q1, in Fig. 3, on. This grounds Q2's base, keeping it turned off and the LED dark. When the sensor circuit detects an object, the output at D1 goes low, allowing Q1 to turn off and Q2 to turn on, lighting the LED. The LED indicator can be replaced with a relay or an optoisolator to control other circuitry.

I Heard That!

The next stop on the "Basic Circuitry Train" is at Echo Bend, where we'll look at a sound-operated proximity sensor. Again, the versatile LM567 phase-locked loop IC is placed in service, performing a dual function in our ultrasonic proximity-sensor circuit shown in Fig. 5. The LM567 is connected in a tone-decoder circuit that produces an output when the proper tone is received. The LM567 is also operating as a tone transmitter that generates the very tone the receiver section is designed to receive. Only two external transistors and a few components are necessary to complete the sensor circuit.

The transmitter portion of the circuit sends out a high frequency audio signal through the piezo speaker. The receiver's pickup, an electret-microphone element, detects the reflected tone signal and sends it to Q1 for amplification. From there, the amplified signal goes on to the input of the LM567. The piezo speaker and the microphone element are positioned as shown in Fig. 6.

Any object placed in front of the microphone and speaker that reflects a sufficient amount of the signal back to the microphone will activate the circuit and light the LED. The circuit can be set up to sense objects at distances from a few inches to over a foot.

Here's how the circuit operates. The LM567's internal oscillator frequency is set by C1 and R5. The actual operating frequency isn't critical so long as it falls somewhere between 14 kHz and 20 kHz. If the frequency is too high, the electret microphone's output will be reduced and the operating range will suffer. If you don't mind listening to the high-frequency sound, the circuit will work fine at a much lower frequency. The LM567's internal oscillator pro-

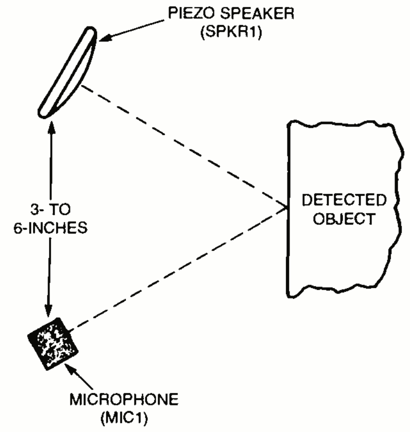


Fig. 6. Note that the reflected sound waves behave just like light bouncing off a mirror—the exiting angle equals the entering angle.

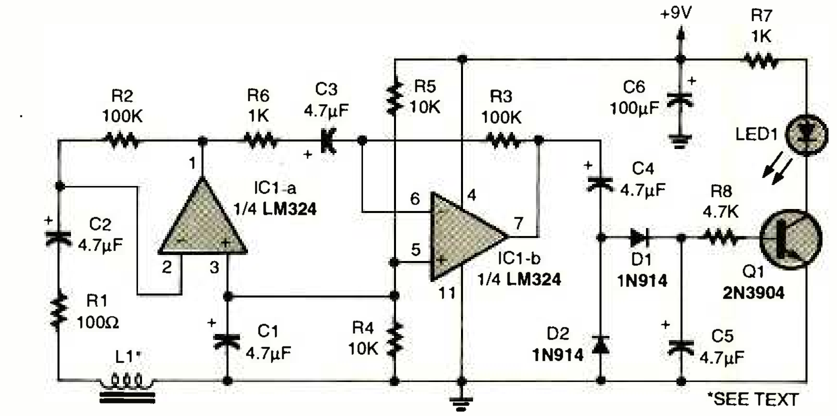


Fig. 7. Any large piece of iron passing near L1 will distort the Earth's magnetic field, creating a weak signal that's amplified by IC1.

duces a squarewave output at pin 5. That signal is isolated from the LM567 by Q2 operating as an emitter follower, which sends the signal to the piezo speaker. The speaker's output level is set with R8.

Transistor Q1 is connected as a common-emitter amplifier that increases the reflected tone signal to a level sufficient for the LM567's input circuitry to detect and lock on.

The circuit is an easy one to set up and adjust. Select the type and size of object that you want to detect and place it in front of the speaker and microphone. Adjust R8 until the LED lights. The range of operation will depend mainly on the object used as a reflector.

This is an excellent experimenter's circuit. The operating frequency can be varied by replacing R5 with a 20,000-ohm potentiometer, and the value of C1 can be changed as well. Larger values of either component lower the operating frequency and small values increase the frequency.

Finding Iron Giants

Our last proximity-sensor circuit on this trip is only turned on by a moving ferrous object. The ferrous proximity-sensor circuit, see Fig. 7, uses a hand-made pickup coil to detect and produce a low-frequency output signal when a ferrous-metal object is moved by its pole piece.

The coil is wound with about 200 turns of 28-gauge enamel-covered copper wire on a ¼-inch diameter by 1-inch long soft-iron bolt. The coil may be jumbled or layer wound; either way will work just fine.

Two op-amps of an LM324 quad op-amp IC are used to amplify the weak signal generated by the pickup coil. The amplified signal is coupled to a rectifier circuit made up of C4, C5, D1, and D2. The rectifier's positive output turns Q1 and the LED on when a ferrous object pass by the pickup coil. The LED only remains on for a very brief period, depending on the speed of the moving ferrous object. The head end of the bolt should be used as the pickup point.

The circuit's sensitivity can be increased by winding additional turns on the coil or by increasing the value of either R2 or R3. If the amplifier's gain is increased too much, the circuit can become unstable and go into a self -oscillating mode.

If the circuit is operated in an area where strong AC fields are present, a 0.1 to 0.22-µF capacitor may be connected across the pickup coil to help reduce interference from those signals.

The circuit could actually be used in a model-train layout to signal when a train wheel or car passes by or used on an assembly line to count certain types of parts as they move past the sensor.

PARTS LIST FOR THE IRON-SENSING CIRCUIT (FIG. 7)

SEMICONDUCTORS

IC1—LM324 quad op-amp, integrated circuit
Q1—2N3904 NPN silicon transistor
LED1—Light-emitting diode, any type or color
D1, D2—1N914 silicon signal diode

RESISTORS

(All resistors are ¼-watt, 5% units.)
R1—100-ohm
R2, R3—100,000-ohm
R4, R5—10,000-ohm
R6, R7—1000-ohm
R8—4700-ohm

CAPACITORS

C1—47-µF, 25-WVDC, electrolytic
C2–C5—4.7-µF, 25-WVDC, electrolytic
C6—100-µF, 25-WVDC, electrolytic

ADDITIONAL PARTS AND MATERIALS

Iron bolt, 28-gauge enamel-covered copper wire, IC socket, etc.

Help Me Out Here, Audience...

That's the last stop for the Circuit Train for now, but before leaving, I would like to ask a favor of you. I intended to include several proximity circuits using the high sensitive IR detectors found in security lights, but have not located a source for just the IR detector. I don't want to use surplus items here because of available supply and differences in actual detector devices. If you can help with a suggested source, send an e-mail message or write to me at: Charles D. Rakes, P.O. Box 445, Bentonville, AR 72712.

See you here next month!

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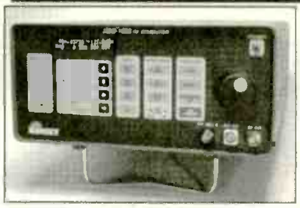
RAMSEY

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

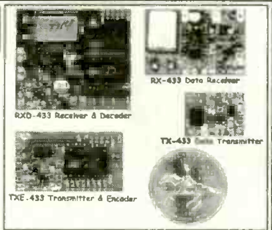
1 GHz RF Signal Generator



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

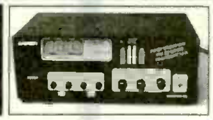
Wireless RF Data Link Modules



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

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.*

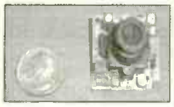
FM-100, Pro FM Stereo Transmitter Kit $249.95
FM-100WT, Fully Wired High Power FM-100.............. $399.95

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



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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

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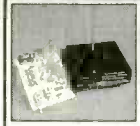
Operates in standard AM broadcast band. Pro version, AM-25, is synthesized for stable, no-drift frequency and is setable for high power output where regulations allow, typical range of 1-2 miles. Entry-level AM-1 is tunable, runs FCC maximum 100 mW, range 1/4 mile. Both accept line-level inputs from 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!

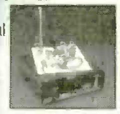
AM-25, Professional AM Transmitter Kit..... $129.95
AM-1, Entry level AM Radio Transmitter Kit... $29.95
CAM, Matching Case Set for AM-1.......... $14.95

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.

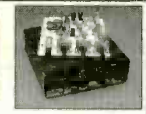
FM-25, Synthesized Stereo Transmitter Kit $129.95



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
CFM, Matching Case and Antenna Set $14.95
FMAC, 12 Volt DC Wall Plug Adapter...................... $9.95

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

RF Power Booster

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LPA-1, Power Booster Amplifier Kit $39.95
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LPA-1WT, Fully Wired LPA-1 with Case $99.95
FMBA-1, Outdoor Mast Mount Version of LPA-1 .... $59.95

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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!

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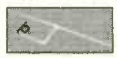

TM-100, FM Antenna Kit $39.95
FMA-200, Vertical Antenna $114.95

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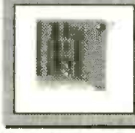

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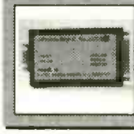

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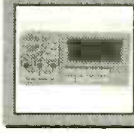

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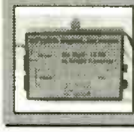

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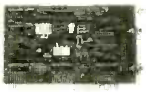

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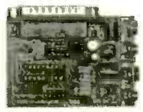

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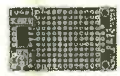

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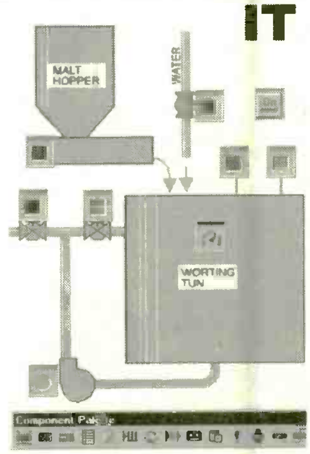

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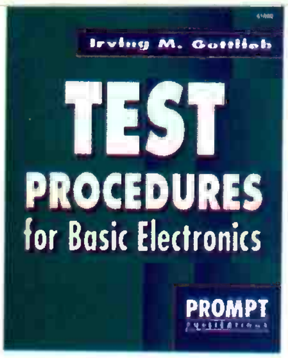

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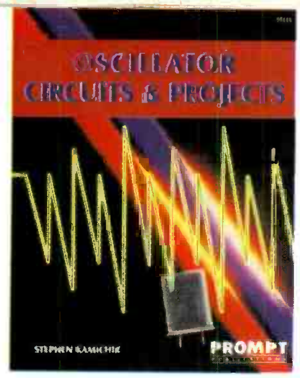

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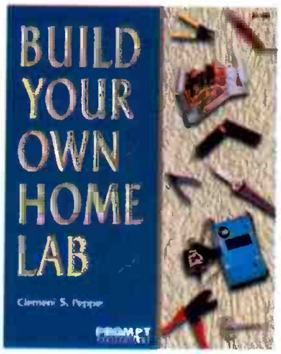

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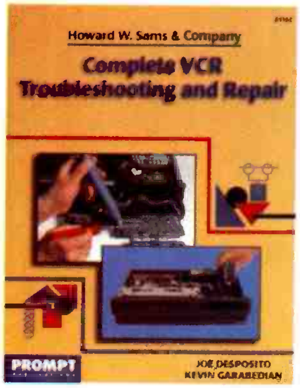

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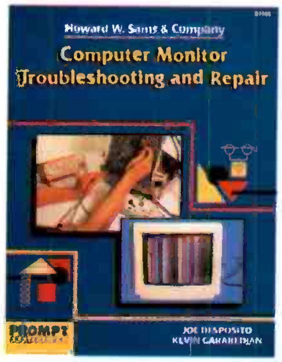

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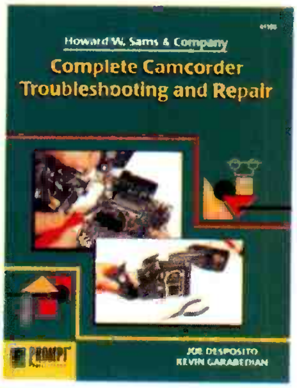

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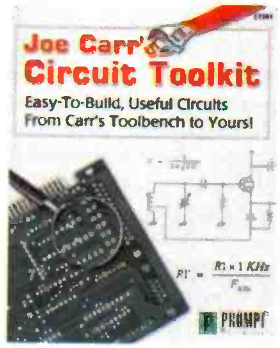

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