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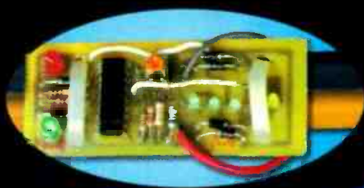

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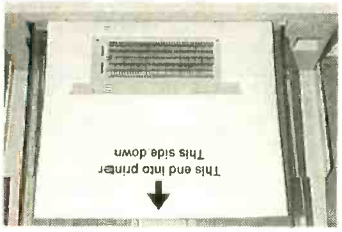

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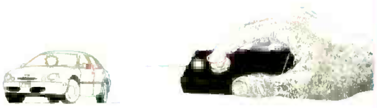

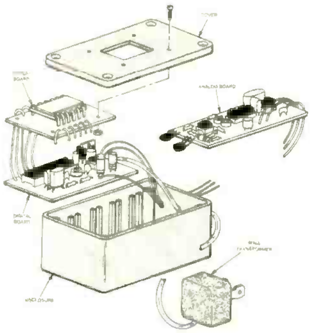

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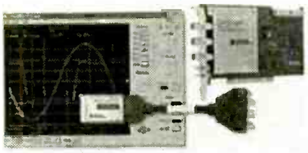

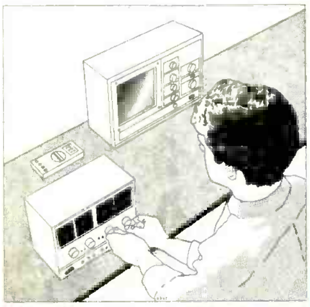

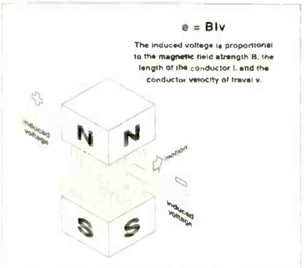

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EDITORIAL

A New Resource

As regular readers of this magazine no doubt know by now, **Electronics Now** has been making a major move to the Internet over these last few months. If you are Internet connected and have visited our Web site (*www.gernsback.com*), the benefits of the move are evident. For example, our chat forums give readers a way to interact with each other that heretofore was impossible. It also lets us get article updates and corrections to you much faster than ever before. Other features include a searchable article index, a download area for article-related files, information for potential authors and advertisers, ordering information for subscriptions and back issues, and much, much more.

But that's not to say that everything is perfect. One complaint that we have often heard is that our magazines themselves are not available online. While that is true, and will remain so for the foreseeable future due to financial and practical constraints, we've come up with what we think is the next best thing.

We have made arrangements with another site to place some of the best of our older material online, with a special emphasis on construction articles. That site is *www.poptronix.com*. There material can be viewed while online, or can be downloaded in Adobe Acrobat (.pdf) format for easy printing and off-line viewing.

Older **Electronics Now** articles are not all you will find at the Poptronix Web site. You'll also find articles from other sources, and they eventually plan to post some that have never appeared in any form anywhere else. In addition, you'll find information on new products, book reviews, a directory of parts suppliers, and more. In short it's a complete online electronics magazine.

Though it is still under construction as this is being written, I've visited the Poptronix site and come away impressed. There are still a few bugs to iron out, but those are being worked on at a feverish pace. There's no doubt that the site will fast become a welcome new resource for the electronics hobbyist. And, if you haven't done so already, it's still another good reason to get yourself connected to the Net.

Carl Laron
Editor

Where do more people go for electronics accessories?

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WHAT'S NEWS

A REVIEW OF THE LATEST HAPPENINGS IN ELECTRONICS

Wind Tunnels and Computers

A NASA computer-network tool called Darwin will help shorten airplane design and test time. The key to Darwin's success is its ability to funnel data from a wind tunnel into a server computer and then send results to researchers in "near real time"—from 30 seconds to five minutes.

Wind tunnels are a key part of the design test process. In the tunnels, air is blown around airplane and rocket models to simulate flight. Pressure gauges, strain gauges, and other instruments attached to the models take readings during experiments while the air flows. Data from the readings report how much lift, drag, and maneuvering performance an airplane model can produce at different flight angles, and at various speeds, altitudes and conditions. By linking the tunnels directly to computers, nearly instant test results can be sent to NASA, aerospace companies and academic centers that are thousands of miles apart.

"With Darwin, we're helping to reduce the aerospace design cycle time by around a quarter. Previously such knowledge had to be derived by scientists and engineers in the days and months following wind tunnel tests," said Dr. David Korsmeyer, deputy project manager at NASA's Ames Research Center (Moffet Field, CA). The Darwin Project team is led by Dr. Dennis Koga. John Schreiner, also of Ames, shares deputy managerial responsibilities with Korsmeyer.

Knowledge gained about airplane design in wind tunnel tests helps engineers make design decisions or needed modifications before expensive full-size prototypes are built. Since the models themselves cost over $1 million each, and running the wind tunnels costs tens of thousands dollars per hour, engineers prefer not to have to make return tests with modified models.

"Engineers use supercomputers to try to predict how new designs will work before an airplane model is built. That works fairly well for straight, level flight, but even that kind of analysis is not perfect. What happens during takeoff and landing is especially difficult to predict with supercomputers because air turbulence occurs. The wind sneaks back around and does unexpected things," said Korsmeyer. "Testing a model in a wind tunnel, you get actual physics because you have real wind blowing over a wing."

"Now Darwin collects data, and it is translated into a useable form. In addition to the normal graphs and charts engineers use, they also can step through images like frames of a movie to see changes of colorized air pressure and wind speed," he explained.

DVD Video Group Formed

Executives of the home-video units of film studios and music labels joined consumer-electronics manufacturers to form the DVD Video Group. The purpose of the group is to communicate the benefits of the DVD video experience—such as superior picture and sound, backwards player compatibility with existing CDs, and multiple camera angle options for the viewer—to the consumer, the retailer, and the media.

Founding members of the group in the entertainment industry include Columbia TriStar Home Video, Image Entertainment, LIVE Entertainment, MGM/UA Home Video Inc., PolyGram Video, Sony Wonder/Sony Music Entertainment, Warner Home Video and Warner Music Group. Manufacturers in the group are Panasonic Consumer Electronics, Philips Consumer Electronics Company, Pioneer Electronics (USA), Samsung Electronics America, Inc., Sony Electronics Inc., Thomson Consumer Electronics, Toshiba America Consumer Products, and Zenith Electronics Corporation.

According to Chairman Emiel Petrone (Philips Consumer Electronics Company), "The DVD Group will provide a constant flow of information about DVD Video benefits, as well as updates about hit movies, re-released classics and innovative music videos from chart-topping artists to consumers, retailers, and the media so that they can make informed decisions about this exciting format breakthrough."

"Right now, our group includes many of the companies that are in the process of introducing DVD Video players, movies, and music videos," added Petrone. "Naturally we hope to welcome other companies into the DVD group as they solidify their plans and announce their intention to launch DVD products."

Some current movie titles available in DVD format are: *Batman*, *Disclosure*, *Eric Clapton: Unplugged*, *Jerry McGuire*, *Mars Attacks*, *Rainman*, *Sesame Street: 25th Anniversary*, *The Three Tenors*, and *Twister*.

The DVD group, headquartered in Los Angeles, opened its doors in the late summer.

Engineering in the 21st Century

What would happen if a kilometer-wide comet struck the Atlantic Ocean? How can we make buildings strong enough to withstand terrorist attacks? These and questions like it are being asked and answered at Sandia National Laboratories (Albuquerque, NM). With the help of advanced modeling and the Department of Energy's teraflops computer (located at Sandia), which can perform one trillion calculations per second, scientists are able to make calculations that were never before possible. Soon instead of designing a product, building a prototype, testing it until it fails, then redesigning it to correct problems, most of the process will happen in "virtual" space in a fraction of the time previously required.

This past June 26th, Sandia sponsored a day-long event for media, industry, academia and congressional representatives in Washington, DC. They demonstrated how this "revolution in engineering" is impacting manufacturing, oil and gas exploration, scientific visualization, and the forecasting of catastrophic events. Another highlight was the role such high-performance computers play in ensuring the safety and security of our nuclear stockpile.

Sandia developed the teraflops computer with Intel for the Department of Energy's Accelerated Strategic Computing Initiative (ASCI). One of its main functions is to manage the nuclear stockpile as it ages. Its tremendous speed and memory are key to doing so. Scientific analysis, "virtual" testing, and aging effects simulations will all be done on a high-performance computer, rather than in actual physical testing.

Sandia Vice President Gerry Yonas said that the integration of high-performance computing into engineering has just begun, but should become the standard over the next two decades. Regardless, Sandia "will be showing the way."

To browse through remarks by speakers on June 26th or to find out about specific technologies exhibited there, visit the "Revolution in Engineering" Web site: http://www.sandia.gov/WashRIE.htm

Motorola Microcontroller Milestone

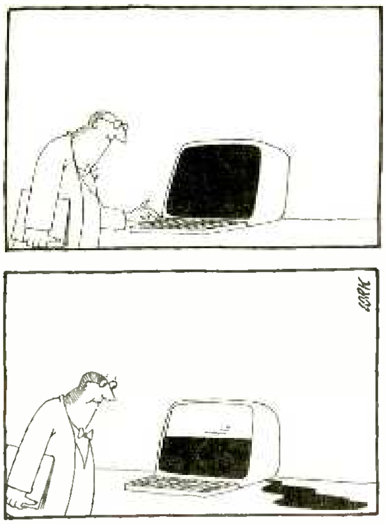
Motorola recently announced that it had shipped its two billionth 68HC05 8-bit microcontroller. The two billionth microcontroller was presented to Ford Automotive Components Division in a ceremony in Austin, Texas on April 29th. It is one of many Motorola semiconductors used by Ford. This particular microcontroller is used in the message center of some Ford vehicles.

Since the early work on the 6805, the 68HC05's predecessor, most electronic products rely on a specialized microcontroller or integrated processor to control its functions. Today, microcontrollers are an integral part of our everyday lives. For instance, a typical vehicle contains ten microcontrollers, and high-tech homes may have as many as 150 of them. They are also found in numerous communications, computer, and consumer-electronics applications.

International Privacy Protection

An ad hoc advisory group has been established by the Technical Management Board (TMB) of the International Organization for Standardization (ISO)

Continued on page 13



Q & A

READERS' QUESTIONS, EDITORS' ANSWERS

The Time and the End of the Tape

Q *In the July issue, reader T.A.S. wanted a clock that kept itself correct by using the signal from TV broadcasts. If all he needed was an accurate clock, how about one that sets itself from shortwave station WWV? One is available for about $80 from Damark (Tel: 800-799-9000); they call it the Time Machine. For computers, Parsons Software has a product called Atomic Clock that communicates by modem with atomic clocks around the world to keep your computer's clock perfectly accurate.*

In the same issue, reader B.B. wanted to know how cassette players stop at the end of the tape. You said that there was a tape-tension sensor. That's how reel-to-reel decks usually work, but cassette decks usually use a motion sensor. The take-up reel is free to slip on its drive belts, and it will stop turning at the end of the tape. On every turn, the take-up reel either closes a switch momentarily or actuates a magnetic Hall-effect sensor. When those switch closures or actuations stop, a control circuit stops the tape deck. — Douglas "Enzo" McCallum, Shiawassee Technical Services, Lansing, MI

A Thanks very much for the amplification. We've seen both kinds of cassette-deck stop mechanisms. Besides the Damark WWV clock that you mentioned, the Heathkit "Most Accurate Clock" is still very popular on the secondhand market.

VCR Plus Decoded

In August we reported that the VCR Plus code, used to set VCRs to recognize particular programs automatically, was proprietary and has not been made public. That is true—but numerous amateur "crypto-analysts" have cracked it anyhow!

The code is too complicated to describe here, but several computer programs that implement it are available on the Web. Try http://www.tinaja.com/third /vcrplus.pdf (a site maintained by our columnist, Don Lancaster). Also go to http://www.yahoo.com and do a search on "VCRplus."

Thanks to Martin R. Green, James B. Parnes, Lee McClary, and the many others that wrote in for sharing this information.

Receiver Improved

Q *I built the regenerative receiver from "Q&A," July 1997, but it would not oscillate until I changed the 22-pF capacitor to 100 pF. Also, a common electrolytic capacitor works fine in place of the 22-µF tantalum power supply bypass. — T. P., Austin, TX*

A Thanks for the tips. In a regenerative circuit, the optimum feedback capacitor depends on many factors, including the circuit layout—ours may have had more stray capacitance than yours. As for the electrolytic capacitor, we specified tantalum because tantalum capacitors work better at radio frequencies, but in the broadcast band, the difference might not be significant.

Delayed Power-On

Q *I need to sound a buzzer or alarm about two minutes after power is applied to a circuit. I've been trying to use a 555 timer IC with no success. Can you help? — J. C., Raleigh, NC*

A Figure 3 shows a circuit that will do the trick. When power is turned on, there's a very brief voltage spike at the output that won't affect your buzzer; then the output stays low for two minutes, goes high, and stays high.

The delay in seconds is R1 in megohms × C1 in microfarads. As shown, R1 is 1.2 megohms so that a 100-µF capacitor gives a 120-second delay, accurate to five or ten percent. Aging of C1 will be the main source of inaccuracy; use a tantalum capacitor for best results.

What's a MOV?

Q *In every surge suppressor there are MOVs (metal oxide varistors). Just what is that device, how does it work, and how are they rated? Could you furnish a typical schematic? — B. B., Ft. White, FL*

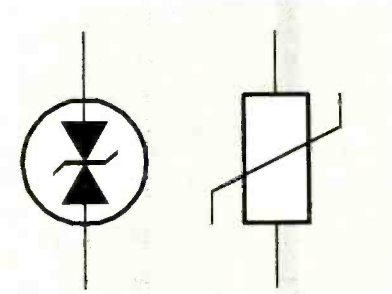


FIG. 1—HERE ARE THE TWO SYMBOLS that are most often used to indicated a voltage-variable resistor (or varistor) in a schematic diagram.

A A varistor, or voltage-variable resistor, is a component that has high resistance at low voltages, but when the voltage exceeds a certain limit, the resistance suddenly becomes much lower. Varistors work rather like Zener diodes, but the internal principles are different, and varistors are not sensitive to polarity; thus they can be used in AC circuits. Fig. 1 shows the schematic symbol.

Metal-oxide varistors are made of substances such as zinc oxide. Their most common function is to absorb spikes or surges of excess voltage across the power line. Figure 2 shows how they're used. Surges usually come from nearby lightning strikes or from electric motors shutting off and suddenly converting their magnetic energy back into electricity. Of course a varistor can't do anything about momentary voltage drops or power fail-

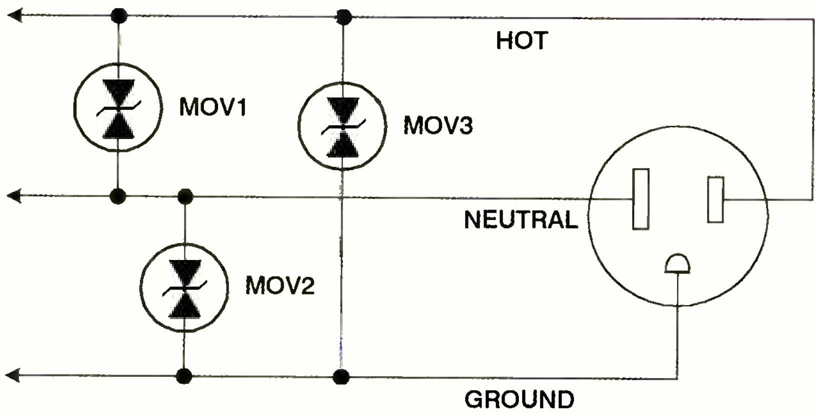


FIG. 2—ALTHOUGH MOV1 DOES MOST OF THE WORK, completely protecting an AC outlet requires the use of 3 MOVs configured as shown.

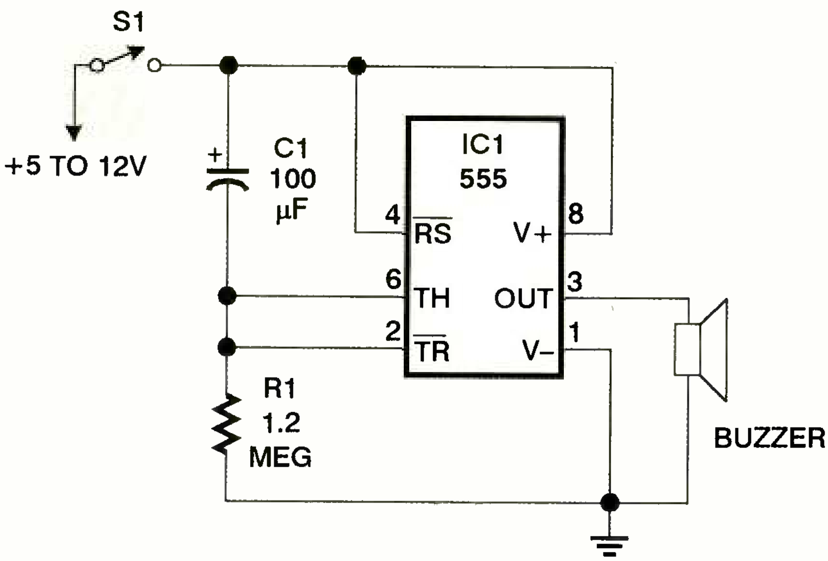


FIG. 3—HERE'S HOW TO CONFIGURE A 555 timer IC to sound a buzzer after a two-minute delay. Different delays can be set by changing the values for R1 and C1.

ures; for that you need a UPS (uninterruptible power supply).

A varistor is rated for its breakdown voltage (which should be slightly higher than the highest voltage that will ever normally be present) and its energy-absorbing capacity in joules (where one joule is equivalent to one watt for one second, or 1000 watts for 1/1000 second, and so on). After a few years of hard work, a varistor stops absorbing surges and should be replaced.

Recording Sound Digitally

Q *I'm currently working on a sound recorder using integrated circuits. I would like to get a chip that can record up to 30 minutes and use it in a radio to record music. Currently, I can only find 20-second recording chips, but I see phone answering machines that can do 30 minutes of recording. Are there any suppliers of these parts, and could this technology replace CDs? — T. J., Prairie Grove, IL*

A Taking your last question first, we're still a few years away from replacing CDs with memory chips. Half an hour of high-fidelity music requires half a CD, *i.e.*, 300 megabytes of memory. That's the equivalent of thousands of dollars' worth of RAM, and the power requirements are appreciable.

Telephone answering machines record 14 minutes of speech in one megabyte of flash EPROM by compressing the data heavily, taking advantage of known limits on the shape of speech waveforms. In effect, they analyze the speech and then synthesize it back. If you record music on a digital answering machine, it generally sounds awful—try it!

One supplier of answering-machine voice-recording chips is Tri-Tech Microelectronics, 1400 McCandless Drive, Milpitas, CA 95035, *http:///www. tritech-sg.com*. Ask for data on their TR83100CF chip, which comes in an 80-pin surface-mount package and requires external flash memory.

Written-Pole Motor

Q *ASHRAE* Journal, *April 1997, described a "Written Pole" motor. What is it? — C. D., Montreal, Quebec, Canada*

A It's an AC induction motor whose poles are magnetically recorded ("written") on the rotor during operation. Thus the number of poles can be changed as the motor starts up and comes up to working speed. That makes it possible to start and run a very large motor (such as 100 horsepower) from a single-phase 120-volt line. Written Pole motors with flywheels and generators are sometimes used as uninterruptible power supplies for large industrial equipment.

"Written Pole" is a trademark. The motors are a product of Precise Power Corporation, 715 60th Street Ct. E, Bradenton, FL 34208, and Electric Power Research Institute (EPRI), 3412 Hillview Ave., Palo Alto, CA 94304.

Telltale Clue

Q *What could be ailing my 1978-model Zenith television set? Until the set is quite warm, the brightness will go off abruptly several times, leaving a completely black picture for one or two minutes. I can usually restore brightness by thumping the side of the cabinet. Are there some voltage levels I should check using my HV probe? — W. A. E., North York, Ontario, Canada*

A The fact that you can fix it by thumping is an important clue—the problem is some kind of loose connection, most likely a bad solder joint. Using high-voltage precautions, operate the set with the cover off and see if you can find the loose connection by tapping lightly with a wooden stick. Start with circuits that connect to the base of the CRT. You'll probably find a solder joint that needs to be re-melted, or possibly a loose plug-in connector. **Remember**

that potentially lethal voltages are present even after the set is turned off. If you are not 100%, absolutely sure of what you are doing, do not attempt to do the troubleshooting yourself; instead seek qualified, professional help.

Closed-Caption Decoder

Q *Where can I get a closed-caption decoder that can be put in line between the VCR and the TV? I am told closed-caption decoding has been built into all new TVs since 1993, and separate closed-caption decoders are hard to find. — A. A. S., Deltona, FL*

A You can still buy closed-caption decoders from companies that sell products for the hearing-impaired. One vendor is Auditech, Inc., 381 Cockerell Road, Vicksburg, MS 39180; Tel: 601-638-1517 (voice or TDD); Web: *http://www.southernnet.com/auditech.*

Automotive Scope Probes

Q *I was excited to see the questions in the August 1997 issue regarding the use of oscilloscopes for automotive testing. My company manufactures probes and other accessories for automotive testing with any 20-MHz or better, dual-channel scope. We have also produced a video that details the procedures for viewing secondary ignition. — Carlos Menchu, Automotive Electronics Services, 3849 N. Fine Avenue #102, Fresno, CA 93727, Tel: 209-292-7851, Web: http://www.aeswave.com*

A Thanks! Your catalog shows quite a selection of oscilloscopes and accessories, mostly with an automotive slant. Readers, if you want to scope your car engine, here's where to get the special probes.

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Many electronic component manufacturers have Web pages; see the directory at http://www.hitex.com/chipdir/, or try addresses such as http://www.ti.com and http://www.motorola.com (substituting any company's name or abbreviation as appropriate). Many IC data sheets can be viewed online.

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, 1-800-872-7423) 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 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** and **Popular Electronics** (post 1992 only) are available from our Claggk, Inc., Reprint Department, P.O Box 4099, Farmingdale, NY 11735; Tel: 516-293-3751.

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Service manuals: Manuals for radios, TVs, VCRs, audio equipment, and some computers are available from Howard W. Sams & Co., Indianapolis, IN 46214 (1-800-428-7267). The free Sams catalog also lists addresses of manufacturers and parts dealers. Even if an item isn't listed in the catalog, it pays to call Sams; they may have a schematic on file which they can copy for you.

Manuals for older test equipment and ham radio gear are available from Hi Manuals, PO Box 802, Council Bluffs, IA 51502, and Manuals Plus, PO Box 549 Tooele, UT 84074.

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

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

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

Old Computer Needs Disk

Q *I'm interested in locating a boot-up disk for a Victor 9000 computer. This computer runs CP/M, not DOS, and was made by Victor Cash Register around 1985. I want to use it for assembly language programming. — Edwin C. Fawcett, 313 Sailfish Lane, New Philadelphia, OH 44663*

We can't help with this, but maybe a reader can. We're publishing your name and address in the hope that someone will come through. Also, you might ask on the Usenet newsgroup *alt.folklore.computers*, which is where the old-computer enthusiasts hang out.

Killer Volts

Q *I did something very wrong to my multimeter. I put one test lead to a high voltage, about ten kilovolts, and you know what happened. To prevent this from happening again, could I protect the multimeter with something like a neon lamp or a protective diode? — S. D., St.-Jean-Richelieu, Quebec, Canada.*

A Our condolences to your multimeter. Neon lamps or protective diodes might work up to a few hundred volts, but at 10 kV, electronic components don't work the way you expect. Electricity doesn't stay in the wires; it pierces through insulation, leaps half an inch or more through the air, and creeps along

Continued on page 13

RAMSEY ELECTRONIC HOBBY & AMATEUR RADIO KITS

Personal Speed Radar

Speed readout is on two LED displays which can be set accurately (better than 1%) to show MPH, Kilmeters-per-hour, or feet-per-second. An earphone output allows you to actually hear the Doppler frequency shift of moving objects. Uses two 13 oz. coffee or juice cans for antenna, able to be remoted up to 300 feet away. The SG-7 is easy and informative to build. No exotic tubing is needed. Your Speedy kits includes a deluxe black ABS plastic case with SPEEDY graphics for a professional look. Operates on 12 VDC. Case size: 3 5/8" x 5 3/4" x 1 1/8".

SG-7 Speedy Radar Set..........$99.95
AC12-5 12 Volt DC Wall Plug Adapter..........$9.95

Personal Autopatch

Your own private mobile phone system -just hook up to the mike and speaker jacks on your base station rig and plug into the phone line! Complete control, including long distance is assured through touch-tone access codes that you set and change at will, preventing fraudulent usage. All codes and setups are stored in special nonvolatile memory immune to power failures. Power required is 12 volts DC at 100mA. The SDP-600 is made in the USA and carries a one year warranty.

SDP-600 Personal Autopatch Fully Wired..........$249.95
SDPA 12 Volt Power Supply Unit..........$11.95

2 Meter Power Amp Kit

The PA-1 will give you a ten times power gain, 2 watts in for 20 watts out, 4 in for 40 out. Power required is 12 to 14 volts DC at 5 amps with 40 watts out. You provide the power supply, enclosure/heatsink, RF and DC connectors, optional T-R switching, receive preamp and, of course, the building of the kit. To save parts searching, a companion T-R switching kit and preamp are available. Size: 4"w x 1/2"h x 2 1/2"d.

PA-1 2 Meter Booster Amplifier..........$34.95
RFS-1 RF Sensed T-R Relay Kit..........$14.95
PR-10 Two Meter Preamp Kit..........$17.95

Dr. Ni-Cad, Nicad Battery Conditioner/Fast Charger

Rejuvenate and condition your batteries for peak capacity. Quick charge rapidly brings battery to full charge, squeezing every last bit of energy into each cell without cooking your batteries, in less than 1 hour or just 15 minutes for some. Charges NiCads or NiMH packs from 2 to 10 cells and current capacities up to 10 Amp-hours. Runs on 12 -15 VDC at up to 1.5 A. Available in money saving kit form or wired and tested with case at a special price.

DN-1 Nicad Battery Conditioner/Fast Charger..........$49.95
CDN Matching Case Set..........$14.95
DN-1WT Fully Assembled Dr. Nicad w/Case..........$89.95

BayPac Portable Packet Modem

Most popular packet interface in the world...Simple to hookup and tiny in size, sophisticated features like digipeating, file transfer and remote terminal access as well as routine message handling are available. It comes fully assembled and plugs directly into the serial COM port. An RJ-11 style telephone jack is used for easy connection to your transceiver's mike and speaker jacks. Software and extensive documentation is included. The Multi-Mode BP-2M has all the great features mentioned, plus Multi-Mode capability using a wide range of shareware, freeware and commercial software. Easy switching between modes and a comprehensive Help screen is available. The BP-2 is supplied with a list of compatible software, how to set up, and best source for download or purchase.

BP-2 BayPac Portable Packet Plus Sofware..........$49.95
BP-2M Multi-Mode BayPac Portable Modem..........$69.95

Fantastic FM Transceivers synthesized-no crystals

The FX is ideal for shack, portable or mobile. The wide frequency coverage and programmable repeater splits makes the FX the perfect rig for Amateur, CAP or MARS applications. Packeteers really appreciate the dedicated packet port, "TRUE-FM" signal and almost instant T/R switching. Twelve diode programmed channels, 5W RF output, sensitive dual conversion receiver and proven easy assembly. Why pay more for a used foreign rig when you can have one made by you for less. Order our matching case and knob set for that pro look.

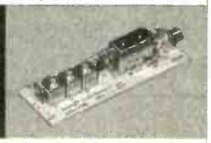
FX-50 Kit (6 m)..........$149.95
FX-146 Kit (2m)..........$149.95
FX-223 Kit (1-1/4 m)..........$149.95
FX-440 Kit (3/4 m)..........$169.95

20 Meter SSB/CW Transceiver

Pint-sized package with the DDS synthesizer that runs in 10 Hz steps with exceptionally low phase noise for fantastic weak signal reception. The SX-20 has a built-in iambic CW keyer that has a digital readout of your CW speed, even checking the CW key jack to determine what type of key you're using! A pair of VFO's, with memory, to hop around, dual selectable AGC, plus one button WWV reception lets you get a quick check of reception conditions and calibration. Perky 10 watt RF output can be tuned down for the QRP operation. Includes hand mike with remote up/down tuning buttons and a dirt and water resistant membrane front panel. The SX-20 is compatible with all ICOM style desk microphones. CW buffs will appreciate the optional CW filter with DIP switch selection of bandwidth, from 2400 Hz down to a sharp 100 Hz. Available in both fully assembled and fun to build kit form. Runs on 12 VDC supply, not included, 5 Amp fused power line cable included. Case size 9 5/8"w x 3 3/4"h x 9"d.

SX-20 20 Meter SSB/CW Transceiver Kit..........$299.95
SX-20WT 20 Meter SSB/CW Tranceiver, Fully Wired..........$369.95
SX-CWNWT Digital CW Filter for SX-20, Fully Wired..........$49.95

High Performance 2 Meter Receiver Preamp



Here's the ideal preamp for repeaters, base stations, mobiles,or anywhere a selective low noise signal boost is needed. Unlike other preamps, the PR-100 features extensive RF filtering to crush intermod before it reaches your radio. Two poles of sharp Helical filtering combined with a 3 pole L-C tank allows only signals of interest to reach your receiver. A low noise microwave bipolar transistor provides an excellent 1 dB noise figure while remaining ruggedly insensitive to static and strong signals. This is actually included as part of our Weather Satellite receiver system! Preamp is easily configured to be powered via the coax or powered through a separate power cable. Kit is designed to fit snugly into a 3" long piece of 1 1/2" PVC pipe with end caps, making an ideal outdoor enclosure. Runs on 9 to 15 VDC. Size 4"w x 7/8"h x 1 3/8"d.

PR-100 High Performance 2 Meter PreAmp Kit..........$59.95

Crystal Radio Set

A radio that needs no batteries or reliance on modern semiconductor devices, similar to the ones built by early radio pioneers. The detector uses an actual piece of Galena, a mineral with semiconductor properties. The Crystal Set requires no soldering, making it ideal for introducing newcomers to the "art" of radio and for old timers to relive the golden years of radio. We show you how to build a standard AM broadcast band radio as well as a shortwave set capable of picking up signals from across the ocean. Complete with all parts, including a sensitive crystal ear piece and even some antenna wire. Assembled on a pine base with brass screws. Size: 6 1/4"w x 3 1/2"d x 3"h.

CS-1 Crystal Radio Set..........$19.95

Full Feature VHF/UHF Booster Amps

Give your hand-held a big voice at a small price. These great new, all mode amplifiers are housed in an attractive but rugged anodized aluminum case that gives a new meaning to the word durable. The 2 meter amps give you a 10x power gain, up to 40 watts out. The 220 and 440 models give you an 8x power gain with up to 25 watts output. Features include switchable low noise receive preamp, FM/SSB operation and the power on/off switch automatically bypasses the booster amp when switched off. All units have provision for an optional helical filter for superb rejection of out-of-band signals -good by intermod! LED indicators for Preamp On, Power On, and Transmit. All units completely wired and tested. Power required is 12 to 14 VDC at 5 amps. Size 5"l X 6"w X 2.25"h.

PA-146WT 146 MHzAmp..........$109.95
PA-220WT 220 MHz Amp..........$109.95
PA-440WT 440 MHz Amp..........$129.95

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LETTERS

SEND YOUR COMMENTS TO THE EDITORS OF ELECTRONICS NOW MAGAZINE

Address Correction

It has come to our attention that ATC Electronics, the source for the DTMF-PLUS kit (Build the DTMF-Plus, ***Electronics Now****, July, 1997), and the Modem Commander kit (Build the Modem Commander,* ***Electronics Now****, January 1997) has moved. Their new address is: ATC Electronics, PO Box 43033, Phoenix, AZ 85080-3033; Tel: 602-516-2926; e-mail: 103463.301@compuserve.com. We're sorry for any inconvenience that might have been caused.—Editor*

The Internet: Resource or Latest Craze?

In response to your editorial of August 1997, I have some thoughts to share. You urge us all "Don't miss out." Well, I say, "Be careful what you don't miss. Here there be tigers."

Personally, I do not yet have an access account of my own; it has a limited value to me. However, I will get one fairly soon for one reason: Less than ten years ago, the Fax machine was not everywhere. The only things that were faxed were very important things, and the competition for Fax was Federal Express. Remember when places had signs in the window, "Fax Here." I can recall running down the block to transmit some document. Now Faxes are everywhere. I have one at my office and here in my home. One could not imagine doing business without a Fax. What would your reaction be if you asked someone for their Fax number and he had none? Now, Internet addresses have almost achieved that level of expectation. Businesses expect you to be able to download something, and they expect you to be able to respond in kind. Essentially I am forced by current practice to get on the Internet.

Yes, the Internet is a resource, but it is also a substitute for resourcefulness: an analogy to the humble calculator. If you always use a calculator, you forget how to do arithmetic. My sister really likes the Internet; she forgot the phone number of my local university-affiliated credit union. She went to the university home page, linked to the credit union home page, and then found the number. She said she didn't know what to do without her Internet. Apparently she forgot about dialing directory assistance!

Every company under the sun has a home page, but, frankly, it seems a little more than electronic junk mail. Fancy ads. Radio row? Yes, I am sure there are some esoteric parts advertised on the Net, but most needs are met by the ads in the back of your magazine.

My shop is a professional electronics maintenance and repair facility. We work on professional audio, lighting, and other show-business electronics. We service consumer audio, and all aspects of the coin-op amusements industry—juke boxes, pinballs, video games, etc. I work on a lot of different stuff, but 99% of my non-OEM parts come from a few catalogs: MCM, Digi-Key, Mouser, Allied, MECI, Hosfelt, Dalbani, and Jameco. With that stack and my industry-specific suppliers, there is little I can't get in terms of parts.

I really cringe when you tell people to answer their questions on the Internet. Of all the problems, that is the largest. Newsgroup discussions are no more than conversations in a tavern. There is no filter. Every participant can weigh in with his ideas—worthless or brilliant. The novice has no way to know the difference. Just like beer talk in a bar, everyone has an opinion, and they all think they know something whether they do or not. Even professionals can have screwy ideas. I know a professional soundman who thought high-frequency sounds traveled faster than low. He makes musicians sound very good, but he had erroneously rationalized an audio phasing phenomenon.

In the bar, you can at least see whom you are talking to, and your "nonsense" detector has a chance. On the Internet, who knows. We have all heard stories of thirteen-year-old boys pretending to be twenty-two-year-old women. Well, the newsgroups have their equivalent: thirteen-year-old boys pretending they are engineers. Even the old-timers don't always get it right. A lot of conventional wisdom ain't really wisdom.

No doubt the Net is a powerful tool, and it has many things to offer. However, just think what would happen if the young electronics enthusiast, instead of surfing the Web, would put the same time into reading books. Read the TTL cookbook or the CMOS cookbook or the Op-Amp cookbook. Read the Radio Amateur Handbook. Read a general text. Study logic and microprocessors. There is so much more out there than staring at a CRT.

America loves to get giddy when anything new comes along. The Internet thing has blossomed the last couple of years, and we have all gone nuts. As a nation, we seem to have decided that the Internet is the ultimate answer, the panacea for the 1990s. For example, here in Lansing, school funding is a serious problem. We are trying hard to avoid closing the city library for lack of money; we have trouble getting books; and a local middle school had actually lost accreditation due to low test scores. At the PTA meetings, what does the school administrator say? "Well, we need to set up a home page for the school."

Yes sir, that will fix everything.

DOUGLAS "ENZO" MCCALLUM
Lansing, MI

Write To:
Letters,
Electronics Now Magazine,
500 Bi-County Blvd.,
Farmingdale, NY 11735

Due to the volume of mail we receive, not all letters can be answered personally. All letters are subject to editing for clarity and length.

WHAT'S NEWS

continued from page 7

to study the development of international standards for the protection of personal data and privacy. The recommendation to develop personal data and privacy standards arose at the 1996 Annual Meeting of ISO's Committee on Consumer Policy (COPOLCO), which cited the need for such standards due to rapid advances in technology and the growth of the Internet. The recommendation states that "while regulations in this area differ throughout the world, consensus-based standards could provide a global base for the protection of personal information." ANSI's International Advisory Committee (IAC) has also established a similar group to get input on these issues from interested U.S. parties, whether or not they are ANSI members.

By the time you read this, the ad hoc advisory group will have presented a preliminary report to the TMB. A final report will be issued in early 1998. One major issue will be an analysis of the impact an ISO standard will have on implementation of the European Union's (EU) Privacy Directive. Under that directive, member states are prohibited from transferring personal data to non-EU member states that have inadequate privacy protection. EN

Q & A

continued from page 10

surfaces by following invisible films of oil or moisture. That's why high-voltage probes are so big and have so many protective ridges. There's no reliable way to make a multimeter withstand 10 kV while using components and probes of convenient size and shape.

Still More On Printed Circuits

Sam Overman, of Dahlgren, VA, writes with a very sensible suggestion. Since more people use toner transfer methods than photo-resist nowadays, we should print our PC board patterns backward so they can be transferred to paper or plastic with a Xerox machine and then ironed onto the copper. Those who prefer photo-resist can still make negatives in the normal manner and then flip them. Every pattern should include some writing so people can tell whether they're looking at it forward or backward.

Sam also points out that older clothes irons are not calibrated in degrees and thus can't be set to 200° F. He suggests preheating the copper-clad board in an oven or toaster oven instead.

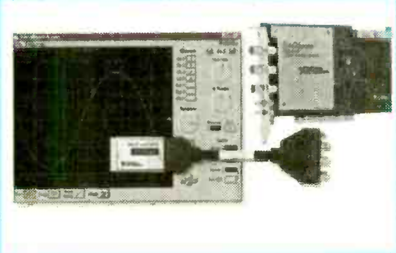
Writing to Q&A

As always, we welcome your questions. Write to Q&A, **Electronics Now** Magazine, 500 Bi-County Blvd., Farmingdale, NY 11735. The most interesting ones are answered in print usually within nine months. Please be sure to include plenty of background information (we'll shorten your letter for publication). *If you are asking about a circuit, please include a complete diagram.* Without it, your inquiry willl likely be impossible to answer. Due to the volume of mail received, we regret that we cannot give personal replies. EN

EQUIPMENT REPORTS

NATIONAL INSTRUMENTS DAQSCOPE 5102 DIGITAL OSCILLOSCOPE

Pack the power of a high-quality digital oscilloscope into a notebook computer, but leave the bulk behind.



The notebook computer was a blessing in disguise for many people. No longer did they have to jot down notes on paper and then enter the data back at work or home—the computer traveled with them, ready to input data or run a program at a moment's notice. Of course for field service technicians, the notebook computer was just something else to lug around along with the oscilloscope, tool kit, and other test gear.

At least that's how it used to be. Now, thanks to National Instruments' *DAQScope 5102* digitizing oscilloscope, you can safely leave that heavy oscilloscope behind when you go into the field. That's because when the DAQScope's data-acquisition hardware and software is added to a computer, the resulting combination is a digitizing oscilloscope that offers the functionality of a traditional oscilloscope with the storage capacity and processing power of a computer. This dual-channel, 20-megasample per second digital oscilloscope comes in PCI and ISA forms for desktop systems and as a PC Card for notebook computers. Software is provided for Windows 3.1, 95, and NT, although 95 and NT are preferred. A PC running any of those operating systems that has 16MB of memory and 20MB of free hard disk space will do the trick.

The PC Card version of the DAQScope, reviewed here, makes for a very portable digital storage oscilloscope, although a notebook computer is, of course, a prerequisite. The benefits of tying an oscilloscope to a personal computer are many; for example, captured waveforms are instantly stored in RAM and can even be logged to disk. The computer's processing power enables quick plotting of data, and a printer can provide hard-copy readouts.

Specifications

The DAQScope has a 15-MHz bandwidth and analog input with two simultaneously sampled channels. Real-time sampling ranges from one kilosample-per-second (kS/s) to 20 megasamples-per-second (MS/s) per channel. AC and DC coupling is software-selectable. Input impedance is 1 megohm. It has one analog trigger and two digital triggers, or PFI lines that allow master/slave synchronization.

The analog-to-digital converter on the DAQScope is a pipelined flash converter that can simultaneously sample both inputs at a rate of 20 MS/s for the effective bandwidth of 15 MHz. It has two acquisition modes, post-trigger and pre-trigger. To ensure that signal anomalies aren't missed due to having the trigger point set incorrectly, the DAQScope provides different trigger thresholds, programmable hysteresis values, bi-level triggering, and more.

Setup

Setting up the DAQScope is fairly simple, but with slightly better documentation, it could be made much easier,

Continued on page 16

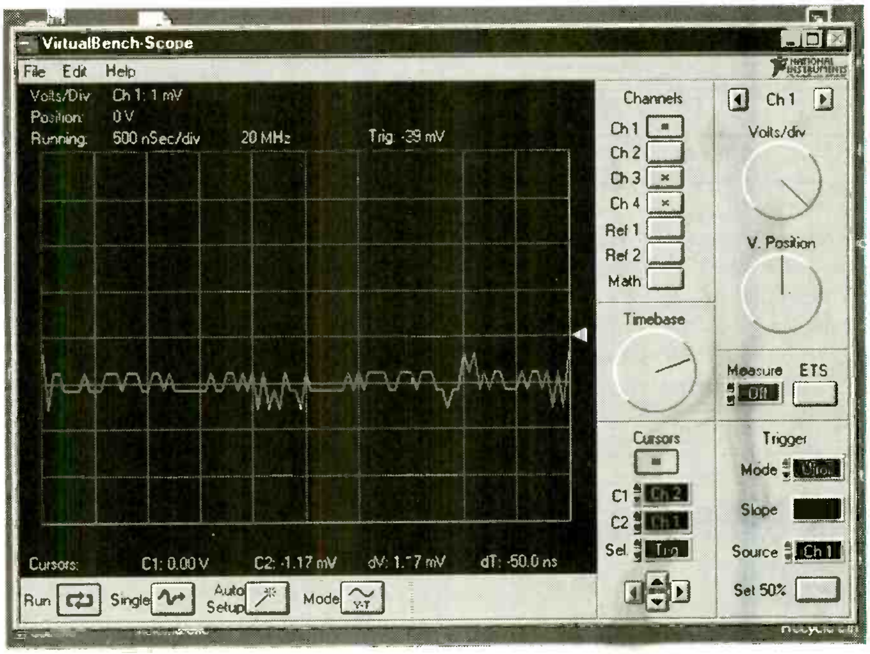


FIG. 1—THE VIRTUALBENCH SOFTWARE, which is included in the DAQScope package, places the familiar look of a modern oscilloscope on your PC's or laptop's screen.

NEW LITERATURE

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1997/98 Test Instruments & Accessories Catalog

B & K Precision
6470 W. Cortland Street
Chicago, IL 60707-4098
Tel: 773-889-1448
Fax: 773-749-9740
Web: www.bkprecision.com
Free

CIRCLE 338 ON FREE INFORMATION CARD

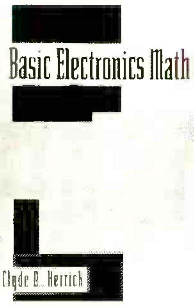
B & K Precision's 1997/98 product catalog highlights the company's new line of high-performance oscilloscopes, digital multimeters and power clamp-on meters. With the addition of products such as the 5300-series 50,000-count digital multimeters, B & K now offers one of the largest selections of test instruments available. All price ranges and performance levels are represented.

The 72-page catalog features an index and product guide for quick reference, as well as detailed specifications on each product category. The product categories are oscilloscopes, DMMs, power supplies, function generators, spectrum analyzers, and a wide variety of component testers, test leads and accessories.

Basic Electronics Math

by Clyde N. Herrick
Newnes, Butterworth-Heinemann
225 Wildwood Avenue, Unit B
P.O. Box 4500
Woburn, MA 01801-2041
Tel: 617-928-2500
Fax: 617-933-6333
Web: http://www.bh.com/bh
$24.95

Most students entering an electronics-technician program have an understanding of mathematics. What this book provides is a practical application of those basics to electronics theory and circuits.



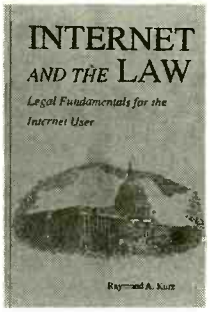
CIRCLE 339 ON FREE INFORMATION CARD

The first half of this book contains a review of mathematical concepts. The second half covers applications to electronics. The reader is lead by graduated exercises to a thorough comprehension of the mathematics of electronics. Each chapter contains an introduction, clear examples, problems to solve, and a summary of the concepts covered in that chapter. Answers to the problems and an index are found in the back of the book.

Subjects covered include series-parallel resistive networks and circuits, Thevenin's theorem, band-pass filter circuits, Boolean algebra, and more.

Internet and the Law: Legal Fundamentals for the Internet User

by Raymond A. Kurz
Government Institutes
4 Research Place
Rockville, MD 20850-3226
Tel: 301-921-2300
Fax: 301-921-0373
E-mail: ginfo@govinst.com
Web: http://www.govinst.com
$75 plus S/H



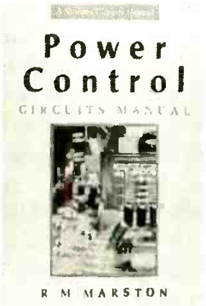
CIRCLE 340 ON FREE INFORMATION CARD

The explosion in Internet use has thrust unsuspecting but well-intentioned companies and individuals into potential legal nightmares. This book provides timely guidance for the Internet user to navigate through the legalities of cyberspace. It outlines steps to take to avoid or minimize the chance of unknowingly engaging in illegal activity when downloading information. In addition, there are guidelines that help protect your rights as an Internet user. It contains practical advice for the lawyer and business user.

The basic principles pertaining to laws of copyright, trademark, trade secret, patent, libel/defamation, and licensing are explained in detail. The author, a lawyer specializing in intellectual property litigation, has included numerous hypothetical problems and their solutions.

Power Control Circuits Manual: 2nd Edition

by R.M. Marston
Newnes, Butterworth-Heinemann
225 Wildwood Avenue, Unit B
P.O. Box 4500
Woburn, MA 01801-2041
Tel: 617-928-2500
Fax: 617-933-6333
Web: http://www.bh.com/bh
$28.95



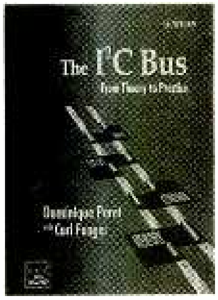
CIRCLE 341 ON FREE INFORMATION CARD

Presented in an easy-to-read, non-mathematical manner, this book takes an in-depth look at the subject of electronic power control, covering everything from basic principles to AC-power control data to house re-wiring. A wide range of useful circuits and diagrams is included, designed for engineers, technicians, hobbyists, and students.

Electronic power circuits can be used to control lamps, motor speed, the temperature of heating devices, or the loudness of audio signals. These control circuits use either electromechanical switches or relays; or electronic components, such as transistors, SCRs, Triacs, or power ICs.

The I²C Bus: From Theory to Practice

by Dominque Paret with Carl Fenger
John Wiley & Sons, Inc.
605 Third Avenue
New York, NY 10158
Tel: 212-850-6336
$79.95 including disk



CIRCLE 342 ON FREE INFORMATION CARD

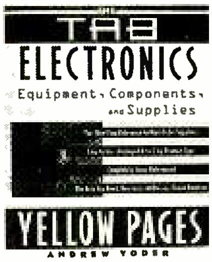
The I²C or Inter-Integrated Circuit bus is a two-wire control bus for linking micro-controller and peripheral ICs. This guidebook through the world of microcontroller-managed serial buses enables the reader to design an I²C bus-based system for virtually any application.

Featured in this book is an examination of typical industrial and consumer applications for effective design in a real-world environment. Examples of modular solutions of varying complexity, and instruction on building bridges to other buses are also included. An accompanying diskette contains I²C bus instruction software. Structured in four parts, the text covers protocol, components, applications, and development tools.

The versatility of the I²C bus has resulted in its widespread adaptation in areas from telecommunications and automobile dashboards to energy-management systems and medical equipment. Linking theory with practice, this user-friendly source allows both professional circuit designers and electronic and electrical engineering students to learn all about this technology.

The TAB Electronics Yellow Pages: Equipment, Components and Supplies

by Andrew Yoder
McGraw-Hill, Inc.
11 West 19th Street
New York, NY 10011
Tel: 800-2MCGRAW
Fax: 212-337-4092
$49.95 hardcover; $29.95 paperback



CIRCLE 343 ON FREE INFORMATION CARD

This one-stop reference to mail-order suppliers is an easy-to-use resource for locating any electronic component, eliminating the need for searching through many different catalogs. It is arranged alphabetically by the company name. There is a product index that groups companies according to product types. The reader can use this section to locate companies that supply the parts he is interested in and can turn to the individual entries for complete information. Useful coupons are located at the back of the book.

Each listing has addresses and phone numbers, fax numbers, 800 numbers, e-mail addresses, and technical-support numbers, if available. Included in each entry are key facts, such as credit card information, shipping minimums—if any, a brief description of items supplied, and whether or not a catalog exists.

Categories covered include audio equipment, radio, CPUs, cameras, robotics, and surveillance and video equipment, and others.

Catalog #39 A

MCM Electronics
650 Congress Park Drive
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Tel: 800-543-4330
Fax: 937-434-6959
Web: www.mcmelectronics.com
Free

CIRCLE 344 ON FREE INFORMATION CARD

Over 36,000 national brand-name items for the consumer electronics repair, hobbyist and service industries are included in MCM Electronics' latest catalog. The catalog is organized into 25 groupings for easy reference.

Semiconductors, connectors, test equipment, accessories, computer, and audio products, along with hundreds of original OEM and generic TV/VCR repair parts are some of the 9,000 items that have been added. Among the manufacturers represented for the first time

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EQUIPMENT REPORT

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especially for the neophyte. Not that there isn't plenty of documentation, mind you, but the key thing that's missing is a single "Start Here" sheet of paper that explains what everything is and in what order to do things. For example, the driver for a PC Card is normally provided by Windows automatically or by the user on diskette, and the procedure normally takes just a few seconds. However, NI-DAQ, the driver software for the oscilloscope PC Card, is provided on a CD-ROM, and the file is not easily recognized simply by browsing the disc.

NI-DAQ is a comprehensive driver package that recognizes an entire line of National Instruments DAQ Cards. It must be installed from the CD-ROM before the DAQScope card will be recognized by a notebook computer. That is not intuitive, or made obviously clear by the documentation, and caused this reviewer some headaches. But now that you're reading this review, you have the advantage of knowing all about that!

From this point, installation is easy. VirtualBench is installed next. That Windows program places a virtual oscilloscope front panel onto a PC screen (see Fig. 1). The interface is intuitive and easy to use, although the hands-on feeling of the actual controls on a real oscilloscope is lost. Like NI-DAQ, VirtualBench can provide more than just the oscilloscope function. However, *only* the oscilloscope function is "unlocked" from the CD-ROM by the serial number provided with a DAQScope. Other functions work with other National Instruments packages.

DAQScope is perhaps a glimpse into a future world where there are no more "real" pieces of test gear. We'll simply have cheap portable computers that do everything. But wait—we already have them. We just have to get rid of all the bulky test gear.

The DAQScope 5102 digital oscilloscope has a retail price of $1,295. Included are the PC Card oscilloscope, a probe and accessory assortment, the Virtual Bench software, all the necessary drivers, documentation, and a nylon pouch. For more information on it, contact National Instruments Corporation (6504 Bridge Point Parkway, Austin, TX 78730; Tel: 512-794-0100; Fax: 512-794-8411; Web: www.natinst.com) directly, or circle 15 on the Free Information Card. EN

NEW LITERATURE

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are Philips/Magnavox, Sony, Tektronix, Duracell, Belden and Klein Tools.

Real-World Interfacing With Your PC:

A Hands-On Guide to Parallel Port Projects
by James "J.J." Barbarello
Prompt Publications
2647 Waterfront Parkway, East Drive
Suite 300
Indianapolis, IN 46214-2041
Tel: 800-428-7267
Web: http://www.hwsams.com
$16.95

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As personal computers become increasingly prevalent, their uses and applications continue to grow. For those who want to use their computers for things other than manipulating text, data, and graphics, interfacing is the wave of the future. The parallel-port is a general purpose input/output device, but it can be used for things like operating an analog-to-digital converter or in building a swipe-card system that provides entry via an electronic door lock.

Written by frequent Electronics Now contributor J.J. Barbarello, this hands-on guide to parallel-port projects provides a basic understanding of writing software to control that hardware. Geared to electronics hobbyists, this book walks the reader through an entire analog-to-digital converter project, from design to construction to checkout. A chapter on project construction techniques, as well as a checklist for easy reference and a recommended inventory of starter electronic parts, helps less-experienced readers get started. EN

NEW PRODUCTS

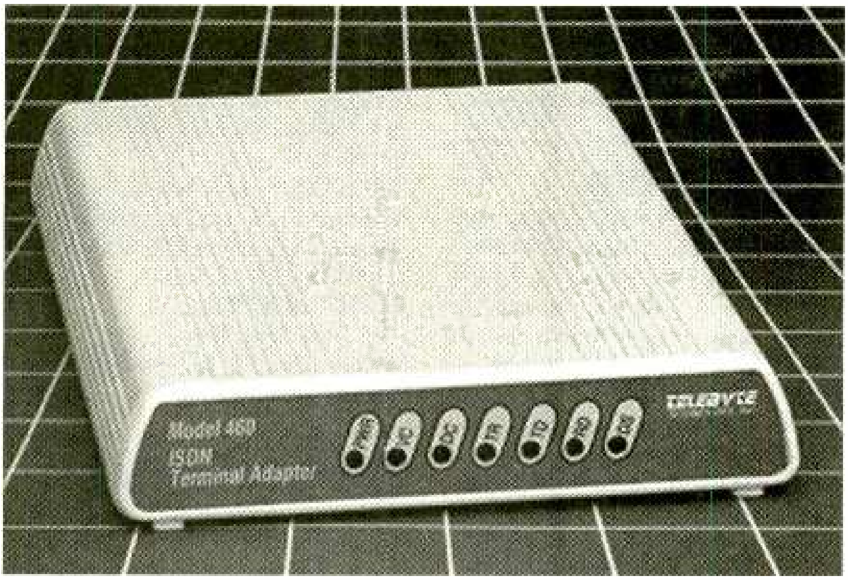
USE THE FREE INFORMATION CARD FOR FAST RESPONSE

ISDN Terminal Adapter

FROM ANY LOCATION, THE Model 460 ISDN Terminal Adapter from Telebyte provides high-speed, reliable digital access to the Internet and the Web. It runs at speeds up to 460 KBPS using V.42 bis compression. Aimed at the remote office or home market, the Model 460 handles applications such as remote access and telecommuting where fast connect time and high throughput are essential. Other applications include fast file transfer, retail, security, slow scan video, and data collection.

The Model 460 includes a high-speed data port, as well as two analog or phone ports, allowing telephones, modems, or faxes to be easily connected to an ISDN line. There are also RS-232 ports, which provide serial devices with connect times of under one second typically. The device's V.120 rate adaptation allows for flow control, error correction, as well as interoperability with products from other manufacturers.

The Adapter has flexibility built-in, allocating the bandwidth in three modes. Two data calls— which can be bonded to form a single 128 KBPS data pipe, one data call/one voice call, or two voice calls—can be processed at once. Since the Model 460 is able to use both ISDN "B" channels simultaneously for data transfer, you get 128 KBPS network throughput. Data compression can be added to enable data transmission between the Adapter and the PC (or DTE) at up to 460.8 KBPS, but only if the PC contains a high-speed serial card.



CIRCLE 20 ON FREE INFORMATION CARD

Other features include caller ID, an internal call log, and FLASH memory. North American ISDN is handled by the Model 460, while the international version is the Model 461.

Model 460 and Model 461 retail at $299 and $450, respectively.

TELEBYTE TECHNOLOGY, INC.
270 Pulaski Road
Greenlawn, NY 11740-1616
Tel: 800-TELEBYTE, 516-423-3232
Fax: 516-385-8184
E-mail: sales@telebyteusa.com
Web: http://telebytusa.com.

Analog Multimeter

A new low-cost analog multimeter from HC Protek is ideal for most electronic and electrical applications. The Model A-803 is a 26-range multimeter

CIRCLE 21 ON FREE INFORMATION CARD

with built-in transistor test and identification capabilities. Featuring 30K ohm/volt sensitivity, it measures AC voltage to 1000 volts, DC voltage to 100 volts, DC current to 10 amps, and resistance to 50 megohms. Other features include a large mirrored scale, an audible continuity buzzer, and fuse/diode protection. The unit is rated to operate at temperatures between -60°F to +500°F and adheres to UL and CE standards. Three lower-cost units, the A-802, A-801, and A-800 are also available.

The A-803 has a list price of $44.95.

HC PROTEK
154 Veterans Drive
Northvale, NJ 07647
Tel: 201-767-7242
Fax: 201-767-7343
E-mail: hcprotek@aol.com
Web: http://www.techexpo.com./WWW/hcprotek

Color Video Lamp

The VL-300 Color Lamp from American Innovations is an affordable, high-tech surveillance device. This ordinary-looking desk or table lamp covertly houses a color camera with a low 2 lux sensitivity rating. The camera also has built-in backlight compensation and a horizontal resolution of 380 lines, result-

CIRCLE 22 ON FREE INFORMATION CARD

ing in excellent picture quality. Requiring only a pinhole opening at the base of the lamp, the video camera is virtually undetectable. Designed for use in any hidden video application, this black and gold touch lamp, which stands 19-inches high, blends in with any environment.

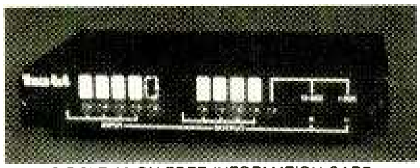
The VL-300 Color Video Lamp sells for $595.

AMERICAN INNOVATIONS, INC.
119 Rockland Center
Suite 315
Nanuet, NY 10954
Tel: 914-735-6127
Fax: 914-735-3560
Web: http://www.spysite.com.

Video Sequencer

The V4×4 is the world's only four-input, four-output, microprocessor-controlled video sequencer, according to the manufacturer, NetMedia. Using this miniature device, it's possible to monitor four different video sources on four different outputs. With push button control, you can monitor either manually or automatically, selecting from varying rotation patterns. Watch any video source independently, while other outputs are being automatically sequenced.

Combining small size (5.5 × 3.5 × 0.9



CIRCLE 23 ON FREE INFORMATION CARD

inches) and light weight (8.6 ounces) with easy sequencing options, the device is suitable for all commercial and residential multiple-camera monitoring applications. The V4×4 comes with a 110-volt transformer or can operate on 12-volt DC power source, including batteries or solar cells.

Suggested retail price is $299.

NETMEDIA, INC.
10904 N. Stallard Place
Tucson, AZ 85737-9527
Tel: 888-RUN-TABS
or 520-544-4567 in Arizona
Fax: 520-544-0800
E-mail: sales@homeautomation.com
Web: http://www.homeautomation.com

Electromagnetic Meter

Compact, inexpensive, and easy-to-use, the Tri-Field Natural EM Meter from Alphalab, Inc. detects changes in extremely weak static (or natural) electric and magnetic fields. Both a tone and a needle-type gauge signal changes in either electric or magnetic fields. A radio wave and microwave detector is also built into this device. The meter has been designed to ignore AC fields, which could interfere with the readings.

When set on "MAGNETIC," the Tri-Field Meter signals the movement of any strong magnetic source in the sky,

CIRCLE 24 ON FREE INFORMATION CARD

even if the sky is cloudy or the source dips behind a hill. Since walls do not block magnetic fields, the meter can be used indoors, as well. The tone enables it to be used in the dark also. Sensitive to changes in the magnetic field as small as 0.5%, the tone sounds whether the field increases or decreases. If the field stabilizes for more than five seconds, the tone stops and the meter returns to normal. The threshold level or squelch of the tone is adjustable by turning the side knob.

On the "ELECTRIC" setting, the meter responds to changes in electric fields as small as 3 volts per meter. Because of this sensitivity, it can be used as motion-activated intruder alarm and can even detect the presence of a person through a wall.

If you turn the dial to "SUM," the meter will add any changes in the electric field to any changes in the magnetic field. The "RADIO/MICROWAVE" mode reads radio waves from 50 MHz to 3 GHz and can also check a microwave for leakage.

The Tri-Field Natural EM Meter sells for $229, which includes UPS Ground Delivery or $232 with UPS Second Day Air service.

ALPHALAB INC.
1280 South Third West
Salt Lake City, UT 84101-3049
Tel./Fax: 503-543-6545

Uninterruptible Power System

Deltec's PowerRite Pro II Series Uninterruptible Power Systems (UPS) addresses the need for high data availability and integrity for LANs, file servers, PCs, workstations and other sensitive electronic equipment. Among the features of this UPS are hot-swappable batteries, longer battery service life, wide voltage regulation, precision power control to extend run times to critical servers, and network/modem surge protection. In addition, Deltec's LanSafe and FailSafe III software is bundled with the unit and provides remote network-wide monitoring, control, and testing, as well as prioritized, sequential shutdown, of all networked devices.

With the PowerRite Pro II's advanced battery-management technology, battery life is extended in a three-step charging process: fast, floating, and rest. Batteries are quickly recharged within four hours after a blackout. Another plus of this UPS is the alarm that gives a warning

Continued on page 26

BY SAM GOLDWASSER

An Introduction to Troubleshooting

THIS MONTH WE ARE GOING TO PRESENT THE FIRST IN A SERIES OF COLUMNS DEVOTED TO THE BASICS OF CONSUMER-ELECTRONICS TROUBLESHOOTING AND REPAIR. ALONG THE WAY WE WILL ALSO TALK A BIT ABOUT SELECTING THE RIGHT TEST EQUIPMENT, the tools and supplies you need, parts, home-made troubleshooting aids, "Incredibly Handy Widgets™," and safety.

While there are many excellent schools dedicated to electronics repair, this column is written from the perspective of the motivated do-it-yourselfer, hobbyist, and tinkerer. That means that you mostly will learn by doing, but you do need to prepare. For example, the Repair FAQs usually list suggested reference books for each area of repair. You can find most of those, or similar titles, at your local public or university library.

To get started in your education, collect broken electronic devices and appliances from your friends, relatives, the dump, garage sales and flea markets, etc. Start on those that have been written off—you are bound to make mistakes at first, we all did. As times passes, your batting average will improve. It may not happen overnight, but as long as you apply yourself, it will happen eventually.

There will be many relatively easy successes, but the 'tough dogs" may make up for those triumphs. Don't let them get to you—not everything can be repaired. Sometimes, the basic design is flawed or someone before you messed up royally.

Troubleshooting is like being a detective, but at least the device is generally not out to deceive you. Experience will be your most useful companion. If you go into the profession, you will obtain or have access to a variety of tech-tips databases. Those are an excellent investment where the saying "time-is-money" rules. However, to learn, you need to develop a general troubleshooting approach—a logical, methodical, way of narrowing down the problem. A tech-tip database might suggest "Replace C536" for a particular symptom. That is good advice for a specific problem on one model. However, what you really want to understand is why C536 was the cause and how to pinpoint the culprit in general if you don't have a service manual or schematic, and your tech-tips database doesn't have an entry for your sick TV or VCR.

While schematics are nice, you won't always have them or be able to justify the purchase of one for a one-of-a-kind repair. Therefore, in many cases, some reverse engineering will be necessary. The time will be well spent; even if you don't see another instance of the same model in your entire lifetime, you will have learned something in the process that can be applied to other equipment problems.

WARNING!!

This article deals with and involves subject matter and the use of materials and substances that may be hazardous to health and life. Do not attempt to implement or use the information contained herein unless you are experienced and skilled with respect to such subject matter, materials, and substances. Neither the publisher nor author make any representations as for the completeness or the accuracy of the information contained herein and disclaim any liability for damages or injuries, whether caused by or arising from the lack of completeness, inaccuracies of the information, misinterpretations of the directions, misapplication of the information, or otherwise.

Basic Troubleshooting

Here are some of my rules of troubleshooting. If you take the time to learn them well, you'll find that you have properly invested your time:

Safety first. Know the hazards associated with the equipment you are troubleshooting. Take all safety precautions. Expect the unexpected. Take your time.

Always think "what if". That applies both to the analytic procedures as well as to precautions with respect to probing the equipment. When probing, insulate all but the last $^1/_8$-inch of the probe tip to prevent costly shorts.

Learn from your mistakes. We all make mistakes—and some of them can be quite costly. A simple problem can turn into an expensive one due to a slip of the probe or being over eager to try something before thinking it through. While stating that your experience in these endeavors is measured by the number of scars you have might be stretching the point, expect to make mistakes. Anyone who has spent any time troubleshooting can point to that disaster caused by inexperience or carelessness. Just make it a point not to make the same mistake again.

Don't start with electronic test equipment. Instead, start with some analytical thinking. Many problems associated with consumer electronic equipment do not require a schematic (though one may be useful). The majority of problems with VCRs, CD players, tape decks, and answering machines, are mechanical and can be dealt with using nothing more than a good set of precision hand tools; some alcohol, degreaser, contact cleaner, light oil and grease; and your powers of observation. Your built-in senses and that stuff between your ears is the most important test equipment you have.

If you get stuck, sleep on it. Sometimes, just letting the problem bounce around in your head will lead to a different, more successful approach or solution. Don't work when you are really tired—it is dangerous and mostly non-productive (and sometimes, even destructive).

Many problems have simple solutions. Don't immediately assume that your problem is some combination of esoteric, complex, and convoluted failures. For a TV, the problem might just be a bad connection or failed diode. For a VCR, it might just be a bad belt or idler tire—or an experiment in rock placement by your three-year old. For a CD player, a dirty lens or need for lubrication could be the cause of the malfunction. Try to remember that the problems with the most catastrophic impact on operation—a dead TV or a VCR that eats tapes—usually have the simplest solutions. The kind of problems we would like to avoid at all costs are the ones that are intermittent or difficult to reproduce: subtle color noise, occasional interference, or the dreaded horizontal-output transistor blowing out every three months syndrome.

Whenever possible, try to substitute a working unit. With modular systems like component stereos and computers, narrowing down a problem to a single unit should be the first priority. That same principle applies at the electronic- or mechanical-parts level. Note that there is the possibility of damaging the known good part by putting it into a non-working device or *vice versa*. The risk is greatest with the power circuitry in amplifiers, TVs and monitors, power supplies, etc. With appropriate precautions, the risk can be minimized.

Don't blindly trust your instruments. If you get readings that don't make sense, you may be using your equipment in a way that is confusing it. DMMs are not good at checking semiconductors in-circuit, or the power transistor you are testing may have a built in damper diode and/or base resistor. Your scope may be picking up interference that is swamping the low-level signal you are searching for (TVs and monitors, or low-level circuits in VCRs and CD players). Your frequency counter may be double triggering due to noise or imperfect signal shape. Or, you may be attempting to measure voltages between the line (non-isolated) and signal (isolated) circuits of your TV, monitor, or other device with a switch-mode power supply.

Realize that coincidences do happen but are relatively rare. Usually, there is a common cause for what appears to be a cluster of unrelated problems. For example, if a TV has no vertical deflection and no picture, it is much more likely that a common power-supply output has failed than for parts in both the deflection and video subsystems to be bad. In other words, look for a common root cause before trying to locate bad parts in separate circuits. It might help to question the owner to determine if all the problems you are troubleshooting have all just appeared. It is very common to be given a device to repair that has now totally died, but previously had been exhibiting some characteristic that the owner had chosen to ignore or perhaps did not notice. Exceptions to the common-cause rule include damage due to lightning, power surges, being dropped, water, or a previous repair person. Also, in the case of seemingly unrelated failures in older equipment, suspect the electrolytic capacitors as those degrade over time and could conceivably fail in bunches.

Confirm the problem before diving into the repair. It is amazing how many complaints turn out to be impossible to reproduce or are simple "cockpit" error. It also makes sense to identify exactly what is and is not working so that you will know whether some fault that just appeared was actually a preexisting problem or was caused by your poking. Try to get as much information as possible about the problem from the owner. If you are the owner, try to reconstruct the exact sequence of events that led to the failure. For example, did the TV just not work when turned on or were there some preliminary symptoms like a jittery or squished picture prior to total failure? Did the problem come and go before finally staying for good?

Get used to the idea of working without a schematic. While service information for TVs is nearly always available in the form of Sams' Photofacts, that is hardly ever true of other types of equipment. Sams' VCR facts exist for less than 10 percent of VCR models, and only the older ones include mechanical information beyond the obvious. While a service manual may be available from the manufacturer of your equipment or another Sams-like source, it may not include the information you really need. Furthermore, there may be no way to justify the cost for a one-time repair. With a basic understanding of how the equipment works, many problems can be dealt with without a schematic—not every one, but quite a few.

Whenever working on precision equipment, make copious notes and diagrams. You will be eternally grateful when the time comes to reassemble the unit. Most connectors are keyed against incorrect insertion or interchange of cables, but that's not universally true. Apparently identical screws might be of differing lengths or have slightly different thread types. Little parts may fit in more than one place, or with more than one possible orientation.

Keep pill bottles, film canisters, and plastic ice-cube trays handy. Those are great for sorting and storing screws and other small parts after disassembly. That is particularly true if you have repairs on multiple pieces of equipment under way simultaneously.

Select a work area that is wide open, well lighted, and where dropped parts can be easily located. It goes without saying that working in an area with a deep-pile shag rug is just asking for trouble. The best location will also be relatively dust free and allow you to suspend your troubleshooting to eat, sleep, or think without having to pile everything into a cardboard box for storage.

Understand the risks of electrostatic discharge (ESD). Some components, like ICs, are vulnerable to ESD. There is no need to go overboard, but taking reasonable precautions, such as getting into the habit of touching a "safe" ground point before touching the device, makes good sense. ***WARNING: Even with an isolation transformer, a live chassis should NEVER be considered a safe ground point.***

Rules of Thumb

Problems that are erratic or intermittent—that come and go suddenly—are almost always due to bad connections. Cold solder joints or internal or external connectors that need to be cleaned and re-seated are common causes. It is amazing just how many common problems fall into that category.

Problems that change gradually—usually they decrease or disappear—as the equipment warms up are often due to dried up electrolytic capacitors.

Problems that result in a totally dead unit or affect multiple functions are generally power-supply related. They are usually easy to fix.

Catastrophic failures often result in burnt, scorched, cracked, exploded, or melted components, or similar consequences. Use your senses of sight and smell for the preliminary search for such evidence.

Listen for signs of arcing or corona—snapping or sizzling sounds. A component on the brink of failing due to overheating may provide similar audible clues.

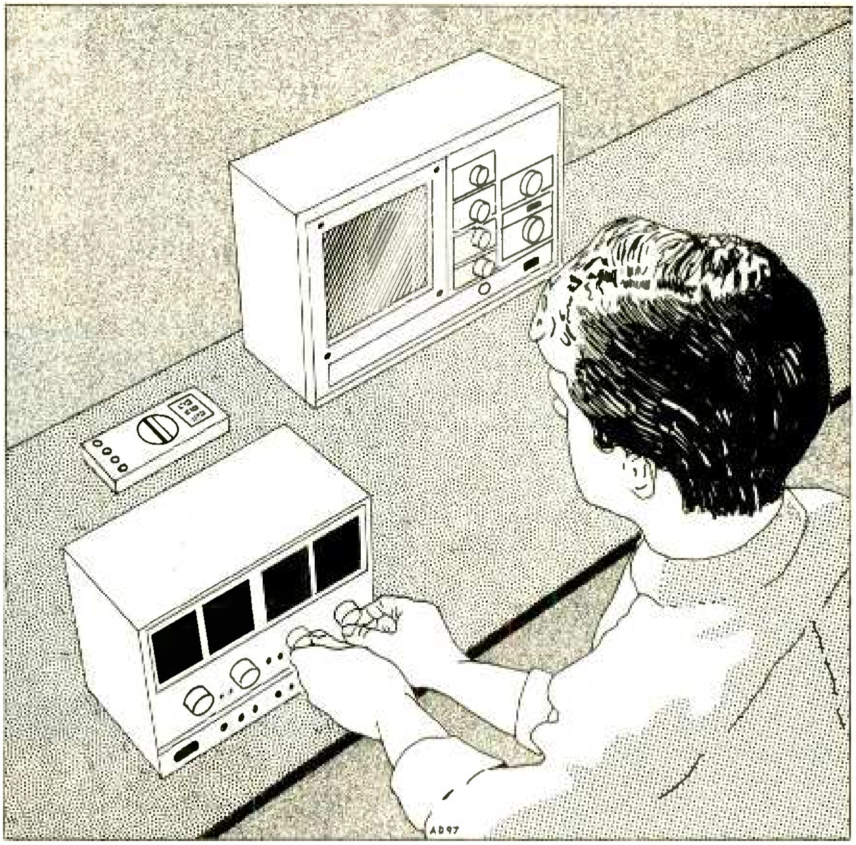
Most VCR problems are mechanical in nature. Worn or deteriorated rubber parts, gummed up lubrication, or abuse (bad tapes or toy storage).

Many CD player problems are mechanical—dirty lens, worn or oily drawer belts, dirt/gummed-up grease on sled tracks/gears, bad/partially-shorted spindle or sled motor. Power problems with portables seem to be common as well. No matter what the symptoms, always make it a habit to clean the lens first—many peculiar failure modes are simply due to a dirty lens. Actual laser failure is relatively uncommon. CD players are also remarkably robust. Optical alignment is rarely needed under normal conditions of operation.

TV and monitor problems are very often power supply or deflection related. These tend to have obvious causes—blown rectifier diodes, filter capacitor, Horizontal Output Transistor (HOT), or chopper. A flyback transformer that has shorted windings, or shorts between windings, in the voltage multiplier (if used), or in the screen/focus divider network are also common. Where the HOT or chopper is involved, operation should be observed after the repair as components in the vicinity may cause the new parts to fail. HOTs should generally not run hot to the touch. If they do, check for weak drive, excess B+, etc.

Ink-jet printers are extremely reliable electrically. Look for simple problems such as caked ink in the "service-station" area, misaligned print-head contacts, or a nearly empty cartridge when erratic printing problems develop.

Laser printers tend to develop problems in the fuser, scanner, or power-control modules. Those are often simple to troubleshoot and repair, and include things like a burned out lamp, bad motor, or bad connections.



WHILE A WELL-EQUIPPED, conventional test bench is always helpful, the first step in troubleshooting should be to use the test gear located between your ears.

Turntables or record-changer problems are very likely to be due to gummed up grease (but you might never see one of those dinosaurs again!).

Like VCRs, problems with audio-tape decks are mostly mechanical; similar solutions apply. Where one channel is out, suspect a broken wire at the tape head before assuming it is a bad chip.

Telephone-line-connected equipment, like modems and phones, are susceptible to phone-line surges. Where a device seems to respond to user commands but does not dial or pickup, suspect a blown part near the phone-line connector.

Sam's Magic Spit™

Using a moistened finger to probe **LOW-VOLTAGE CIRCUITS** has come to the rescue many times. Touching various parts of a circuit from the solder side of the board in an attempt to evoke some sort of response can work wonders. Once a suspect area has been identified, use a metal probe to narrow it down to a specific pin.

The reason this works is that the reduced resistance of your moist skin and your body capacitance will change the signal shape and/or introduce some slight signal of its own.

In logic circuits, marginal timing or signal levels will undergo a dramatic change in behavior with a slight "body" load. It has been possible to locate a race condition or glitchy signal on a 305-pin PGA chip using that approach in less time than it would have taken to roll the logic analyzer over to the system under test. Generally, signals that have proper levels and timing are remarkably immune to this sort of torture.

In analog circuits, signal behavior can again be altered with this technique. In the case of audio amps, probing with a finger is just as effective as the use of a signal injector—which is actually what you are doing—and the equipment is always handy. By evoking hum, buzz, clicks, and pops, locating the live or dead parts of a circuit is rapid and effective.

In unknown circuits, where no schematics are available, it may be possible to get the device to do something or locate an area that is sensitive to probing. The function of a section of circuit ry can often be identified by observing the effects of touching the components in that area.

For example, I was able to quickly identify the trigger transistor in a wireless doorbell by using my finger to locate the point that caused the chimes to sound. That quickly confirmed that the problem was in the RF front end or decoder, and not the audio circuitry.

You can also use that technique to troubleshoot bad bypass capacitors. Touching the power/signal side of a good bypass capacitor should result in little or no effect. However, a capacitor with high ESR and/or reduced capacitance will not be doing its job bypassing the pickup from your finger to ground—there will be a dramatic effect in audio or video systems.

Don't get carried away—too much moisture could have unforeseen consequences. Depending on the condition of your skin, a tingle may be felt even on low-voltage circuits under the right conditions. However, this is pretty safe for most battery operated devices, TTL/CMOS logic, audio equipment (not high-power amps), CD players, VCRs (not switching power supply), etc.

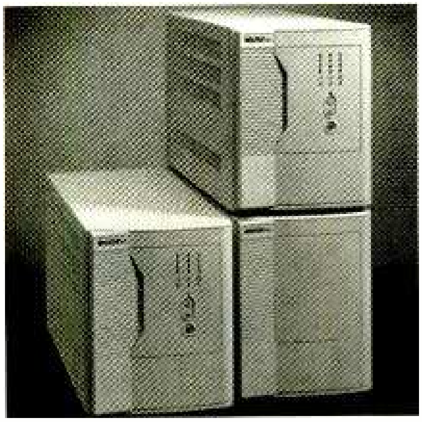
WARNING: Make sure you do this only with LOW VOLTAGE circuitry. You can easily fry yourself if you attempt to troubleshoot your TV, computer monitor, photoflash, or microwave oven in this manner! If you are not absolutely sure about the circuit you are dealing with, do not attempt this technique!

That's about all we have room for this time. Next column we will take a look at on-line tech-tips databases and an introduction to the tools you will need. In the meantime, why not visit the Sci.Electronics.Repair FAQ Web site at http://www.repairfaq.org/; if you have any questions about what has been presented here, you can reach me via e-mail at sam@stdavids.picker.com. EN

NEW PRODUCTS

continued from page 22

60 days in advance that the batteries are getting weak. When the batteries die, users can either replace the entire unit under the 10-year warranty or hot-swap the batteries without powering down the UPS.



CIRCLE 25 ON FREE INFORMATION CARD

Available in tabletop or rack-mount configuration, the PowerRite Pro II UPS starts at $699.

DELTEC ELECTRONICS CORPORATION

2727 Kurtz Street
San Diego, CA 92110
Tel: 800-DELTEC-1
Fax: 619-291-2973
E-mail: info@deltecpower.com
Web: http://www.deltecpower.com

40-Meter Loop Antenna

The smallest, highest efficiency, 40-meter through 15-meter antenna made for ham radio use, the MFJ-1788 40-Meter Super HI-Q Loop Antenna from MFJ Enterprises is very easy to use. Featuring automatic band selection, an SWR/wattmeter with two ranges, welded butterfly capacitor, and remote-control box with power supply, the antenna needs no extra control line, just a coax feed line.

CIRCLE 26 ON FREE INFORMATION CARD

Measuring just 36 inches in diameter, the antenna does not require a ground, radials, counterpoise, or separate antenna tuner; covers 40 through 15 meters continuously; and can handle a transmitter output to 150 watts. The antenna comes with MFJ's super remote control and features Automatic Band Selection, which auto-tunes the MFJ-1788 to the band you choose and beeps when it has done so. The dual fast and slow tune push buttons make manual tuning very easy.

You can take this antenna with you on trips, vacations, DXpeditions, or camping. Its small size and the fact that it can be mounted vertically or horizontally also make it an excellent choice for apartment residents.

The MFJ-1788 costs $359.95.

MFJ ENTERPRISES, INC.

300 Industrial Park Road
Starkville, MS 39759
Tel: 800-647-1800
Fax: 601-323-6551

EN

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Anchorage, AK 99503

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El Cajon, CA 90202

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Buena Park, CA 90621

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14928 Oxnard Street
Van Nuys, CA 91411

Gateway Electronics of CA
9222 Chesapeake Drive
San Diego, CA 92123

Mac's Electronics
191 South "E" Street
San Bernardino, CA 92401

Electronics Warehouse
2691 Main Street
Riverside, CA 92501

Orvac Electronics
1645 E Orangethorpe Ave.
Fullerton, CA 92631

Sav-On Electronics
13225 Harbor Blvd.
Garden Grove, CA 92643

JK Electronics
6395 Westminster Blvd.
Westminster, CA 92683

Marvac Dow Electronics
980 S. A Street
Oxnard, CA 93030

Kandarian Electronics
1101 19th Street
Bakersfield, CA 93301

Whitcomm Electronics
105 W. Dakota #106
Clovif, CA 93612

Marvac Dow Electronics
265-B Reservation Road
Marina, CA 93933

Minuteman Electronics
37111 Post St., Suite 1
Fremont, CA 94536

HCS Electronics
6819 S. Redwood Drive
Cotati, CA 94931

Halted Specialties Co.
3500 Ryder Street
Santa Clara, CA 95051

Metro Electronics
1831 J Street
Sacramento, CA 95814

HSC Electronics
4837 Amber Lane
Sacramento, CA 95841

Colorado

Gateway Electronics of CO
2525 Federal Blvd.
Denver, CO 80211

Centennial Electronics
2324 E. Bijou
Colorado Sps., CO 80909

Connecticut

Signal Electronics Supply
589 New Park Avenue
W. Hartford, CT 06110

Cables & Connectors
2198 Berlin Turnpike
Newington, CT 06111

Electronic Service Prod.
437 Washington Avenue
North Haven, CT 06473

Georgia

Norman's Electronics, Inc.
3653 Clairmont Road
Chamblee, GA 30341

Illinois

Tri State Elex
200 W. Northwest Hwy.
Mt. Prospect, IL 60056

Kansas

Electronic Hobby Shop
309 E. McKay
Frontenac, KS 66763

Maryland

Mark Elec. Supply Inc.
5015 Herzel Place
Beltsville, MD 20705

Amateur Radio Center
1117 West 36th Street
Baltimore, MD 21211

Massachusetts

U-Do-It Electronics
40 Franklin Street
Needham, MA 02194

Michigan

Purchase Radio Supply
327 East Hoover Avenue
Ann Arbor, MI 48104

Norwest Electronics
33760 Plymouth Road
Livonia, MI 48150

The Elec. Connection
37387 Ford Road
Westland, MI 48185

Elec. Parts Specialists
711 Kelso Street
Flint, MI 48506

Minnesota

Acme Electronics
224 Washington Avenue N.
Minneapolis, MN 55401

Missouri

Gateway Electronics Of MO
8123-25 Page Blvd.
St. Louis, MO 63130

William Elec & Ind Supply
803 Davis Blvd.
Sikeston, MO 63801

New Jersey

Lashen Electronics Inc.
21 Broadway
Denville, NJ 07834

New York

R&E Electronics
4991 Rt. 209
Accord, NY 12404

Unicorn Electronics
Valley Plaza
Johnson City, NY 13790

Ohio

Philcap Electronic Suppliers
275 E. Market Street
Akron, OH 44308

Oregon

Norvac Electronics
7940 SW Nimbus Avenue
Beaverton, OR 97005

Taztronics
257 N. Wasson St.
Coos Bay, OR 97420

Pennsylvania

Business & Computer Bookstore
213 N. Easton Road
Willow Grove, PA 19090

Texas

Mouser Electronics
958 N. Main Street
Mansfield, TX 76063

Tanner Electronics
1301 W Beltine
Carrollton, TX 75006

Electronic Parts Outlet
3753 B Fondren
Houston, TX 77063

GMD Electronics
2625 S. Loop Hwy.
Alvin, TX 77511

Electronic Parts Outlet
17318 Highway 3
Webster, TX 77598

Washington

Amateur Radio Supply Co.
5963 Corson Ave., Ste 140
Seattle, WA 98108

Wisconsin

T.V.-VCR Repair
1306 W. Madison St.
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BY JEFF HOLTZMAN

Command Line C

GUI-BASED RAD (RAPID APPLICATION DEVELOPMENT) ENVIRONMENTS ARE THE RAGE FOR DEVELOPING CODE THESE DAYS. BUT SOMETIMES IT'S NECESSARY TO DROP BACK TO A MORE "PRIMITIVE" ENVIRONMENT. I WAS CALLED UPON RECENTLY to investigate alternatives and configure some systems for doing DOS-based code development in C. Available resources were slim, and included several old 386 PCs, and several copies of MS Visual C++ 1.5x (MSC).

For comparative purposes, I felt it necessary to investigate at least one alternative. The GNU C compiler was of interest because of its cost (free), and because of my ongoing interest in the U.S. Robotics (whoops, I mean 3Com, as the deal has now been finalized) Palm Pilot, as discussed here in the August issue. Some enterprising souls have put together the appropriate header files, resource editors, and what-not so that it is possible to develop Pilot programs using only public-domain software tools.

What's GNU, you ask? GNU is not UNIX. GNU is a suite of publicly available compilers and related tools covering C, C++, assembly, Pascal, and other languages. The GNU project is associated with the Free Software Foundation. For more information on GNU and the FSF, check out the web sites listed in the sidebar. GNU products are available for many platforms.

Criteria

My task was to evaluate both compiler suites according to the following criteria:

- Ease of installation
- Size of installation
- Ease of configuration
- Resource usage
- Compiler speed
- Compiled code size

If you're interested only in the results, MSC won most categories, and tied the others.

Installation and configuration

Installing and configuring either product for command-line use is not a process for a beginner. While installing MSC is easy if you want to use it for Windows-hosted development, how to set up for DOS-based development is basically undocumented. I ended up doing a full Windows install on one machine, then transferring needed components to the target machine. A fair amount of trial and error was required to determine what really was required. Anyway, when all was said and done, I was able to reduce the 67MB Windows installation to a little under 2 MB. That figure includes link libraries for small-model programming only. It also includes a 400K executable, DOSXNT.EXE, a DOS extender that allows components of the compiler to run in 32-bit mode (*i.e.*, to access extended memory). Importantly, MSC produces pure DOS executables that do not require the DOS extender to run.

Configuration is simple; you just have to run a batch file that adds the bin directory to your path and sets a few environment variables so the compiler and linker can find header and library files. Listing 1 shows the batch file I created to aid installing the compiler in various locations on different machines. Listing 2 shows the batch file I use to compile a C program using MSC. Listing 3 shows a simple C program used to verify that files could be successfully compiled and executed. The program counts the number of occurrences of each letter in a file, then outputs the counts and percentages. Run the program like this: C:>freqdist <fn.ext, where fn.ext is the name of the file you want to analyze. If you don't specify a file, the program reads from the keyboard. Terminate keyboard input with a Ctrl-Z, or press Ctrl-C to end the program.

I created a list of all necessary run files, but it's too long to print here. I'll include the file, and a corresponding one for the GNU compiler, in CCNOV97.ZIP on the Gernsback ftp site (ftp.gernsback.com/pub/EN).

LISTING 1—MSC SETUP FILE

```
@echo off
set MSVC_DRV=D:
set MSVC_PATH=\c\msvc
set mx=%MSVC_DRV%%MSVC_PATH%

set PATH=%mx%\BIN;%PATH%

set TOOLROOTDIR=%mx%\MSVC152

set INCLUDE=%mx%\INCLUDE;%INCLUDE%
set LIB=%mx%\LIB;%LIB%
set INIT=%mx%;%INIT%
```

LISTING 2—MSC BUILD FILE

```
@echo off
if (%1) == () goto SYNTAX
if not exist %1.c goto SYNTAX
cl %1.c
if exist %1.obj del %1.obj
goto END

:SYNTAX
Echo Specify a filename
Echo Don't specify the extension, 'c' assumed
Echo EG: build my_prog

:END
```

GNU C

GNU C is poorly documented—at best. (I read somewhere that "This is not the product to use if you're just learning programming.") The complete package is huge and messy. Fortunately, someone named DJ Delorie has taken the trouble to prepare a version focused on Intel-based DOS/Windows development. That version (DJGPP) is not documented any better, but there is less to deal with. For example, the regular package includes complete source code, which is omitted from the DJ version. So is documentation, which you must download separately. There is a FAQ available for the DJ port; it mostly covers installation and getting started. The separate GNU documentation covers the language itself.

The basic DJ installation consumes about 8.1 MB; after pruning nonessentials, I got it down to about 3.5 MB. The installation batch files force you to use either drive C or drive D, however, they're easy enough to tweak for other (*e.g.*, network) drives. Listing 4 shows a batch file for setting path and environment variables, and Listing 5 is a batch file for building programs.

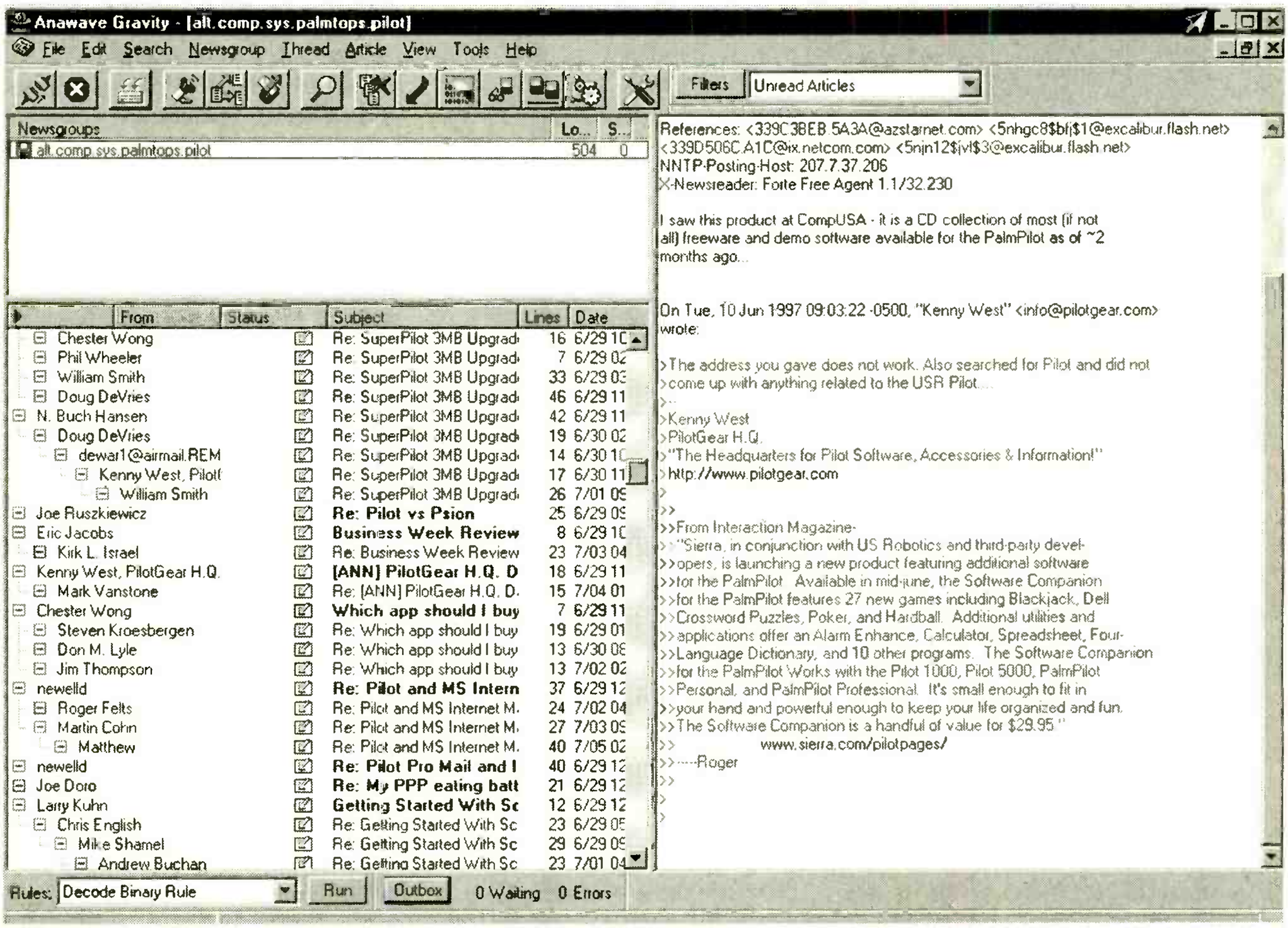
Like MSC, DJGPP requires a DOS extender for use on a plain DOS machine. However, whereas Microsoft's version is required only at compile time, the DJ version is required for both compiling and running programs. (The reason is that GNU C is 32-bit, period.) That's the bad news. The good news is that it's a small file (less than 80K). As long as it's available on your path somewhere, any programs compiled with DJGPP will run on a DOS-only machine.

RESOURCES

URL	Description
http://www.delorie.com/djgpp/	DJGPP home page
http://www.fsf.org/links/links.html	Free SW Foundation
http://www.mygale.org/05/poulainl/gcc4ms_us.htm	GCC for Wintel
http://www.delorie.com/djgpp/	GCC for DOS
http://dictator.nt.tuwien.ac.at/ezgcc/	EZ-GCC
http://eudora.com	Eudora Light, Pro e-mail readers
http://www.anawave.com	Gravity, net news reader

Ratings and Conclusions

MSC wins hands down for both compilation speed and executable code size. In several tests conducted on several machines, under both DOS and NT 4.0, MSC consistently ran twice as fast as DJC. In addition, MSC executables typically ran about 66% the size of DJC programs. In addition, the MSC executables don't require the run-time engine.



ANAWAVE'S GRAVITY is a high-powered Internet news reader that sells for an extremely reasonable $30. It's good stuff.

LISTING 3—TEST PROGRAM

```
/* Case insensitive character frequency distribution
 * Based on K&R example
 * jkh 7/3/97
 */

#include <stdio.h>
#include <ctype.h>
#include <math.h>

main ()
{
    char c;
    long i;
    long total;
    float a[26];
    float pct;

    printf ("Case insensitive character frequency distribution\n");

    total = 0;
    for ( i=0; i<26; i++ )
      a[i] = 0;

    while ((c = getchar()) != EOF) {
      if (isalpha(c)) {
          total++;
          i = tolower(c) - 'a';
          a[i]++;
      }
}

    printf ("Total alpha chars=%d\n\n", total);
    printf ("Char\tCount\tPercent\n");

    for ( i=0; i<26; i++ ) {
          c = 'a' + i;
          pct = a[i] / total * 100;
          printf("%3c\t%4.0f\t%6.1f\n", c, a[i], pct);
    }

    return 0;
}
```

LISTING 4—DJGPP SETUP FILE

```
@echo off
set DJGPP_PATH=D:\djgpp

set path=%DJGPP_PATH%;%DJGPP_PATH%\bin;%PATH%
set DJGPP=%DJGPP_PATH%\djgpp.env
set GO32=ansi driver %DJGPP_PATH%/drivers/stdvga.grn
```

LISTING 5—MSC BUILD FILE

```
@echo off
if (%1) == () goto SYNTAX
if not exist %1.c goto SYNTAX
if exist %1.exe del %1.exe >nul
gcc %1.c
coff2exe a.out
ren a.exe %1.exe >nul
goto END
:SYNTAX
Echo Specify a filename
Echo Don't specify the extension, 'c' assumed
Echo EG: dbuild jeff
:END
```

GNU is impressive technology. It's impressive that it works at all, and it's impressive that it works as well as it does. Even with its speed/size disadvantage, I wouldn't hesitate to recommend it to experienced developers. Even the simplified DJ port, however, is inappropriate for beginners.

There are other alternatives. Older versions of Microsoft and Borland compilers are still being sold. You may be able to pick one up used.

In addition, there are numerous other shareware/freeware compilers. Two of interest include Small C and C−−(C minus minus). The problem with the latter two are lack of support for some critical language features. Small C includes complete source code and is much more manageable then GNU C. C−− is a widely supported product with lots of add-on shareware libraries and functions. Bear in mind that to run either compiler you'll need some sort of text edito- DJGPP comes with an old version (cir 1990) of the shareware classic Qedit.

Browsers, E-mail, and News Readers

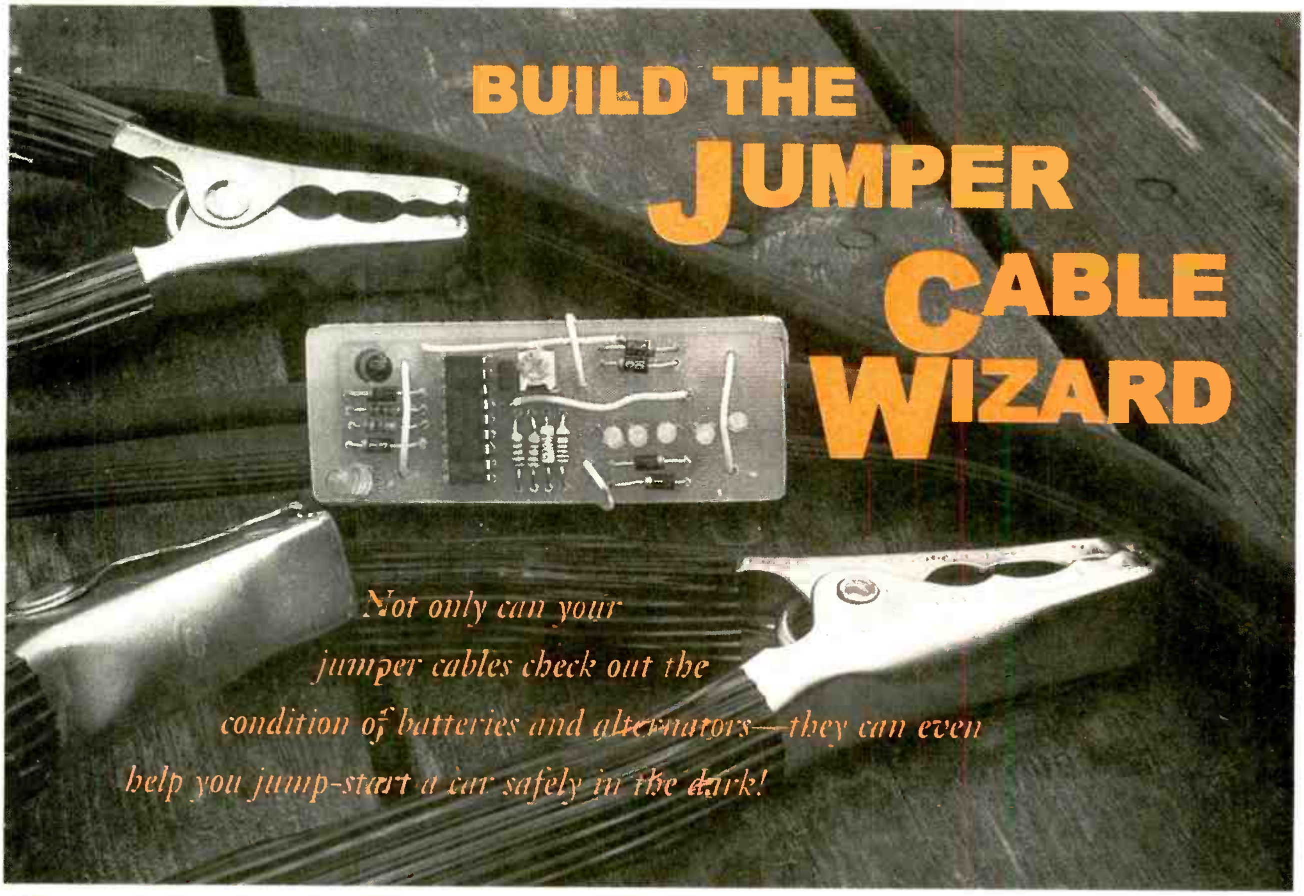
Microsoft apparently expects to win the browser wars by attrition. As a browser, Internet Explorer works fine, albeit slow, especially loading. However, its e-mail client and news reader are atrocious. For example, neither has a search function, and neither allows any clean, hierarchical system of organization.

The solutions are simple: Download copies of Eudora for e-mail, and Gravity for news reading. Gravity costs $30 ($20 for educational users). Eudora Light is free, period. Eudora Pro lists for $69 (download price), or $89 (disks and printed documentation). I've found the light version more than adequate for my needs—and light-years better than IE's mail client.

Also, I located a utility that allows you to transfer mail from IE to Eudora. It's an unsupported utility, with C source, but it seems to work fine. Documentation is a little sketchy, and there are a few errors and omissions. If you use it, note the there is a reference to a file called DESCMAP. DCE. That should be DESCMAP.PCE. Also, the conversion program doesn't parse long filenames correctly, so rename mailboxes like "Sent Items" and "Deleted Items" to "Sent" and "Deleted," respectively. Once the mailbox files are converted, it's a simple drag-and-drop operation to categorize your messages in Eudora. Just sort by "Who" and let'er rip. I converted and categorized about 1000 message in 20 minutes.

Unfortunately, I lost the reference to where I found the conversion utility, but I'll include the source and executable files in CC97NOV.ZIP.

Meanwhile, if you hear of any good, small, C compilers, let me know; you can reach me directly via e-mail at jkh@acm.org. Thanks, and I'll see you all again next time. EN



BUILD THE JUMPER CABLE WIZARD

Not only can your jumper cables check out the condition of batteries and alternators—they can even help you jump-start a car safely in the dark!

TOM FOX

Jump starting an automobile has become an American tradition that many of us wish we could do without. It has brought together neighbors who have never met, has been the catalyst which has started romances, has strengthened the emotional ties between spouses, and has aided in reuniting friends whose friendship has gone cold through the years. It has also caused serious injuries and has fried the electrical components of expensive and inexpensive vehicles alike.

In electrical terms, jump-starting is a simple concept—connecting two batteries of the same voltage together in parallel. While the concept is simple, the practical application in real life situations often isn't. Drained batteries tend to emit explosive hydrogen gas that can be ignited with a small spark. Older vehicles or ones that have had their electrical systems modified might have a positive-ground arrangement. If you get the polarity wrong when connecting the batteries together, you could destroy both electrical systems—not to mention your jumper cables. Even identifying the polarity markings on batteries can be difficult—especially if the markings are caked over with grime and gunk. Some batteries on the market have no polarity markings on them at all!

If those problems aren't enough to struggle with, most often a car will need a jump start after dark, when it becomes difficult, if not impossible, to see what you're doing.

The Jumper Cable Wizard (JCW) presented here is a simple little device that is permanently mounted and connected to a jumper cable. The JCW will let you know with a flashing red LED that you have initially connected the cable improperly, and that disaster looms if you try to go ahead and jump the battery. When the jumper cable is connected right, a green LED will light. With a JCW-equipped jumper cable, you can make safe jumps in near total darkness! As an additional feature, the JCW includes a voltage monitor. With a bit of experience, you will be able to determine the condition of 12-volt batteries as well as alternators by watching the two-color LED bar-graph monitor.

Circuit Theory. The schematic diagram in Fig. 1 shows how simple the JCW actually is. Let's look at the battery polarity sensor first. That part of the circuit consists of D1, D4, D5, D6, R1, R7, LED6, and LED7. If the jumper cables are connected backwards, power flows in through the black clamp. The voltage is blocked by D5, but flows readily through D1. That will light LED6 through current-limiting resistor R1. That LED is the red "wrong way" indicator. The power returns to the red clamp through D6. Since D4 is connected to the battery's negative terminal, LED7 (the green "right way" indicator) does not light. When the cable clamps are connected to the battery the correct way, the roles of all the sensor components flip. Input power is blocked by D6 and conducted by D4 and R7, which lights LED7. Return current now flows through D5.

Incidentally, the LEDs themselves can block any reverse voltage without the need for D1 and D4.

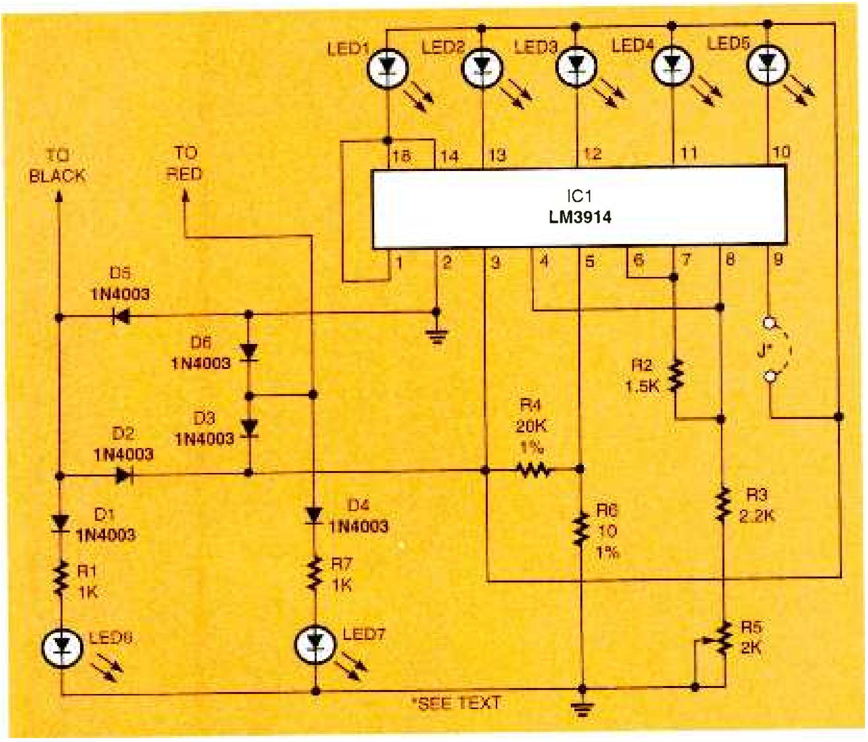


Fig. 1. The Jumper Control Wizard is actually a very simple circuit. Checking for the correct jumper-cable hookup is done by a few diodes and LEDs. An LM3914 is used as a voltage monitor to show the state of your battery's health.

However, light-emitting diodes have a lower reverse-breakdown voltage than rectifier diodes. Diodes D1 and D4 help to extend the life of LED6 and LED7 by reducing the chance that the LED's reverse-breakdown voltage will be exceeded.

The voltage monitor part of the circuit is built around IC1, an LM3914 bar-graph display driver. Diodes D2 and D3, along with D5 and D6 from the polarity-sensor circuit, act as a bridge rectifier so that IC1 will not see the wrong polarity on its power-supply pins if the jumper cables are hooked up wrong.

Within the LM3914 is a series of ten voltage comparators and a resistor ladder that provides a voltage reference for those comparators. The outputs are designed to directly drive an LED without the need for an external current-limiting resistor. A stable 1.25-volt adjustable reference source is also included.

The battery voltage is divided by R4 and R6 before being applied to IC1. That voltage is compared to the reference voltage, which is calibrated by R5. One of the LEDs will light depending on the battery voltage. A high voltage will light LED5, showing that the battery is in top condition. As the battery gets weaker, the other LEDs in the display will light instead. A battery that is still in good condition will light LED4 or LED3. If LED2 lights, the battery is getting quite weak. At the bottom of the display is LED1. If that one lights, the battery is too weak to start the car reliably. Green or yellow LEDs are used to show the battery condition at a glance without having to count which LED is actually lit.

The display is normally set as a moving-dot display. If a bar-type display is preferred, simply connect pin 9 of IC1 to the positive supply voltage.

Building the Jumper Cable Wizard. Since reliability is extremely important, an epoxy-glass PC board is highly recommended. If you wish to etch your own PC board, a foil pattern has been included.

If you use that foil pattern or purchase a kit from the source given in the Parts List, the parts-placement diagram in Fig. 2 shows the correct locations for the various components. Cable ties or wires will be used to fasten the PC board to the jumper cable. Before soldering any components to the board, make sure that the four mounting holes are large enough for the type of fastener that will be used.

Start construction by soldering the jumper wires to the board. Since the jumper wires must bend past several other components, use 22-gauge insulated wire to avoid any accidental shorts. There are three jumpers—two main jumpers that must be installed and one optional jumper next to IC1. If you want the voltage display on the JCW to be a bar instead of a moving dot, install the optional jumper. Deciding which type of display to use is a personal choice and will not affect the operation or reliability of the JCW in any way.

The diodes and resistors can be

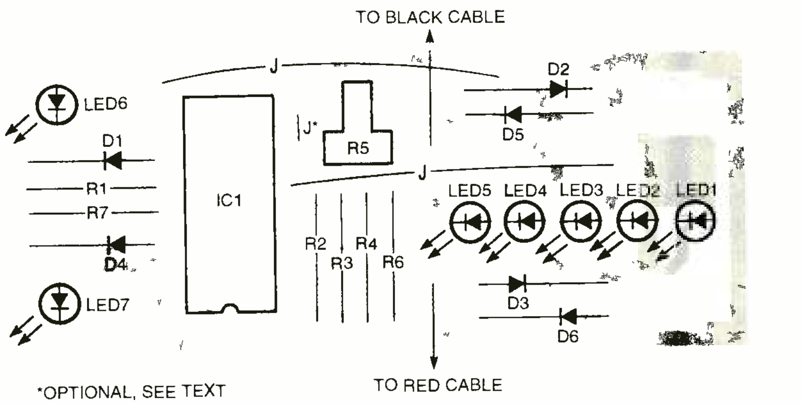


Fig. 2. Use this parts-placement diagram when building the Jumper Cable Wizard. Don't forget the two jumper wires. The third jumper wire is used if you want the voltage display to be a bar that grows and shrinks. Without it, the display is simply a moving dot.

PARTS LIST FOR THE JUMPER CABLE WIZARD

SEMICONDUCTORS

IC1—LM3914N Dot/Bar graph display driver, integrated circuit
D1–D6—1N4003 silicon diode
LED1, LED2—Light-emitting diode, yellow, size T-1
LED3–LED5—Light-emitting diode, green, size T-1
LED6—Light-emitting diode, red, self-flashing, size T-1¾

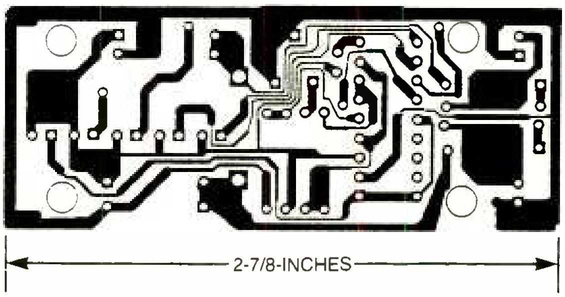
RESISTORS

(All resistors are ¼-watt, 5% carbon units unless otherwise noted.)
R1, R7—1000-ohm
R2—1500-ohm
R3—2200-ohm
R4—20,000-ohm, metal-film, 1%
R5—2000-ohm potentiometer (Panasonic EVN-D8AA03B23 or similar)
R6—10,000-ohm, metal-film, 1%

ADDITIONAL PARTS AND MATERIALS

PC board, hookup wire, electrical tape, potting compound, automotive jumper cable, solder, fasteners, hardware, etc.

Note: A kit of parts, including PC board but not including non-PC board-mounted items such as electrical tape and jumper cable is available from: Magicland, 5426 S. Gordon Ave., Newaygo, MI 49337 for $13.50. 10% discount on three or more kits. Please include $3.00 per order (not per kit) for shipping and handling. Michigan residents include 6% state sales tax.



Here is the foil pattern for the Jumper Cable Wizard. The circuit is simple enough to fit onto a single-sided board. Use a high-quality epoxy-glass board material for the board.

installed next, followed by IC1. For better reliability, do not use a socket for IC1; solder it directly to the board. When soldering the IC in place, do not solder one pin after another down one side. That will build up too much heat inside the chip, possibly destroying it. A better method for soldering integrated circuits is to solder pins at random, skipping from one side to the other and from end to end. By using that method, the IC will not soak up too much heat in one area. After soldering three or four pins, stop for a minute or so in order to let the chip cool down. With an 18-pin chip, you'll be done in about five minutes. Spending a few extra minutes now will save time and money troubleshooting a defective circuit later.

Before installing the LEDs, you must decide if you want to leave the circuit board exposed or encase it in a potting compound such as GC Potting Epoxy. If you do not want to encapsulate the board, insert the LEDs all the way into the board. If, however, a potting compound will be used, insert the LEDs so that they are sticking up higher than any other component in the board.

Solder 3-inch lengths of 14-gauge insulated wire in the holes marked "TO RED CABLE" and "TO BLACK CABLE." It is a good idea to use red and black wires so that they can be identified easily.

Look over your work for any mistakes or errors. Double-check the orientation of the diodes and IC1. Make sure that the proper value resistors are in the right locations. Turn the board over and check for solder bridges, unsoldered connections, or cold solder joints. If everything looks good, set R5 to its mid point. You're now ready to test the JCW.

Testing and Calibration. There are two ways to test the JCW—using a variable power supply, or using a car battery. Either way will work fine. In either case, a voltmeter will be needed for voltage measurement.

If you're using a variable power supply, connect the RED wire to the supply's ground and the BLACK wire to the positive terminal. Turn on power supply and slowly increase the voltage until LED6 starts to flash. That should happen at about 4.5 volts. No other LEDs should be lit. Shut the power supply off and reverse the power supply connections. When you reapply power, LED7 should light and LED6 should be unlit. Set the power supply for an output of 12.75 volts. Adjust R5 so that LED5 is lit. If you chose to have the optional bar display instead, all five LEDs will be lit. Slowly readjust R5 so that LED5 either flickers or is relatively dim. As a final check, reverse the power supply connections again. The only change should be that LED6 flashes and that LED7 goes out.

If a suitable power supply isn't available, you can use a 12-volt car battery that is known to start a car reliably. Typically, the open-circuit voltage of a good 12-volt battery that hasn't been charged by a battery charger or the vehicle's alternator for several hours is at around 12.7 volts at normal room temperature. However, measure the battery voltage with a voltmeter to be sure. If the voltage is between 12.6 and 12.9 volts, fine! If it is not, keep that fact in mind when doing the actual calibration.

As with the power-supply procedure, adjust R5 so that LED5 flickers. If the voltage is a shade below 12.6 volts, adjust R5 so LED5 is off while LED4 flickers. If the battery voltage is above 12.9 volts, try turning on the vehicle's headlights to see if the voltage will drop to 12.8 volts or lower.

Final Mounting. Now that the JCW has been tested and calibrated, it is time to mount and wire it to a good-quality jumper cable. The unit will look something like the illustration in Fig. 3. The jumper cable should have 8-gauge or heavier wire. There are several ways to mount the circuit onto the cable. Only a few will be discussed here. Other methods might work just as well.

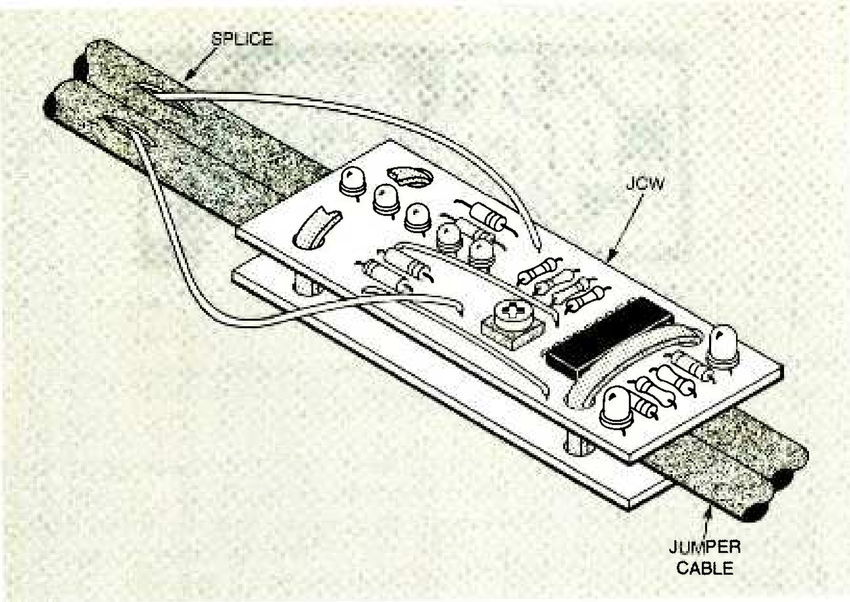


Fig. 3. The Jumper Cable Wizard simply clamps onto a jumper cable. The wires from the JCW splice into the cable. After making the splices, seal the splices over with electrical tape.

The simplest method is to run wires or nylon cables ties through the four mounting holes in the PC board and tie the JCW to the cable. While the exact location isn't critical, mounting the JCW near the middle of the cable makes sense.

As an alternative, a second circuit board without any copper on it can be used to "sandwich" the cable between the JCW and the second board. That type of mounting will be much stronger and protect the JCW from physical abuse. The second board should be about the same size as the JCW. Similar-sized mounting holes should be drilled in the same locations.

For those who want a nearly indestructible JCW, the entire unit can be encapsulated in potting compound such as GC Electronics' Potting Epoxy. For this method, a mold must be made so that the board can be completely immersed in the epoxy, but let the LEDs poke through the surface of the epoxy. Obviously, if the JCW is potted, it will be impossible to recalibrate the voltage monitor later. Although it is possible that the setting could change as the JCW gets older, extreme precision isn't needed here.

Choose a potting compound that doesn't stick well to wood. That will let you build a mold out of some scrap 1×2 wood and ¼-inch-thick plywood. A mold pattern with suggested dimensions is shown in Fig. 4. The actual size of the mold will, of course, depend on the size of your particular unit. When building the mold, use wood screws to hold it together. The easiest way to remove the potted JCW from the mold is to take the mold apart. The bottom of the mold is a piece of ¼-inch plywood that rests on five 6-penny (6d) nails. Make sure that you drill pilot holes for the nails so that you don't split the wood.

Before pouring the potting epoxy into the mold, stick toothpicks in the four mounting holes in the PC board. They will act as a guide for drilling mounting holes after the epoxy has cured. The board should not rest on the bottom of the mold. That will let the potting compound flow underneath. Some small rubber feet about 3/16-inch thick can be used. You could also suspend the board in the mold with the red and black wires that will be connected to the jumper cables later.

Once the potting compound has set up, loosen the sides with a hobby knife and then press on the plywood. The potted Jumper Cable Wizard should pop out. If it doesn't, remove the wood screws and take the mold apart. Break off the toothpicks and drill out the mounting holes. Mount the JCW to the cable as mentioned before.

Solder the red and black wires from the JCW to the cable. Use side cutters to strip away enough of the cable's insulation so that the wires can be soldered to them. Check to make sure that you are connecting the red wire to the cable wire with the red clamp. After soldering, use electrical tape to insulate the connections. To completely seal the splice, paint or spray a tool-handle insulator such as Plasti-Dip over the tape. That material is often used to insulate or repair tool handles and is available at most hardware stores. If you did not pot the JCW, the solder side of the PC board can also be coated with the same insulator compound.

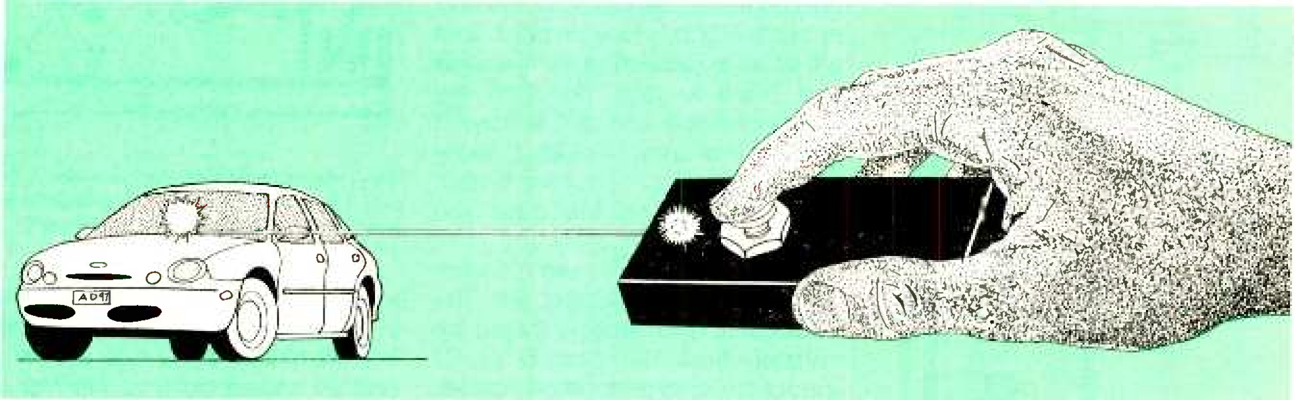
Using the Jumper Connection Wizard. Whenever you use the JCW, make sure you follow all warnings that come with jumper cables. Be warned that batteries tend to give off explosive hydrogen gas that can explode with the slightest spark. Wear safety goggles during the jump-start procedure. You should also not wear any loose-fitting clothes when working around automobile engines. That warning includes scarves and ties. You could also get hurt badly if you have a finger or hand near the fan blade when the engine starts. Another possible hazard from a financial point of view is damage to the vehicle's electrical system if jumper cables are connected backwards. The bottom line is that you should not attempt to jump-start a car or do other emergency repairs if you don't completely understand what you're doing. If that is the case, call a garage and let better equipped and experienced people do the job for you!

Remember that the JCW doesn't eliminate the dangers of jump-starting—it only reduces them. The JCW will only warn you if you are about to do something wrong. It won't stop you from making a mistake.

Using the Voltage Monitor. In addition to letting you know if the jumper cables are connected to your battery properly, the JCW can

continued on page 39

BUILD THE *LAZER FAZER*



How do you know that your laser detector is really working? This simple unit will test any LIDAR detector by sending a beam that looks like a police laser-speed gun.

RICK DUKER

In recent years, a new method for monitoring traffic speed has appeared. Rather than using the Doppler shift of a microwave-frequency radar unit, a series of extremely short pulses of laser light are used to measure the speed of moving vehicles. Like radar, the time it takes for the pulse of laser light to travel to the target and back again to the source measures the distance to the target. If the distance is measured twice, the change in distance during that time can easily be converted into speed. The new system is called *LIDAR*, an acronym for *LIght Detection and Ranging*.

The radar-detector manufacturers have responded to that new technology with laser-light detectors that warn motorists of the presence of LIDAR in the vicinity. Now, nearly all radar detectors also detect LIDAR beams as well. If you happen to own one of those sophisticated detectors, you probably would like to have a way of testing it without searching the roadways for a LIDAR speed trap. Unfortunately, a LIDAR gun will set you back several thousand dollars—even if you could purchase one.

There is a low-cost alternative—the Lazer Fazer. It is a compact device that simulates LIDAR pulses with a narrow-beam infrared LED rather than a true lasing device. The simulated LIDAR signal fools a detector into reacting as if the pulses of light were coming from an actual LIDAR gun. A detector will not respond to just any flashing light source. It scans its field of view for a signature light signal, one with a short pulse duration and low duty cycle. Sensitivity tests can also be performed on different detectors to determine their various abilities.

Circuit Description. The circuit for the Lazer Fazer is shown in Fig. 1. It is built around IC1, a 555-type timer chip configured as an astable oscillator. The frequency and duty cycle of the output is set by R1, R2, and C2. The values shown generate a very narrow negative-going pulse. The negative pulses turn on Q1. That lets high-current pulses flow through infrared emitter D2. The MOSFET transistor used is ideal for that purpose because of its high input impedance, high switching speed, and low on-resistance. Those high-current pulses release the maximum output that D2 is capable of, although the average power is low due to the short pulse duration. With each pulse of cur-

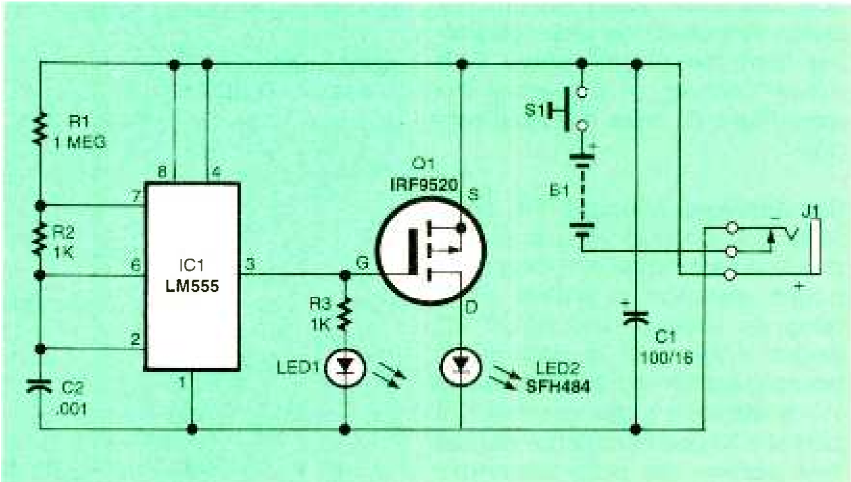


Fig. 1. The Lazer Fazer is simply a 555-type oscillator that puts out an IR signal. It can either be battery powered or plugged into an external 12-volt source.

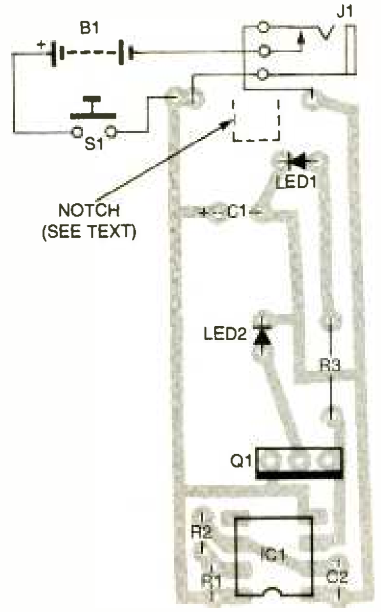


Fig. 2. If you use the supplied foil pattern for the Lazer Fazer, this parts-placement diagram shows where the components are located. If you need to route wires around the board, cut the indicated notch. The notch will prevent any wires from being pinched.

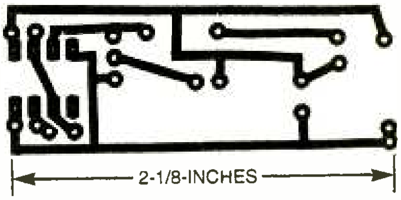
rent, D2 emits a burst of infrared energy. The infrared energy is detected by the laser detector. When D2 is off, D1 is lit to show that the unit is on.

The Lazer Fazer is designed to operate from a 9-volt battery contained inside the case or from a vehicle's 12-volt power. For the latter option, J1 is used to connect the Lazer Fazer to the vehicle's electrical system. When J1 is plugged in, the 9-volt battery is removed from the circuit, and the Lazer Fazer operates continuously. Momentary switch S1 is used only when operating from the 9-volt battery. With either method of powering the Lazer Fazer, C1 filters the input voltage.

Construction. Although the Lazer Fazer can be built using any construction technique, including perfboard, assembly is easiest when using an etched and drilled PC board. If you wish to etch a PC board, a pattern has been included in this article; it is also available as part of a kit (see Parts List). If you use that pattern, the parts-placement diagram in Fig. 2 should be followed when installing the components.

Before mounting any components to the PC board, if you are using the kit previously mentioned, cut a notch in the board at the end opposite IC1 as shown in Fig. 2. That will provide clearance for the wires that have to pass between the board and the wall of the case. If you are not using the kit, it might not be necessary to cut the board; it will depend on the case you select.

If you are going to use a socket for IC1, install that part first. The capacitors and resistors should be installed next. The polarity of C1 should be checked before soldering it to the board. Before installing D1 and D2, decide where those components will be placed in the enclosure. Drill holes in the case for the diodes. If necessary, bend the leads of D1 and D2 so that they will reach from their locations on the PC board to the holes in the enclosure. For example, if the case is held in the hand like a TV remote control, D2 should point out one end and D1 should point to the top of the case. In that way, the user will be able to easily see D1 while pointing D2 at the LIDAR detector. In any case, it is important to note the correct polarity of D1 and D2. Both diodes have flat sides on their lens to denote the cathode lead. Once the alignment and orientation of D1 and D2 are confirmed, their leads can be soldered to the circuit board. Three wires of appropriate length are soldered to the pads on the PC board as shown in Fig. 2.



Here's the foil pattern for the Lazer Fazer. The circuit is simple enough to fit on a single-sided board without any jumpers being necessary.

The last component to be installed is Q1. It is a MOSFET device, so you must observe all standard anti-static precautions when handling the transistor. Install Ql, noting the correct lead orientation; the backside of Q1 should face IC1 when installed correctly. Solder Q1 using as short a soldering time as possible to prevent overheating.

Carefully install IC1 into its socket. Be sure that pin 1 is oriented correctly. Drill appropriately sized holes in the case for S1 and J1. Switch S1 is mounted in the top of the case where it can be easily activated by hand. Glue J1 to the inside of the lower half of the case and align it with the hole drilled for it. Finally, install the PC board into the enclosure.

Solder one of the wires from the positive connection on the PC board to one terminal of S1. The remaining two wires are to be connected to the positive and negative terminals of J1. Most power cords use the center pin for the positive connection and the outer barrel for the negative connection. Check the power cord you will use

PARTS LIST FOR THE LAZER FAZER

SEMICONDUCTORS

IC1—LM555 timer, integrated circuit
Q1—IRF9520 P-channel power MOSFET transistor
LED1—Light-emitting diode, red
LED2—SFH484 narrow-beam IR emitter diode (Digi-Key LT1028-ND or similar)

RESISTORS

(All resistors are ¼-watt, 5% units.)
R1—1-megohm
R2, R3—1000-ohm

CAPACITORS

C1—100-µF, 16-WVDC, electrolytic
C2—0.001-µF, ceramic-disc

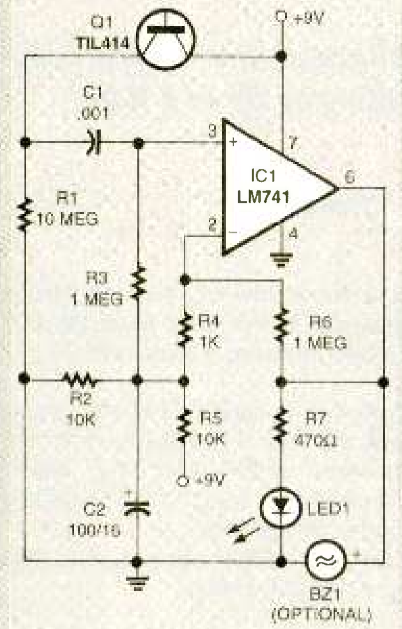
ADDITIONAL PARTS AND MATERIALS

S1—Single-pole, single-throw, momentary-contact pushbutton switch
J1—Power Jack
B1—9-volt battery
PC board, enclosure, battery clip, hardware, etc.

Note: The following items are available from: Quantum Research, 17919 77 Ave., Edmonton, Alberta, Canada, T5T 2S1: Kit of all parts (less battery) - $39.95; Assembled and tested unit - $59.95. Please include $5.00 for shipping and handling. All prices are in US dollars. Please make all payments with check or money order.

TAG—YOU'RE "IT!"

The Lazer Fazer is a low-cost and easy-to-build device, making it a good candidate for a high-tech version of "tag." Below is a schematic for a detector that will react to the IR pulses from the Lazer Fazer. The detector is mounted in a clear plastic case and worn on each player's clothing or belt. Armed with a Lazer Fazer, every player tries to "shoot" one another until there is only one player left.



The game is best played in subdued lighting conditions. That will let the photosensor be sensitive to the Lazer Fazer's light beam. It will also be easy to see the LED indicator on the detector if a player has been tagged. The optional buzzer will also help confirm a hit or miss.

before soldering the wires to the jack. A mistake here will destroy the Lazer Fazer the first time power is applied to J1.

The third terminal on J1 is a switch that disconnects from the negative terminal whenever a plug is inserted. That switch will be used to disconnect the 9-volt battery from the circuit whenever auxiliary power is applied.

Connect the red lead from the battery clip to the other terminal of S1. The black lead of the battery clip is connected to the switch terminal of J1. Install a fresh 9-volt battery and close the case. The Lazer Fazer is now ready for testing.

Operation. To test the unit properly requires a LIDAR detector. Simply point the Fazer at the detector. If using batteries, pressing S1 should activate the detector's alarm. Once the Lazer Fazer is tested, it is ready for use.

The Lazer Fazer can operate from the 12-volt system of a vehicle. Simply plug it into a cigarette lighter jack with a suitable power cord. The LED will light, indicating that the Lazer Fazer is in continuous operation. Remember that S1 does not work when the unit is plugged into auxiliary power. With 12 volts supplied, the IR output of the Lazer will be greatest. To test the range of the device, point it out the front windshield and have a friend approach from the front with a detector facing the vehicle. Measuring the distance when the detector goes off will show the approximate usable range of the Lazer Fazer.

The main purpose of the device is to test the sensitivity of a LIDAR detector. If you have friends who own different makes or models of LIDAR detectors, you can test the various units for sensitivity and response time. It is interesting to see how different detectors respond differently. Ω

JUMPER CABLE

(continued from page 36)

provide some information on the health of the battery and alternator. It does that through five small LEDs—three that are green and two that are yellow. If you are going to be using the JCW for testing a single battery, make sure that the clamps that will not be used are not touching each other.

With the engine not running, connect the JCW to the battery to be tested. At least one of the green LEDs should light. If there are no lights or only the lowest yellow LED lights, the battery needs to be charged or replaced. If the battery passes that test, turn on the headlights. If the battery is good, the LEDs either won't change or will only drop by one level. If the level drops by more than that, the battery needs to be charged or replaced.

If you want to test the alternator, connect the JCW to the battery.

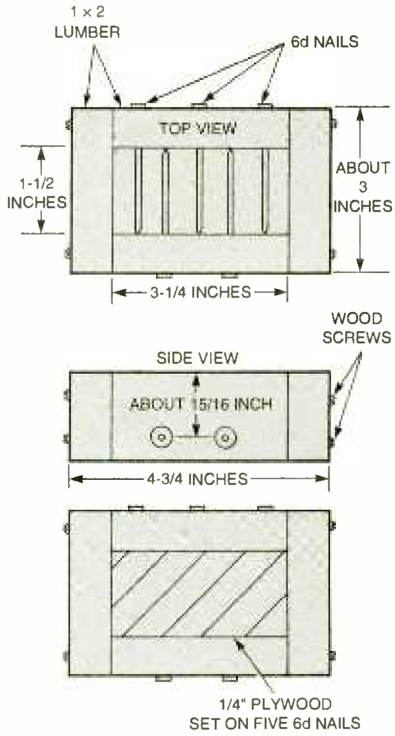


Fig. 4. If you want to pot the Jumper Cable Wizard, this wooden-mold pattern will work nicely. Use wood screws to hold everything together. If the JCW won't come out of the mold, you can always take the mold apart!

Turn the headlights on without the engine running and wait until the indicator drops by two or three LEDs. With the headlights still on, start the engine and run it at moderate speed. If the alternator is operating properly, all of the LEDs should now light.

While the JCW's voltage monitor might seem to be a bit crude, with experience and ingenuity, faulty batteries and alternators can be diagnosed quickly and reliably. Ω

ROADSIDE REPAIRS FOR YOUR CAR'S ELECTRICAL SYSTEM

Some simple supplies and these helpful hints will get you going again in a flash!

TOM FOX

It's raining, it's blowing, and the temperature is barely above freezing. You jump into your car, buckle up, and turn the key. It won't go, it won't start—it won't even turn over! You look around in your "toolbox" which consists of the space under your seat along with the glove compartment. Your stock of tools consists of a rusty pair of pliers, a grubby screwdriver, a piece of used sandpaper, and a dull knife. You also find a half-used roll of duct tape, an emergency cable clamp still in its package, a yard-long length of frayed 14-gauge wire, and a pair of beat-up jumper cables. You wish you had your Simpson 260 VOM or even a cheap digital VOM, but you don't. What to do? Smile and grab the first tenderhearted driver and plead with him or her for a jump-start! There is also the possibility that the problem can be solved without a jump-start. On the other hand, what could be done if even jump-starting will not work?

While your 'tool box' is quite sparse, almost everything needed to make an emergency electrical repair to get the engine turning over is available. In fact, if you are sharp, about the only thing that would stop you here is if the starter itself had seen its last "revolution"!

Remember, while your 'tool box' doesn't have the handy VOM, your vehicle already has one of the best built-in diagnostic tools available—headlights. The only problem is you have to know how to interpret "headlight readings." Experience is the best teacher, but experience is best if it also includes a little theory.

Ohm's Law. Let's start with a brief review of Ohm's Law. Once you understand how it applies to automotive starting systems, most simple electrical repair jobs—including the emergency repair of a vehicle's starting system—become almost trivial.

While Ohm's law can be written several ways, the most useful form for our needs is simply:

$$V=IR$$

To find the voltage (V, in volts) needed for a circuit, simply multiply the current (I, in amps) by the resistance (R, in ohms). For example, if 10 amps flows through a wire that has a resistance of 1 ohm, the voltage drop along that wire is simply 10×1, or 10 volts. .

Let's apply Ohm's Law to a typical fully-charged 12-volt lead-acid car battery. The actual open-circuit voltage of a fully-charged lead-acid battery that has been standing (not being charged) for a few hours is 12.7 volts. If you measure the voltage of a battery right after the engine has been shut off, the voltage might be a few volts higher. That is caused by a surface charge within the lead plates. Another way to remove the surface charge is to turn the headlights on for a few minutes.

All batteries have an internal resistance that must be accounted for in any mathematical model. The actual resistance of a battery varies depending on the design and construction of a particular unit. An average value is 0.01 ohm for a battery that has a cold-cranking amperage (CCA) rating of less than 500 amps. For larger batteries, the resistance will be a bit lower.

A typical starter motor takes about 200 amperes to spin the engine. Powering that motor with a good battery will drop the voltage at the battery terminals to around $12.7 - (200 \times 0.01)$, or 10.7 volts. The voltage at the starter will be a bit less because of the additional resistance from the cables and connections.

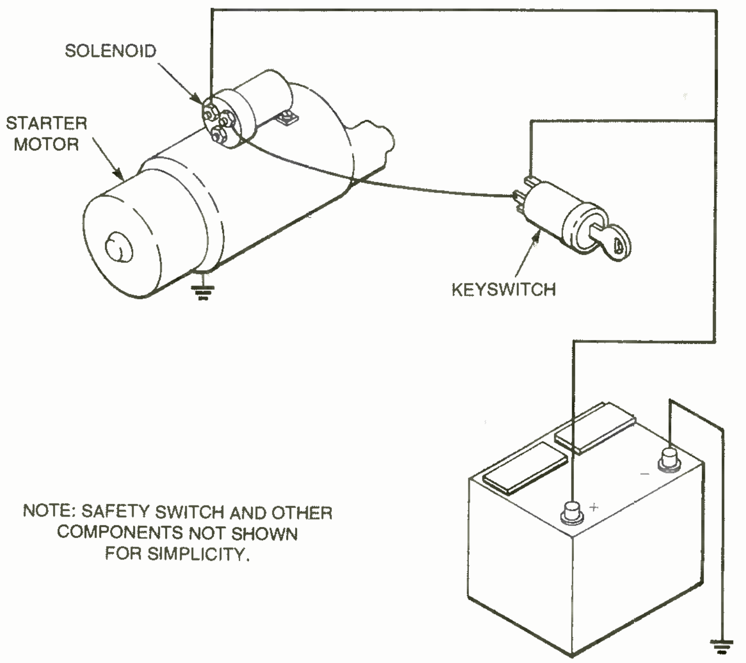


Fig. 1. A typical car-engine starting circuit uses a solenoid as a heavy-duty relay to supply 200 amps of current to the starter without that amount of current needing to go through the keyswitch.

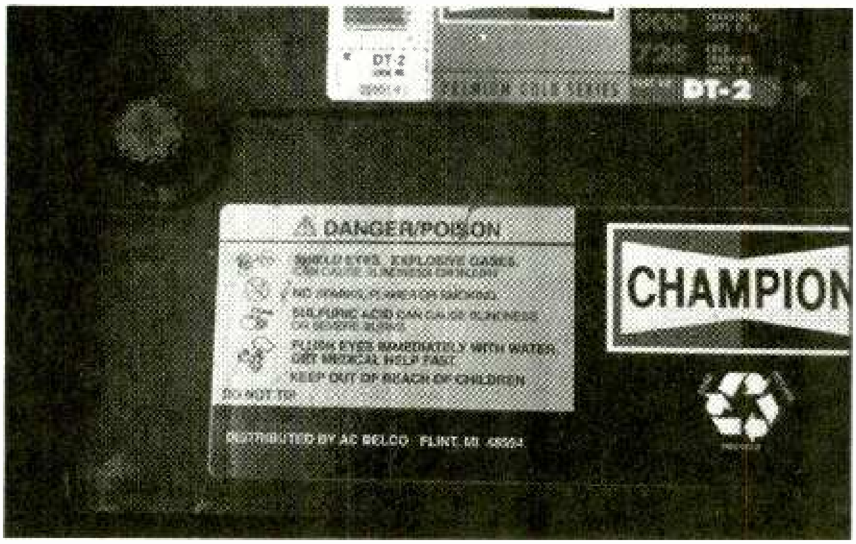


Fig. 2. Lead-acid batteries are constantly charged while the engine is running. That charging causes electrolysis to take place in the acid solution, producing hydrogen gas. Hydrogen gas is extremely explosive—any sparks or flames should be kept away from the battery at all times.

As a battery weakens, the lead plates decay and the internal resistance rises. Although the battery can still be charged to 12.7 volts, it cannot deliver the amperage because of that higher internal resistance. Let's use the above example, only now we'll use an internal resistance of 0.1 ohm. The best the battery can deliver to the starter is now about 50 amps—more than enough to engage the starter solenoid but not enough to really spin the starter with an engine loading it down! On top of that, the 50-amp capacity would be at a voltage of 12.7 - (50 × 0.1), or only 7.7 volts! Of course, the effect of temperature on the battery is being ignored. Since a lead-acid battery uses a chemical reaction to produce electricity, the colder a battery is, the slower the reaction will be, and therefore the less capacity it can deliver.

To complete our look into theory, it should be emphasized that the light output of an incandescent light source, such as the headlights of a car, depends upon the voltage at the light source's input. In simpler terms, you can tell how much juice a battery has by seeing how bright the headlights are.

Many vehicles today use halogen headlamps. Halogen lights put out a super-white light with an abundance of blue in its spectrum. Because of the intense whiteness, it is slightly more difficult to determine a battery's condition by looking at the brightness of halogen headlamps. With some experience, however, halogen headlamps can be used as a diagnostic tool just as easily as standard headlamps.

The Starting Circuit. In addition to knowing the basics of electricity, there is one other little thing you need to repair something—the circuit diagram. Luckily, the circuit diagram of the starting system of a vehicle is simple. However, we will simplify it even further to make it even easier to understand. The simplified schematic of a typical car's starting system is shown in Fig. 1. In some vehicles, there is a separate starting relay between the keyswitch and solenoid that we will not show here.

There is an obvious difference between a solenoid and a relay—a solenoid has a moving plunger while a relay doesn't. The way a starter solenoid is used in cars can be thought of as a heavy-duty relay whose contacts are rated at over 200 amps. Without the solenoid, a car would need a separate heavy-duty switch. Many years ago, such an arrangement was used. To start those cars, you pressed the gas pedal to the floor, which actuated the starter switch. Many vehicles have the solenoid mounted right on the starter itself. That arrangement looks like a starting capacitor on a fractional-horsepower motor. Other vehicles have the solenoid mounted next to the battery.

Another part of the starting circuit that has been left out is the neutral-safety switch. As you can guess by its name, the neutral-safety switch will only let the starter motor operate when the transmission isn't connected to the engine. The usual arrangement is for an automatic transmission to be in the Park or Neutral position. With a manual transmission, the clutch pedal must be depressed.

Diagnosing Starting Problems. As interesting as the theory behind the design of a starting circuit is, the big payoff is in applying that knowledge to an actual situation. A thorough understanding of Ohm's Law along with some practical experience will be enough for some people. However, we'll look at a few real-world examples of what can happen out on the road. The solution to most, but not all, of those problems is jump-starting. Before you open the hood make sure that you have a thorough understanding of the dangers involved with automobile engines and lead-acid batteries. If you've already read "Build the Jumper Cable Wizard," which can be found elsewhere in this issue, you already know that batteries give off hydrogen gas. That is due to the electrolysis that occurs when a battery is being charged. All battery manufacturers place a warning label on their products similar to the one shown in Fig. 2. Read the label on your battery and heed its warnings.

Suppose that a car's starter won't turn over or turns over too slowly to start a car. What's wrong? To diagnose a car's starting problems, first put on the headlights. The brightness of the headlights and the sound of the starting circuit when trying to start the engine are the "instruments" you will use to figure out what the problem is. Sometimes the problem can be fixed at the roadside, but unfortunately there are situations that will require a tow to a garage for some heavy-duty repairs.

If the headlights are dim or do not come on at all, try wiggling the battery cables. If the headlights flicker, the problem is most likely a bad battery cable. The battery might be in good condition. What you can do is clean the battery terminals of any gunk that might be insulating the connections using a battery-post cleaning tool like the one shown in Fig. 3. If the cable clamp is pulling loose from the battery cable, there are several different brands of replacement clamps available at well-stocked automotive-parts stores. A typical replacement clamp and the tools needed to use it are shown in Fig. 4.

Fig. 3. If the battery terminals are corroded from the acid fumes that can be released by the battery, a simple battery-post brush will clean them up.

Fig. 4. In an emergency, you only need a knife and a pair of pliers to do a roadside replacement of a damaged or corroded battery clamp.

Follow the directions that come with the replacement clamp. In general, the method is shown in Fig. 5. Cut the old clamp off of the cable (Fig. 5A). Strip the insulation off the end of the wire (Fig. 5B) and tighten the new clamp around the exposed copper wire (Fig. 5C). Finally, re-attach the new clamp to the battery post (Fig. 5D).

If the headlights stay on and are dim, the battery is probably just weak. In that case, jump-starting will likely get you going. A similar situation would occur if the headlights are bright but almost go out when you try to start the engine. In that case, you will most likely also hear a clicking sound when you attempt to start the engine. That sound is caused by the solenoid engaging. Once again, jump-starting should be successful.

In rare occasions, the trouble is a short in the starter motor or solenoid, which causes an excessive

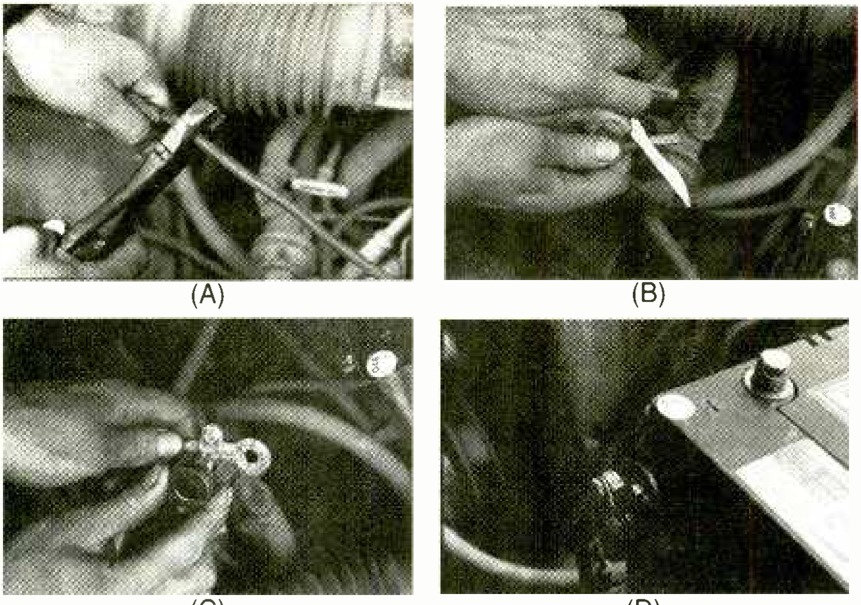


Fig. 5. To use a replacement clamp requires only a few simple steps. Cut the old clamp off of the battery cable (A). Strip the insulation off of the cut end of the cable (B). Tighten the replacement clamp onto the exposed copper of the cable (C). The new clamp is ready to be re-attached to the battery (D).

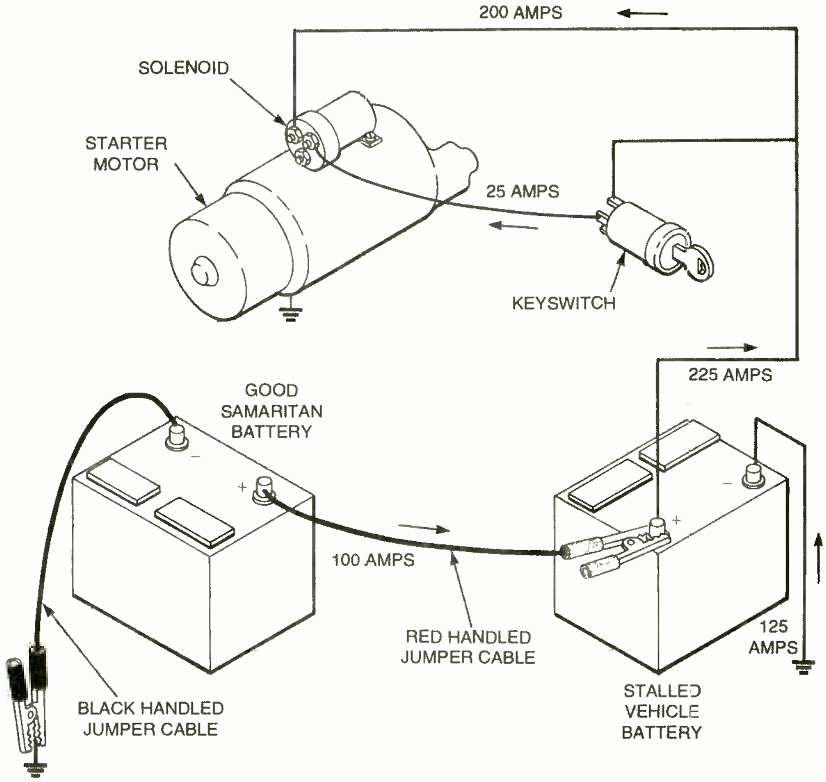


Fig. 6. When jump starting a car, you're putting two batteries in parallel to boost their current output to the starter. Here, we're assuming that the weak battery can only put out 125 amps. An additional 100 amps from the other battery will supply enough current to operate the solenoid and spin the starter.

load on the battery. The only way to start the car in that case is to replace the starter or solenoid. The best way to tell the difference between a weak battery and a shorted starter is to look at the headlights AFTER you let go of the ignition switch. If the battery is weak, the headlights usually remain dim for a while. If, on the other hand, the battery is OK but the starter shorted, the headlights should regain near-normal brightness as soon as you stop trying to start the vehicle.

You could also have an open connection in the starter. In that situation, the headlights would stay bright while you try to start the engine and you would hear a clicking sound from the solenoid. Jump-starting won't help here, either. Again, the starter must be replaced. Depending on the actual wiring of your particular car, there might be a secondary starting relay that might not be operating. If you have a solenoid that is not mounted directly on the starter, there might be a damaged wire going to the starter. That is also a rare condition, and can be easily detected since it appears that the cables are about to come off. It is also possible that a wire is broken internally from fatigue and vibration. Even though the insulation looks to be in perfect shape, the copper inside is not making physical contact and won't conduct any electricity.

Remember that the engine compartment of a modern automobile is probably one of the most hostile environments that can be found on Earth. Heat, cold, vibration, acids, and pollutants all take their toll on equipment.

Jump Starting. Most readers will probably skip this section because they feel it is trivial. Remember, however, that a little knowledge is a dangerous thing—especially when it comes to jump starting!

Many people who jump start a vehicle don't actually know what they are doing. They just assume that you simply connect cables between the two batteries so that the positive and negative terminals are connected to each other. What actually is taking place here is the connection of two batteries in parallel. The result is that more current is available to start the engine. Figure 6 shows how the battery currents combine in the circuit to start the car.

A typical car needs 25 amps to engage the solenoid and 200

Table 1

Wire Size and Material	Resistance	Voltage Drop	Starter Voltage
12-gauge copper	0.03936-ohm	7.87 volts	3.13 volts
10-gauge aluminum	0.04-ohm	8.0 volts	3 volts
10-gauge copper	0.0247-ohm	4.944 volts	6.056 volts
8-gauge aluminum	0.025-ohm	5.0 volts	6.0 volts
8-gauge copper	0.0156-ohm	3.12 volts	7.88 volts
6-gauge copper	0.01-ohm	2.0 volts	9.0 volts
4-gauge copper	0.006-ohm	1.2 volts	9.9 volts
2-gauge copper	0.00384-ohm	0.77 volts	10.23 volts
1/0-gauge copper	0.0024-ohm	0,48 volts	10.52 volts

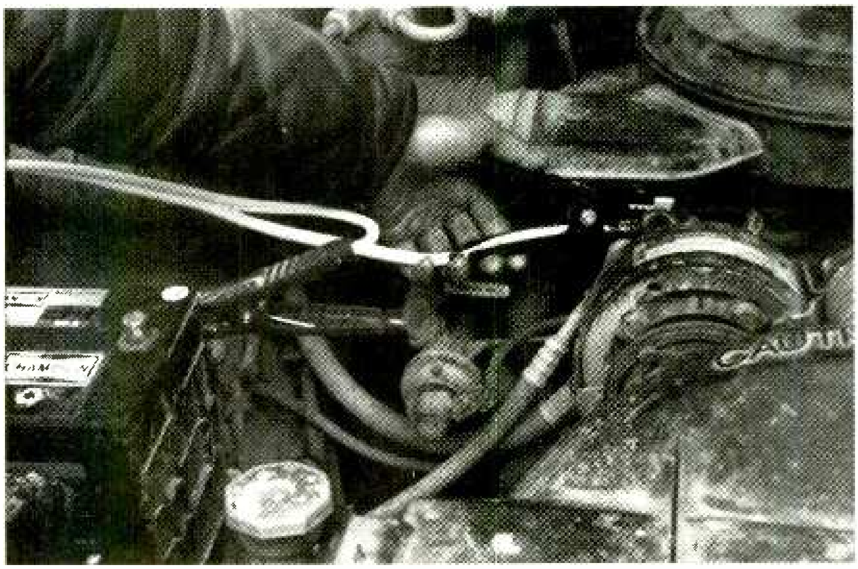


Fig. 7. For safety's sake, don't connect both cable clamps to the battery posts. Connect the red clamp to the battery first; then connect the black clamp to the frame of the car or engine. Any sparks that occur from the final connection will not be close enough to the battery to ignite any hydrogen gas that the battery might be releasing.

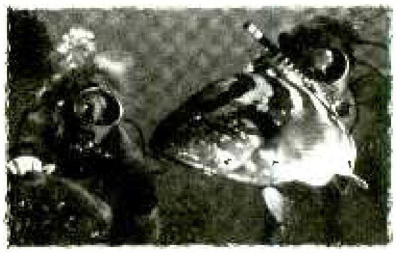
amps to turn over the starter. For example, if the battery in the stalled car can only supply 125 amps, we will need to draw 100 amps from the helper battery to supply the total current needed by the starting circuit.

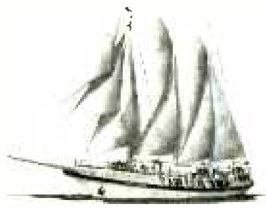
One mistake that is more common than you would think is connecting the positive terminal of one battery to the negative terminal of the other battery and vice versa. Once that circuit is made, the starting circuit would see zero amps. All of the power of the two batteries would be circulating in a short circuit. The practical result would probably be melted metal from the cables and battery terminals, and possibly a large explosion as the spark from the last connection ignites the hydrogen gas that the batteries are giving off! Obviously, that situation must be avoided at all costs.

Another common mistake is in connecting the jumper cables themselves. The safest way to do that is to connect the two red clamps to the positive terminals first. The black clamps should *not* be connected to the negative terminals. Instead, connect them to a metal part of the car's frame. A good location is the bracket that supports the alternator. It is connected directly to the battery's negative terminal, and it will keep the cable away from any spinning parts of the engine such as the fan or the belts. An example of that is shown in Fig. 7.

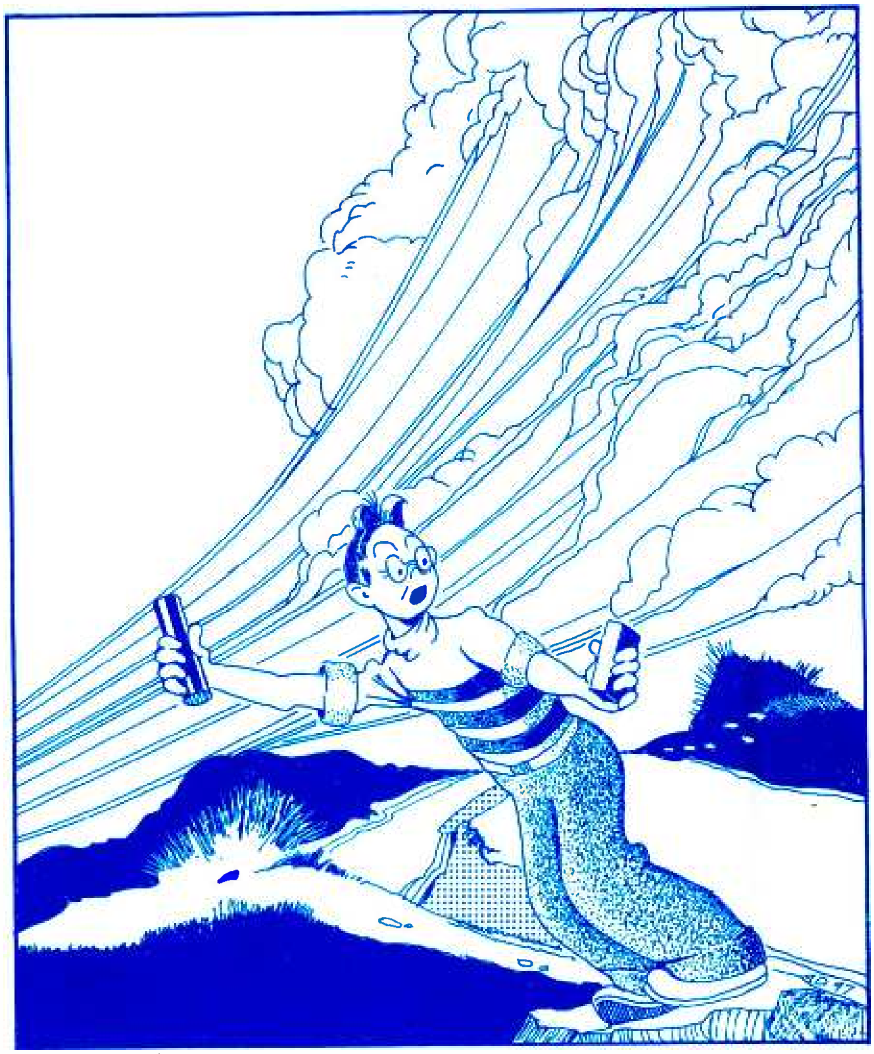
Jumper cables themselves should be heavy-duty ones of at least 8-gauge copper wire. If they are available, 6-gauge or 4-gauge are even better. The reason is shown in Table 1. That table shows the voltage drop that you would get with a 12-foot length of jumper cable (24 feet for the round trip) trying to draw 200 amps from a battery with an initial terminal voltage of 11 volts. Smaller-gauge wires just can't deliver the amperage needed to start the car

With a little forethought and a few well-chosen emergency tools, getting a car started again can be quite a bit easier than you would normally think it is. Just remember to think things through, observe everything, and be careful around the engine. Ω





ANTHONY J. CARISTI



BUILD A SOLID-STATE WIND-SPEED INDICATOR

Measure the speed of the wind with a device that uses no moving parts!

A wind-speed indicator, called an *anemometer*, is the one weather-related instrument that is usually missing from the amateur forecaster's arsenal of tools. Traditional wind-speed instruments, based on a propeller or other rotating device driven by the force of the wind, can be expensive and cumbersome.

A different way to measure wind speed is based on "hot-wire" anemometer technology. That method combines some basic laws of physics with clever analog computer techniques to produce a 100% solid-state wind-speed indicator that can be added to your existing array of weather instruments. The anemometer described here contains a 2-digit liquid-crystal display that allows measurement of wind speed from 0 to 99 mph in 1-mph increments. A permanently mounted unit is powered by a common 9-volt DC wall transformer. For portable applications, such as measuring wind velocity at the top of a mountain, the unit can be powered with a set of either six alkaline or NiCd batteries or a 12-volt car battery.

The solid-state anemometer is not limited to wind-speed measurement. It can easily be used as a "speedometer" for a bicycle, boat, or any other vehicle. Since the anemometer has a high sensitivity to air movement, it could also be used as a "sniffer" to locate drafts around windows or doors.

How It Works. The circuit for the Solid-State Anemometer is designed around King's Law. According to King's Law, the rate of heat loss in an object due to airflow is proportional to the temperature differential between the object and air, multiplied by the square root of the air speed. Simply put, the harder you blow on something, the faster it will cool. By measuring how fast an object cools, it is easy to figure out how hard you're blowing.

Refer to the schematic diagram in Fig. 1. The heart of the sensor is Q1, a self-heating NPN transistor that is connected between 5 volts and ground. Its base is forward biased by current flow through R1 and R2. Transistor Q2, connected as a diode and forward biased by R1, R3, and R4, is used to sense the ambient temperature of the air. That measurement is used as a reference for the sensing circuit. The voltage between the emitter and base of each transistor is fed to the positive and negative inputs of voltage comparator IC2-b.

When potentiometer R1 is properly adjusted, the temperature rise of Q1 reduces its voltage drop (at a rate of 2 millivolts per degree Celsius) to a level just below Q2's voltage drop plus the current drop across R4. Therefore, the open-collector output transistor of voltage comparator IC2-b is switched on, and its output voltage at pin 7 is held at zero volts. That inhibits oscillator IC2-a, which remains off when there is no wind.

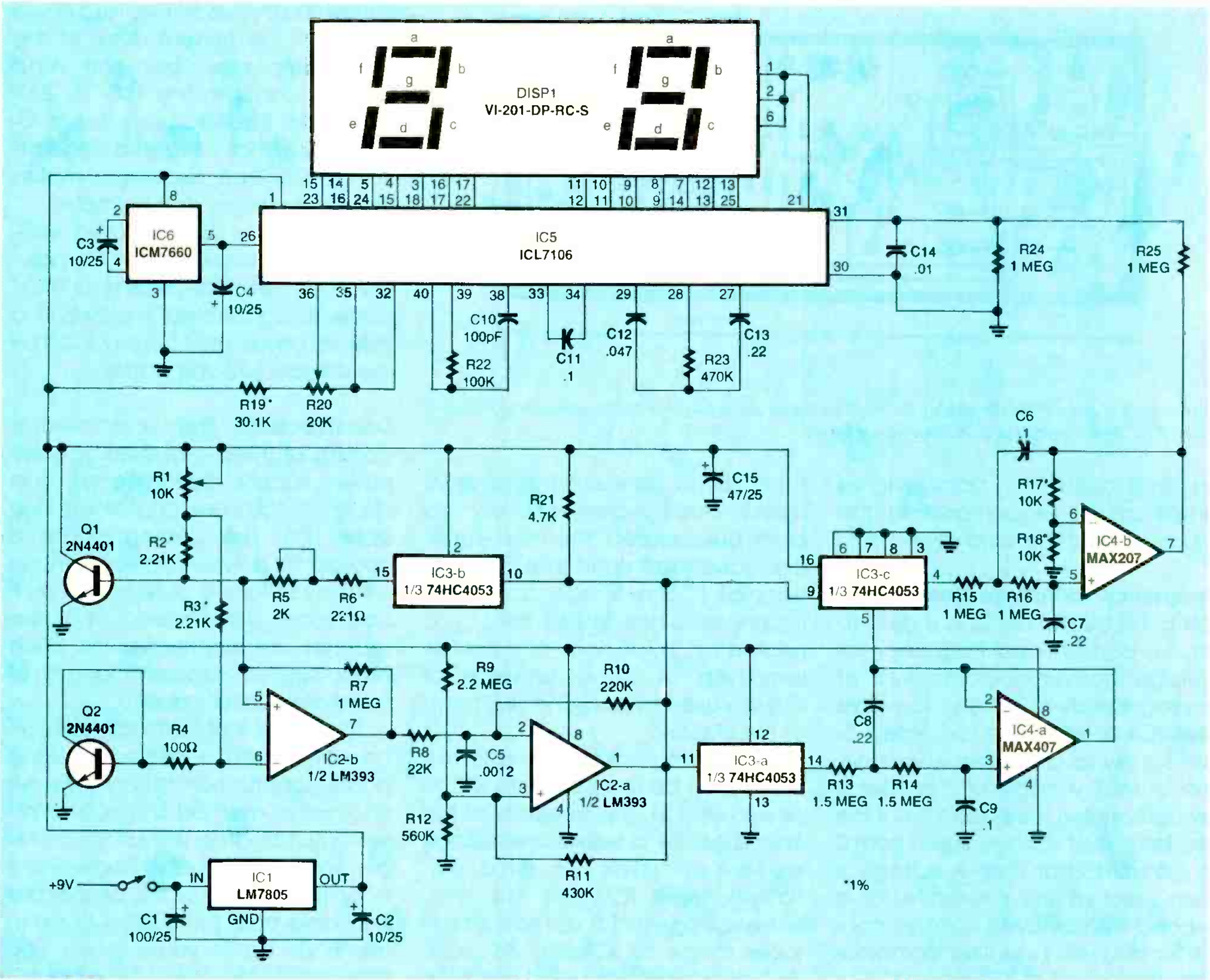


Fig. 1. The Solid-State Anemometer uses a self-heating transistor to measure wind speed. Converting the reading twice lets the circuit comply with King's Law of forced-air cooling.

When air blows across Q1, it cools off. That increases the transistor's voltage drop. When Q1 cools below the reference provided by Q2, the voltage comparator switches on. That lets IC2-a oscillate. The oscillator is a free-running multivibrator that produces a 500-microsecond negative-going pulse at its output terminal, pin 1. That pulse is fed to the three control inputs of IC3, a triple analog multiplexer.

The multiplexer is a set of three single-pole double-throw analog switches that are controlled by digital signals fed to the individual control-input terminals. The switch in IC3-b is used as a single-throw switch that applies 5-volt pulses to the base of Q1 through sensitivity potentiometer R5 and R6. That causes Q1 to conduct additional current, increasing its power dissipation and thus its temperature.

When Q1 is cooled by air blowing across it, the feedback loop created by IC2-a and IC3-b holds the temperature of Q1 constant. The harder the air blows across Q1, the faster the pulse rate of IC3-b will be to maintain the temperature of

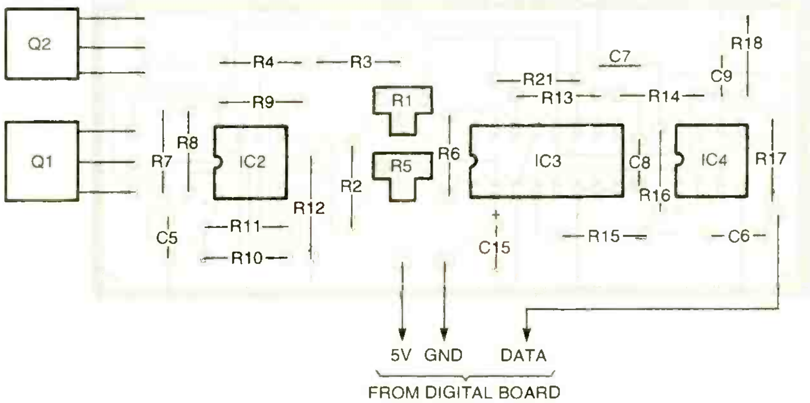
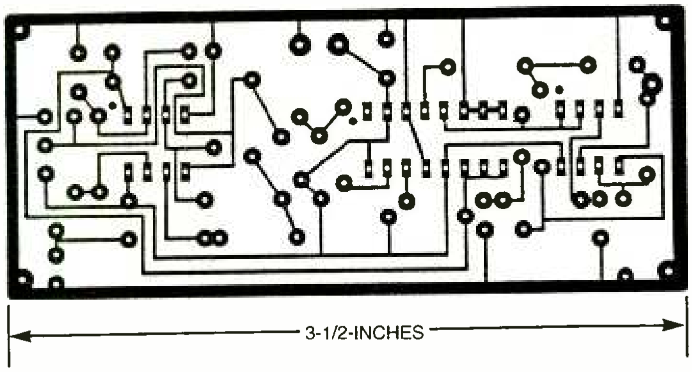


Fig. 2. Here is the parts-placement diagram for the analog board. Transistors Q1 and Q2 should be bent over as shown and stick up away from the edge of the board as far as possible. That way, they can sense the speed of the wind without having to expose the circuit board to the weather.



Here is the foil pattern for the analog board. This single-sided board is narrow enough to fit into a 2-inch PVC-drain pipe as a weatherproof enclosure.

Q1. That pulse rate, according to King's Law, is proportional to the square root of the wind speed.

Frequency-To-Voltage Conversion. The pulse output of IC2-a is used to drive a conventional frequency-to-voltage converter composed of analog switch IC3-a and low-pass filter IC4-a, using the regulated 5-volt supply as a reference voltage. The output voltage of the filter is proportional to the pulse rate of the oscillator. That voltage varies from 0 to 2.5 volts. That output voltage is then used as the reference for a second frequency-to-voltage converter and low-pass filter combination composed of IC3-c and IC4-b. The second stage has an additional gain of 2, which is set by R17 and R18. Therefore, the DC output voltage of IC4-b varies from 0 to 2.5 volts over an oscillator range of 0 to 1 kHz.

Since the oscillator waveform has undergone a frequency-to-voltage conversion twice, the result is a frequency-squared function. The voltage level at IC4-b pin 7 is a direct linear reading of the wind speed sensed by Q1. The sensor is set to zero output with no wind by R1. The range of the circuit is set by R5. Between those controls, the full-scale range of the anemometer can be set to 99 mph.

Digital Readout. The readout is controlled by IC5 and its associated components. That circuit forms a complete analog-to-digital 3-½-digit voltmeter that drives a liquid-crystal display. Since we're only reading a wind-speed measurement range between zero and 99 mph in 1-mph increments, only two digits are required. The most-significant and least-significant digit drivers of IC5 are not used. The squarewave needed by the LCD is generated by IC5 at pin 21. The remaining 14 output terminals of IC5 are used to drive the segments of the display.

The analog voltage (and its reference) to be read is fed to IC5 to pins 30 and 31. The sensitivity of the chip is set by a reference voltage between pins 35 and 36. Potentiometer R20 sets the reference voltage to 1.0 volt so that full-scale range of IC5 is 1.999 volts. With only two digits being used, the maximum voltage appearing between pins 30 and 31 will be 0.99 volt, for a wind speed indication of 99 mph.

Power Supply. Power to operate the circuit is provided by a common 9-volt DC wall-adapter transformer that feeds IC1, a fixed 5-volt regulator. The current draw of the circuit depends upon the wind velocity, and is in the 100- to 200-mA range. Since IC5 requires a –5-volt supply, that voltage is generated by IC6. That technique makes the power supply much simpler.

For portable use, as stated earlier, the anemometer can be powered by a set of six alkaline or NiCd batteries connected in series. In a vehicle, power may be provided by the vehicle's 12-volt battery.

Construction. The anemometer consists of three circuit boards. The power supply, digital board, and display board are contained in a base unit. The analog board is housed in a weatherproof enclosure and placed outside where it can sense wind speed. The two sections are connected to each other with a sufficient length of three-conductor cable.

The circuit is not critical, and can be wired onto a perfboard using good construction techniques. An alternative method is to use printed-circuit boards. The circuit is simple enough to fit onto single-sided boards. Appropriate PC boards are available from the source given in the Parts List. If you choose, you may fabricate your own boards using the foil patterns presented here.

Regardless of which method you use for the PC boards, the parts-placement diagrams in Figs. 2, 3, and 4 should be followed when locating components for the analog, digital, and display boards,

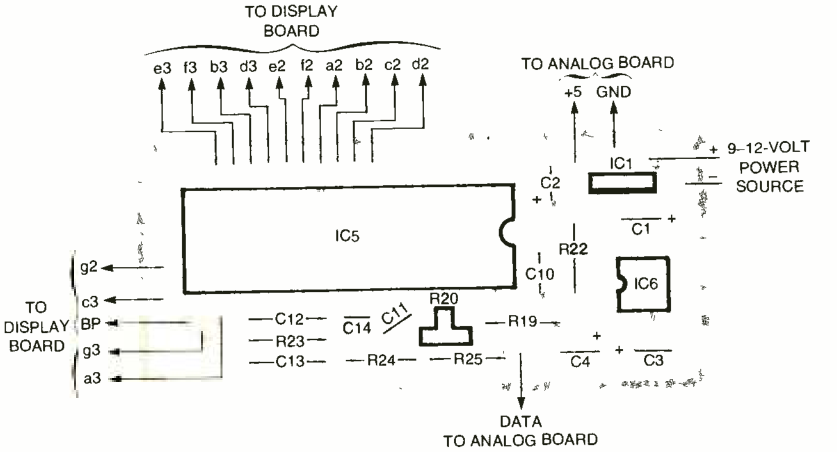


Fig. 3. The digital board converts the reading from the analog board to a digital number and sends it to the display board. The voltage regulators also distribute power to all of the assemblies.

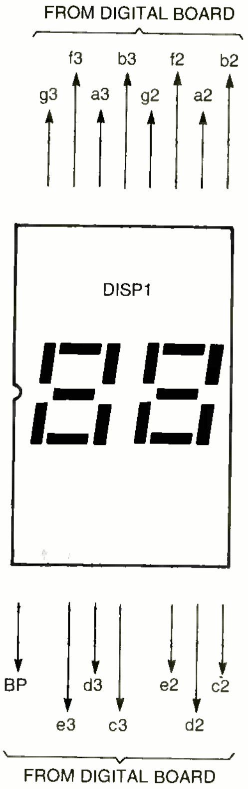


Fig. 4. When mounting the LCD onto the display board, be careful of the orientation of DISP1. Since the LCD is made out of glass, excessive heat and handling can crack the unit, destroying it.

respectively. When placing polarized components into the boards, be sure that they are properly oriented as shown. Just one part placed backwards in the circuit will render it inoperative, and might cause damage to one or more components.

Sockets should be used for the integrated circuits and DISP1. Doing that will make the unit easier to fix should something burn out. To create a socket for DISP1, cut an 18-pin DIP socket in half lengthwise. Each 9-pin section can then be soldered onto the display board.

Please note that IC1 does not require a heat sink if the DC power source is 9 volts, though one will certainly do no harm. However, for 12-volt operation, IC1 must have a heatsink mounted onto it. A clip-on heatsink with a 1-watt dissipation will do.

The analog and digital boards contain several precision metal-film resistors to ensure accuracy and stability of the unit. Ordinary carbon resistors are not temperature stable and should not be substituted where metal-film types are specified. The LCD display is made with glass. It can easily break if it is handled too roughly.

When the printed-circuit boards are assembled, examine each one very carefully for opens, short circuits, and bad solder connections, which may appear as dull blobs of solder. Any solder joint that is suspect should be redone by removing the old solder with desoldering braid, cleaning the joint, and carefully applying new solder. It is far easier to correct problems now rather than later if you discover that the anemometer does not work.

Obtain an enclosure of suitable size for the digital and display boards. If you want to use batteries, the enclosure should be large enough to hold them as well. Make a rectangular cutout for the display, and drill mounting holes for the two boards. Additional holes are needed for the three-conductor cable that connects to the analog board and the wall-adapter transformer. If you choose, you can also mount an optional power switch and a receptacle for the wall-adapter transformer if you do not want to hard-wire the transformer to the unit.

When connecting the display and digital boards together, use 22- or 24-gauge stranded wire. Do not use solid wire—it will break. Use 20-gauge or larger flexible insulated wire for the three-conductor cable, as the analog board can draw as much as 200 mA of current. Sleeving should be used to protect the cable from the elements.

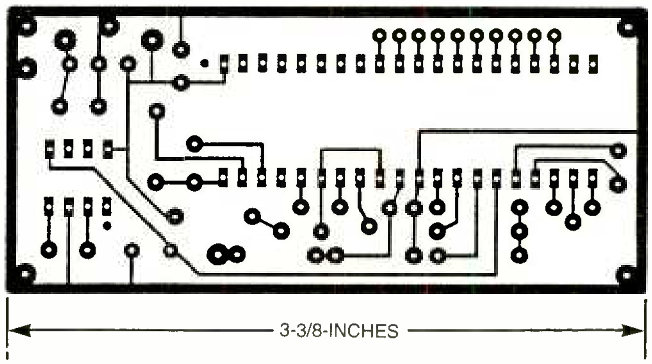
Install the boards into the enclosure. One suggested arrangement is shown in Fig. 5. The boards can be installed with spacers and either 2-56 or 4-40 machine screws and nuts. Be very careful that no stress is placed on the display assembly. If batteries will be used as a power source, use a battery holder that can hold six D-size batteries. Six alkaline or NiCd cells connected in series provide between 7.2 and 9 volts. With battery power, including an on-off switch in the circuit will be more convenient than having to remove the batteries when the unit is not in use.

Sensor Assembly. The analog board will be located outside where it can sense the wind. It must be protected against rain, snow, or other elements. Additionally, Q1 and Q2 must be exposed to airflow, yet be sealed from moisture. This can be accomplished by coating the transistor body and leads with a thin layer of epoxy or epoxy paint.

Figure 6 shows one method by which the analog board might be protected from the weather. Any method that exposes the transistors to the wind, yet protects the circuit from the elements will be fine. Do not close the sensor assembly until the circuit has been tested and calibrated.

When the anemometer is fully assembled, examine the wiring very carefully for proper connections. Do not attempt the checkout procedure unless you are satisfied that the assembly and wiring are 100% correct.

Preliminary Test. A DVM is required to test and calibrate the unit. An oscilloscope, if available, will be handy to observe the oscil-



The foil pattern for the digital board is also a single-sided design.

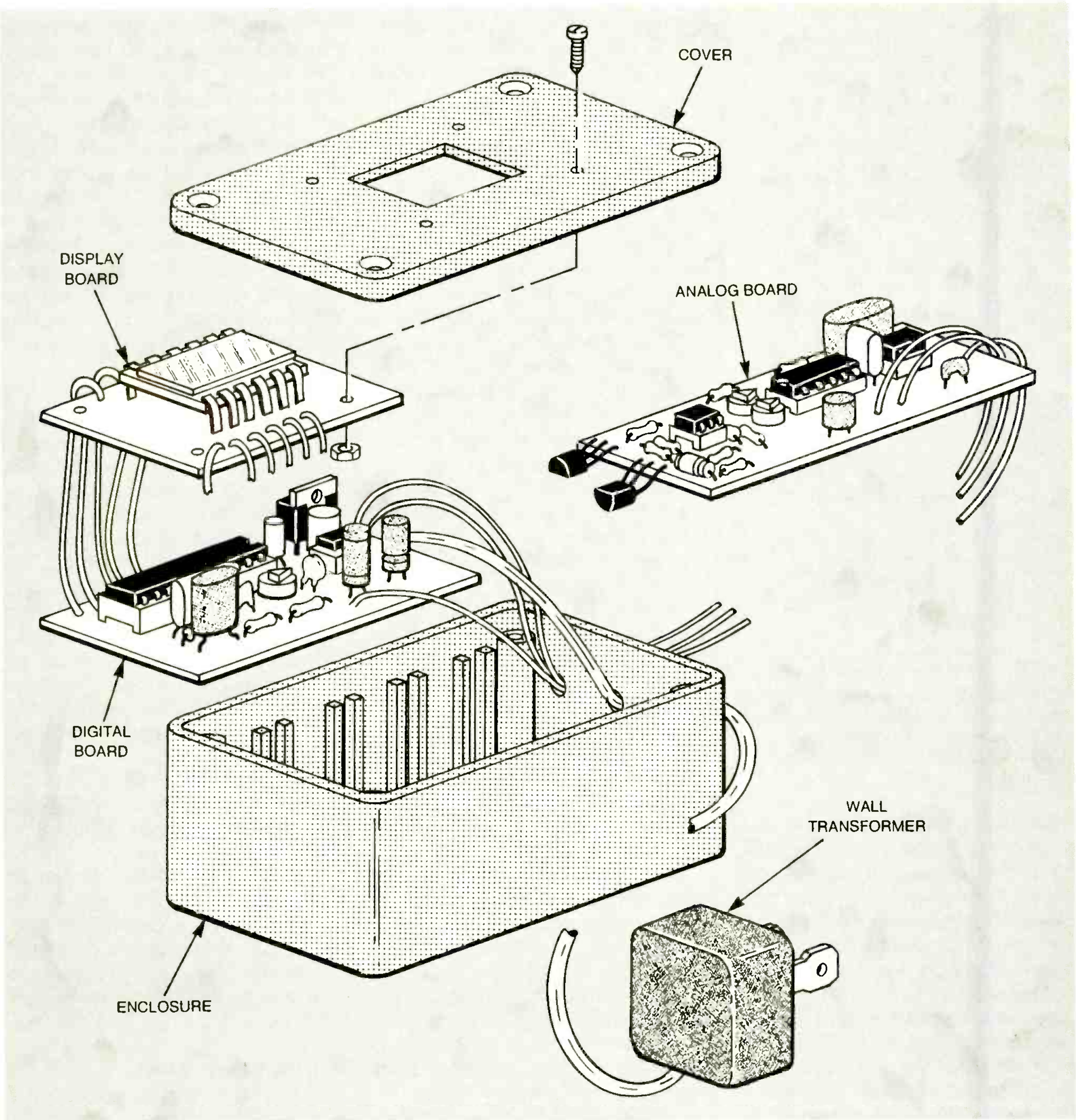


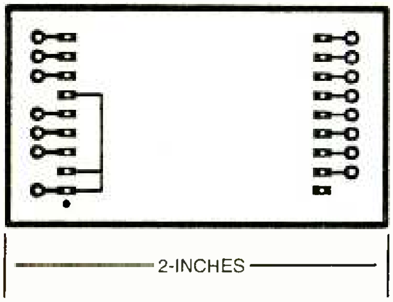
Fig. 5. The main components of the Solid-State Anemometer can easily fit into a standard project box. The wires that connect the digital and analog boards should be long enough to reach to the final mounting locations for each assembly.

lator waveforms. Before applying power to the circuit, measure the resistance between the positive and negative power-input terminals of the digital board. There should be no short circuit. Normal indication, with the positive lead of the DVM connected to the positive side of C1, is about 20,000 ohms or more. If a zero or low resistance is measured, examine the circuit assembly very carefully to locate and correct the fault.

Set R1, R5, and R20 to their mid positions. Apply power to the circuit and measure the voltage output of IC1 at the positive side of C2. It should be between 4.75 and 5.25 volts. The voltage at pin 5 of IC6 should be at about –5 volts.

If you do not obtain the correct voltage readings, remove power from the circuit immediately and troubleshoot it to locate and repair the fault. Check power-input-voltage polarity and the orientation of C1–C4, all integrated circuits, and the transistors. The resistance between the ±5-volt buses and ground should show no short circuits. If necessary, remove all of the ICs from the boards except IC1. Try replacing IC1. If the –5-volt supply is not operating, replace IC6. When the fault has been corrected, continue with the checkout procedure.

The DC voltage between pins 35 and 36 of IC5 is set by adjusting R20 for a reading of 1.0 volt. Measure



Here's the foil pattern for the display board. If you can cut the final board oversized it could be much easier to mount the assembly in an enclosure.

the voltage at the junction of R1, R2, and R3. Set R1 for a reading of 1.25 volts. Note that as R1 is aajusted, the display digits will change. Now, make very small adjustments in R1 and allow the display reading to settle down as Q1's temperature stabilizes. You should be able to obtain a display of 00.

Once zero is set, take a straw or a length of small tubing and blow air on Q1. The display should react with an increase in the reading. The harder you blow on Q1, the higher the reading should be. Bear in mind that Q1 will run quite hot.

If everything is working correctly so far, you can go on to the final calibration step. Otherwise, here are some hints for locating and correcting some possible problems:

If the display has deformed digits, there might be a wiring error between the display and digital board. The location of the incorrect segments of the display will tell you where to check for opens, shorts, or miswiring. Refer back to the schematic diagram in Fig. 1 to verify proper connections.

If the display is totally blank, IC5 might not be operating or the orientation of DISP1 could be incorrect. The display will blank out if the analog voltage at pin 31 of IC5 is 2 volts or more. That would mean a fault in the analog board. Check pin 21 of IC5 for the backplane-drive signal, a 5-volt peak-to-peak square wave.

If the analog voltage at pin 31 of IC5 cannot be set to zero with R1, the trouble is in the analog circuit. Verify that pin 7 of IC2-b can be set to zero volts for part of the adjustment range of R1. Check Q1 and Q2. Try a new chip for IC2.

If the oscillator does not run when pin 7 of IC2-b goes high, check all of the components associated with IC2-a. If the comparator and oscillator sections are operating normally, check all components associated with IC3 and IC4. You can also try replacing those chips.

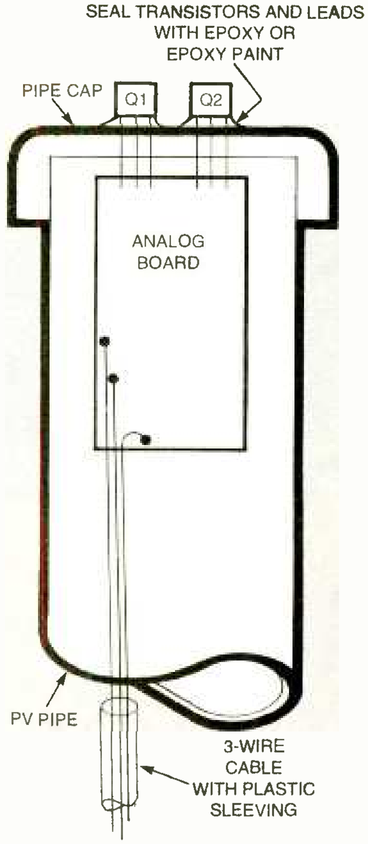


Fig. 6. One way to protect the analog board from the weather, yet expose Q1 and Q2 to the wind is to use a length of PVC pipe and an end cap glued onto one end. Seal around the transistors with epoxy or epoxy paint.

PARTS LIST FOR THE SOLID-STATE ANEMOMETER

SEMICONDUCTORS

IC1—LM7805 5-volt regulator, integrated circuit
IC2—LM393 dual voltage comparator, integrated circuit
IC3—74HC4053 Triple analog multiplexer, integrated circuit
IC4—MAX407CPA dual op-amp, integrated circuit (Maxim)
IC5—ICL7106CPL 3½-digit analog-to-digital converter, integrated circuit (Harris)
IC6—ICM7660SCPA negative-voltage converter, integrated circuit
Q1, Q2—2N4401, NPN transistor

RESISTORS

(All resistors are ¼-watt, 5%, carbon units unless otherwise noted.)
R1—10,000-ohm, potentiometer
R2, R3—2210-ohm, ¼-watt, 1%, metal-film
R4—100-ohm
R5—2000-ohm, potentiometer
R6—221-ohm, ¼-watt, 1%, metal-film
R7, R15, R16, R24, R25—1-megohm
R8—22,000-ohm
R9—2.2-megohm
R10—220,000-ohm
R11—430,000-ohm
R12—560,000-ohm
R13, R14—1.5-megohm
R17, R18—10,000-ohm, ¼-watt, 1%, metal-film
R19—30,100-ohm, ¼-watt, 1%, metal-film
R20—20,000-ohm, potentiometer
R21—4700-ohm
R22—100,000-ohm
R23—470,000-ohm

CAPACITORS

C1—100-µF, 25-WVDC, electrolytic
C2, C3, C4—10-µF, 25-WVDC, electrolytic
C5—0.0012-µF, 50-volt, Mylar-film capacitor
C6, C9, C11—0.1-µF, ceramic-disc
C7, C8, C13—0.22-µF, ceramic-disc
C10—100-pF, ceramic-disc
C12—0.047-µF, ceramic-disc
C14—0.01-µF, ceramic-disc
C15—47-µF, 25-WVDC, electrolytic

ADDITIONAL PARTS AND MATERIALS

DISP1—VI-201-DP-RC-S 2-digit LCD display (Digi-Key 153-1003 or similar)
Enclosures, 9- to 12-volt DC wall transformer or batteries (see text), hardware, wire, solder, etc.

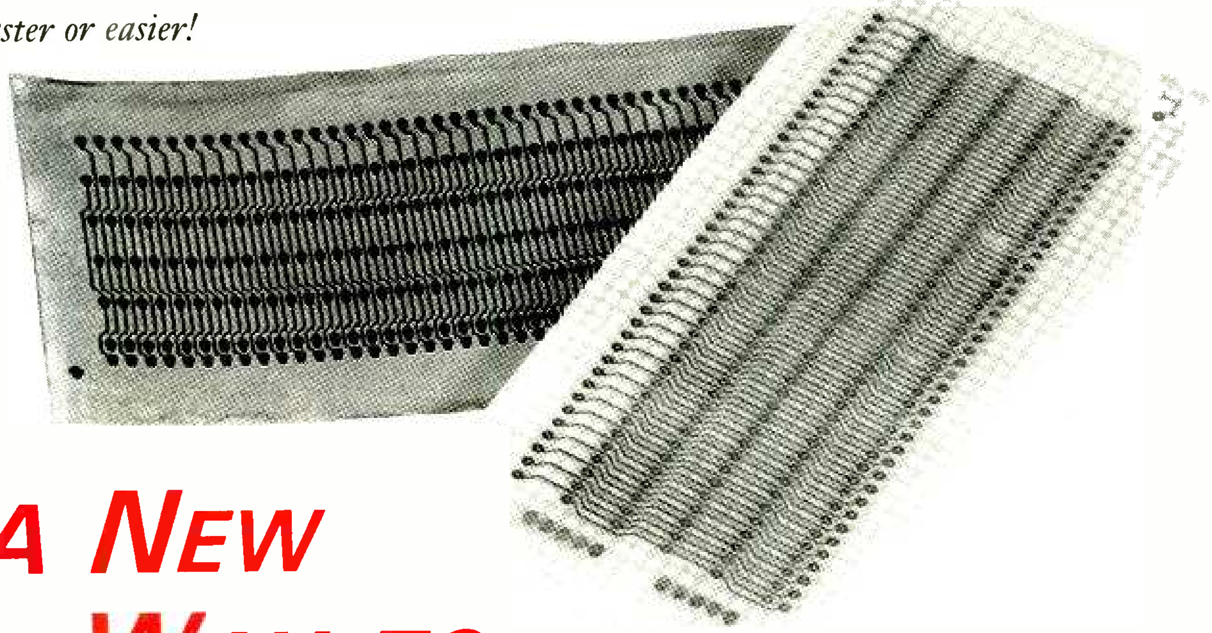
Note: The following parts are available from: A. Caristi, 69 White Pond Road, Waldwick, NJ 07463: Set of three printed-circuit boards, $29.75; Q1, Q2, IC1, IC2, IC3, $2.00 each; IC4, $5.75; IC5, $4.75; IC6, $11.95. Please add $5.00 postage/handling. New Jersey residents add 6% sales tax.

Final Calibration. Final calibration of the anemometer will require four items: A 9- or 12-volt DC power source, a vehicle (preferably with cruise control), a windless day, and an assistant to drive the vehicle.

continued on page 55

Thanks to a flexible copper foil, making PC boards has never been faster or easier!

BILL GREEN



A NEW WAY TO MAKE PC BOARDS

If you stay with this hobby long enough, sooner or later you will need to make PC boards. There's just no getting out of it—I've wire-wrapped, point-to-point wired, and done just about everything else I could think of to avoid making a PC board, but, sooner or later, I had to do it and I really hated it!

Why? First, I hate to drill holes. Second, I don't like working with toxic and noxious photo-resist. And third, I don't like messing with anything as nasty as ferric chloride.

Looking back over my career (and hobby) in electronics, the first boards I ever made were with a squeeze tube of resist. That wasn't so bad since the parts were mostly large, like ½-watt resistors, and there weren't that many of them, so there weren't that many holes to drill. Later when I started to design with ICs and ¼-watt resistors—lots of them and lots of traces—I had to switch to photo-resist. Ugh! Too much time and work, which was not good for me; lots of noxious chemicals, which was not good for the environment; and lots and lots of those miserable holes to drill.

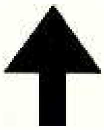
I finally gave up and just sent my artwork to a PC board house and paid them three or four hundred dollars to tool up and make my prototypes. Since most of the projects I designed were going to be commercial products, that was usually an acceptable trade-off. There were obvious drawbacks of course—about three weeks turn-around time and when there was a bug in the design, a charge for retooling. Then too, I didn't always design something that I wanted to market, and the costs involved were too high for one or two boards.

In the past few years I'd tried the iron-on laser-toner-transfer technique many times and with different products. They seemed like a good idea, and perhaps others have had more success than me, but I never even got close to acceptable results (even with a heat press). Besides, even if I had been satisfied with the boards, I still would have had to drill lots and lots of holes.

There had to be a better way, so I thought about the factors involved with all the methods I had used. I discarded most, but eventually hit on the following: Why not use perfboard (the holes are already there) and why not print the laser toner (or copier toner) directly on the foil (the foil would have to be flexible), and why not use a nicer etchant (sodium persulphate) that doesn't stink and stain everything that comes near it?

So that's what I now do. The process works great and I make all my boards that way (for example, the prototype for the MarineLife Acoustic Sensor, which appeared in the October, 1997 issue of **Electronics Now**, was made using that technique).

Now, prototyping or designing a "I wonder if?" project is a lot more fun. There's rarely a need to even breadboard an idea, it's just so easy to put in on a board. And that goes double for double-sided



This end into printer
This side down

Fig. 1. Prepare a carrier sheet like this one and mark as shown if your printer prints on the bottom side (most do); if your printer prints on the top side, change the legend to "This side up."

boards. Cost wise, if you make relative comparisons with available techniques, you will find that on a per-square-inch basis, the flexible-foil/perfboard method is more than competitive.

What You Need. The key to the process is a product called Z-Flex made by Courtaulds. Z-Flex (brand name) is a thin base material of flexible plastic with 1 mil of copper electro-deposited on it. (See the sidebar for information abcut Courtaulds). Z-Flex has been available to major commercial interests in large quantities for a number of years. Now, arrangements have been made to make smaller quantities available to hobbyists and small businesses. Check the Ordering Information box for information on the availability of Z-Flex in 8- by 10-inch sheets.

Bare perforated-construction-board material needs little or no introduction. For this application, you should select material that has 0.042-inch diameter holes on 100-mil centers, and it should be about 0.061-inch thick and be made of epoxy or epoxy-composite material. Such stock is readily available from many mail-order sources.

The adhesive used in the process is "Elmer's Spray Adhesive," but a number of other companies also make a similar product. These are available from building supply and hardware stores as well as the large chain retailers that sell paint and hardware.

As previously mentioned, the etchant used is sodium persulphate. You will need to obtain that locally; the source you presently purchase your etchant from will likely also carry it, or you can try any larger chemical-supply house.

How It's Done. Now that we've got the preliminaries out of the way, let's get to the reason we're all here. What follows are the step-by-step instructions on using this technique to successfully make your own boards:

1. Create your PC foil pattern in the way you usually do, except be sure to lay out all the holes on 100-mil centers, including any vias if you are making double-sided boards.

2. Prepare a carrier sheet (see Fig. 1), mark one side with an arrow, and label that side to be placed face down in the printer (copier) feed tray, unless your printer prints the top side.

3. Place the carrier in the printer tray. Print your pattern for the top (component) side foil non-mirror image. For bottom (solder) side foil, print mirror image. Note the large number of holes and traces and the high density and thinness of the traces on the sample pattern shown in Fig. 2. The process works well for this and even higher density boards.

4. Cut a piece of the foil about one-inch larger than your pattern. **Make very sure that there are no sharp or curled edges** that might scratch your printer drum. Wipe the foil clean with alcohol to remove any grease or other contaminants. Place the foil in a tray of etchant for four to five minutes. Remove and wash very thoroughly and blot dry.

5. Fasten, with masking tape, the foil to the carrier sheet over the previously printed pattern, aligning it so that there is a half inch of clearance on all edges.

ORDERING INFORMATION

The following items are available from Lancelot, PO Box 541005, Merritt Island, FL 32954: Five 8- by 10-inch sheets of Z-Flex foil (ZF-5)—$45.00, plus $3.00 for Priority Mail shipping in the U.S. and Canada; ten 8- by 10-inch sheets of Z-Flex foil (ZF-10)—$80.00, plus $3.00 for Priority Mail shipping in the U.S. and Canada. PA residents please add appropriate sales tax. Payment by check or money order only.

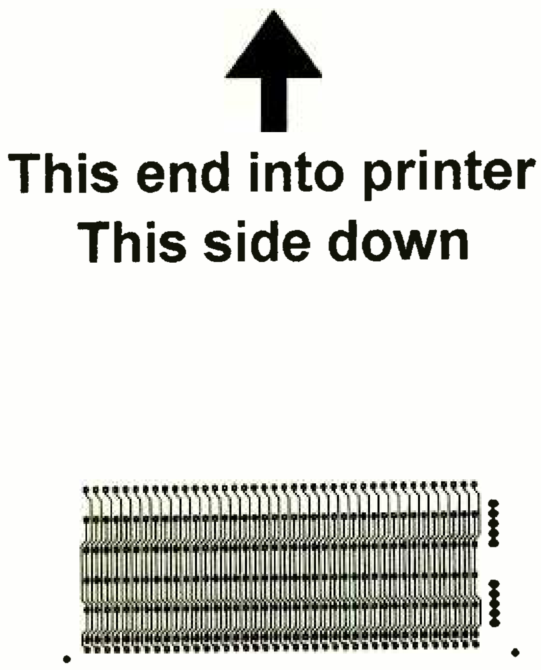


Fig. 2. Once the carrier sheet is created, replace it in the printer tray (with the proper orientation, as indicated) and print your pattern on it. This pattern will be used to make sure your foil is perfectly placed in the next step.

6. Place the carrier and foil in the printer tray and print (see Fig. 3). We recommend that you set the printer for the lightest setting.

7. Carefully peel the tape from the foil. Closely check the printed pattern and touchup with an ultra fine pointed resist pen if necessary.

8. Prepare the sodium persulphate etchant per the package instructions and place it and the foil into the etchant tray. Etch in the normal fashion. See Fig. 4.

9. Remove from etchant and wash the board thoroughly. Wipe the foil with xylene until all traces of toner are removed. Buff with steel wool to brighten. If you wish, you may use an electrolysis tin- or nickel-plating solution to plate the foil and improve its solderability. Note that xylene vapor, like acetone vapor, can be harmful, so make sure you work in a well-ventilated area.

10. Cut a piece of perfboard to the size of the foil. Spray one side with the Elmer's Spray Adhesive (or a similar product). Except along one edge, cover the adhesive with a piece of waxed paper. Lay the foil on the waxed paper and align the holes in the foil to the most convenient holes in the perfboard. Press down on the foil to adhere. Lift the other edge of the foil and remove the waxed paper. Work the foil down onto the board from the attached edge until it is flat and held by the adhesive. For double-sided boards repeat with the foil on the other side.

11. Trim the board down to the final size. Using a needle, pierce each hole in the foil. For strips of holes, such as for IC sockets, you can use a single row header strip (about 5 pins long) to punch multiple holes.

12. Install and solder sockets and components in the usual fashion.

Notes and Thoughts. While the process outlined above appears (and is) simple, that's not to say that there were not problems that had to be overcome in developing it. For example, during the development of the process we were faced with a very thorny problem—getting the toner to adhere to the copper foil. We first tried a coating that was water soluble. The drawback was that you needed to wash the board with soapy water to remove coating after printing the toner on the foil. Otherwise the coating would have acted as resist in the areas we wanted etched away. That technique worked to an extent but it required too much care to prevent damage to the toner. After a lot of trial and error, we hit on the solution to the problem. We pre-etched the foil for a few minutes to prepare the surface for the transfer of toner to it. The problem was solved.

Also, the toner is very hard to remove from the board after etching. That problem was overcome by using xylene, and then using steel wool to polish the bare copper traces, as outlined above.

By the way, there's no need to buy high-priced special toner cartridges for this. We used a HP LaserJet IIP with a factory toner cartridge, and it worked just fine.

As you might have guessed from the introduction to this article, there is nothing I hate more than drilling dozens (or more) of small holes in PC boards. If you don't share that

MANUFACTURER INFORMATION

Z-Flex is a product of Courtaulds Performance Films (PO Box 5068, Martinsville, Va. 24115). Courtaulds supplies Z-Flex in 24-inch by 100-foot rolls. One roll is their minimum order. Courtaulds deals only with businesses; no individuals. You may contact them at the above address for information on Z-flex and other high performance films and materials.

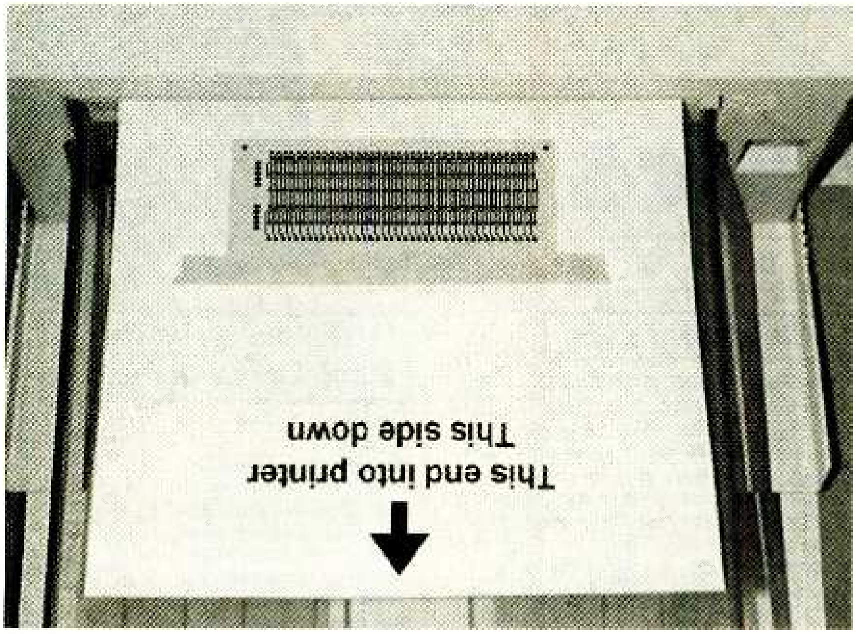


Fig. 3. The Z-Flex foil is cut to the proper size, mounted on the carrier sheet, then run through a standard laser printer as shown. If all goes well, the pattern will transfer perfectly to the foil.

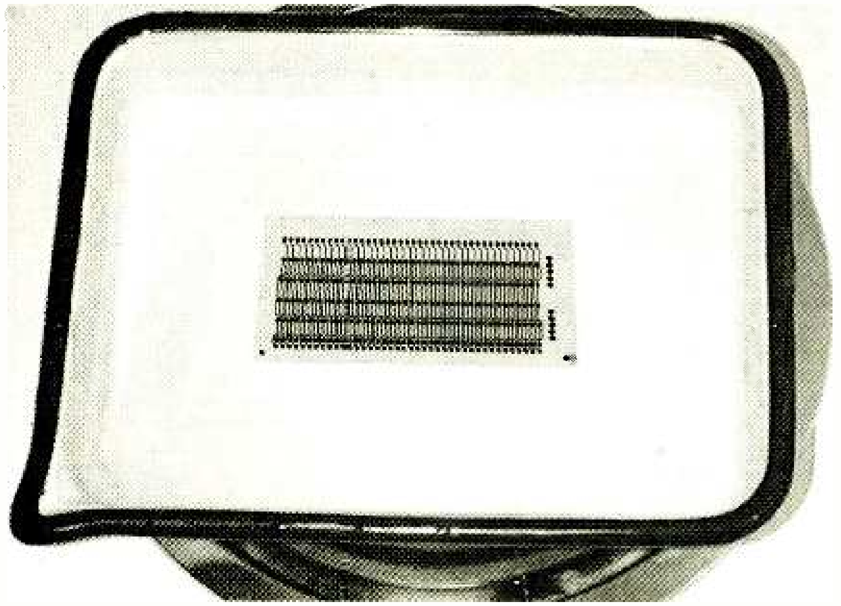


Fig. 4. Once the pattern has been transferred, place the foil in an etchant tray filled with sodium persulphate and etch in the normal fashion

particular hang-up, there's no reason that you can't place the foil on bare (not copper clad) board stock and drill away. If you do that, the restriction that you must lay the board out on 100-mil centers does not apply.

Note that if you are using art that you did not create yourself, such as patterns supplied in this magazine, the odds are good that it will NOT be laid out on 100-mil centers. In that case, you must place the foil on blank, hole-less board. Even so, while it won't save you drilling, this is still one of the easiest ways to transfer a pattern from a printed page to your board.

To take the preceding one step further, you don't even have to put the copper foil on any type of substrate. That means it can be used to make flexible PC boards or interconnect cables!

Well, there you have it. A different way of creating PC boards that gets rid of some of the more unpleasant parts of the job. Once you've tried it, you might never make a board any other way! Ω

WIND-SPEED INDICATOR

(continued from page 51)

Before calibrating the circuit, be sure that R1, the zero set potentiometer, is adjusted to obtain a solid display of 00. Obviously, there can be no air movement around Q1 and Q2 if R1 needs to be readjusted.

Choose a straight and level stretch of highway where your assistant can drive the vehicle safely between 55 and 65 mph. If the vehicle is equipped with cruise control, set it for the desired speed.

Place the analog assembly into the air stream, allow a few seconds for the display to settle down, and note the reading. Adjust R5 and note the new reading. Repeat as needed to obtain a display as close to the vehicle speed as possible.

Once R5 has been adjusted to your satisfaction, the Solid-State Anemometer is fully calibrated and ready for use.

Using The Anemometer. As mentioned before, the analog assembly must be located outside where it can sense air movement. If the circuit is powered by an AC wall-adapter transformer, it can be left on continuously for constant wind-speed indication. If the unit is battery powered, allow sufficient time for the display to settle down after turning power on. After taking a reading, be sure to turn the unit off so as not to inadvertently run the battery down.

The Solid-State Anemometer is a fascinating tool that can be used for many tasks that are only limited by your imagination. It is one project that will "blow your socks off!" Ω

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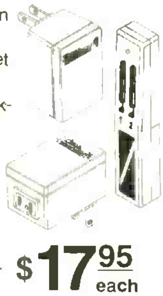

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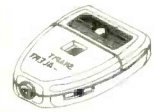

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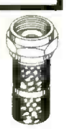

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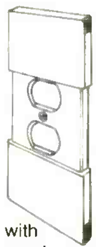

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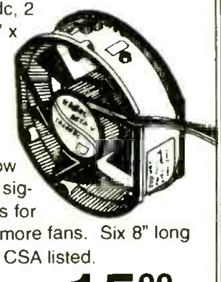

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BY DON LANCASTER

Homopolar Generators, Melody ICs, and More

THERE SURE SEEMS TO BE A LOT OF WEB INTEREST THESE DAYS IN HOMOPOLAR GENERATORS. THOSE REALLY OLD AND POORLY UNDERSTOOD ELECTRICAL MACHINES HAVE NEWLY BEEN BLAMED FOR EVERYTHING FROM "OVER UNITY" PERPETUAL motion rip-offs to cures for warts to three-foot-high killer chickens.

In reality, a homopolar generator can lead to a winning student paper or project, but otherwise is pretty much totally useless due to its extremely low output voltage and its woefully poor efficiency. A few of the more intellectually challenged "Webizens" seem to confuse homopolar machines with magnetic monopoles, and "near monopoles". The latter is the current Scam De Jour of the pseudoscience crowd.

Well, I hate to mention this, but magnetic monopoles flat out do not exist. Your alternate name for "near monopoles" (magnets with one pole appearing much stronger than the other) is bad labwork—labwork so mesmerizingly awful that it flat out is not even wrong.

Some Electrical Laws

Most of the fundamental electrical developments that lie behind motors and generators took place hundreds of years ago, so this ground has been pretty thoroughly plowed; in fact, it's been done over and over again. It's safe to bet that the fundamentals have been pretty well proven far beyond even the remotest shadow of doubt. Let's look at a few basics

Conservation of energy—This tells us that there is no non-nuclear process known by which energy can either be created or destroyed. Connect a hand cranked generator to any lamp via a switch. Closing the switch makes the cranking a lot harder

In the real world, there is always friction. Friction always ends up as useless low grade heat. Even though you cannot create or destroy energy, there is no way you can ever so much as hope to break even. Worse yet, if a heat engine or a temperature differential is in any manner involved, most of your input energy usually is also converted into uselessly low quality heat. That is the Carnot efficiency limitation from that Second Law of Thermodynamics. More on this can be found in HACK64.PDF on www. tinaja. com, and in my hard copy "Hardware Hacker" reprints.

Electric currents—An electric charge is simply some place where there is some excess or a lack of electrons; excess for negative; lack (or excess holes) for positive. Point electric charges can and do exist.

An electric current results when a conductive path is placed between points having positive and negative charge accumulations. Using Ohm's Law lets us calculate the strength of the current based upon the charge differences, the conductivity of the path, its area, and its active length.

The current continues only until the charges fully equalize. A conventional current is defined as positive to negative in a load and negative to positive in a source. The conventional current is the same as the hole current, but is the opposite of the electron current. Always use conventional current in your calculations.

Magnetic flux—Nobody, but nobody, has ever observed a point magnetic charge, otherwise referred to as a magnetic monopole. While certain controversial theories do suggest that magnetic monopoles just might be possible, nobody has yet grabbed one for the cover of *Science* Magazine.

One of Maxwell's equations tells us the total magnetic flux through any closed surface is zero. That tells us that magnetic poles always have to be paired and always have to be of equal strength. What goes out north simply has to come in south. Motors or generators that involve magnetism will always need magnets that provide two poles of equal and precisely opposite strengths. You can easily get from electricity to magnetism by running a current through a wire. Closed circular lines of magnetic flux will form around the wire per a right hand rule. The strength of the magnetic field is proportional to the current and is inversely proportional to the square of the distance from the conductor.

The law of induction—To get from magnetism to electricity, we apply Faraday's Law, which is illustrated in

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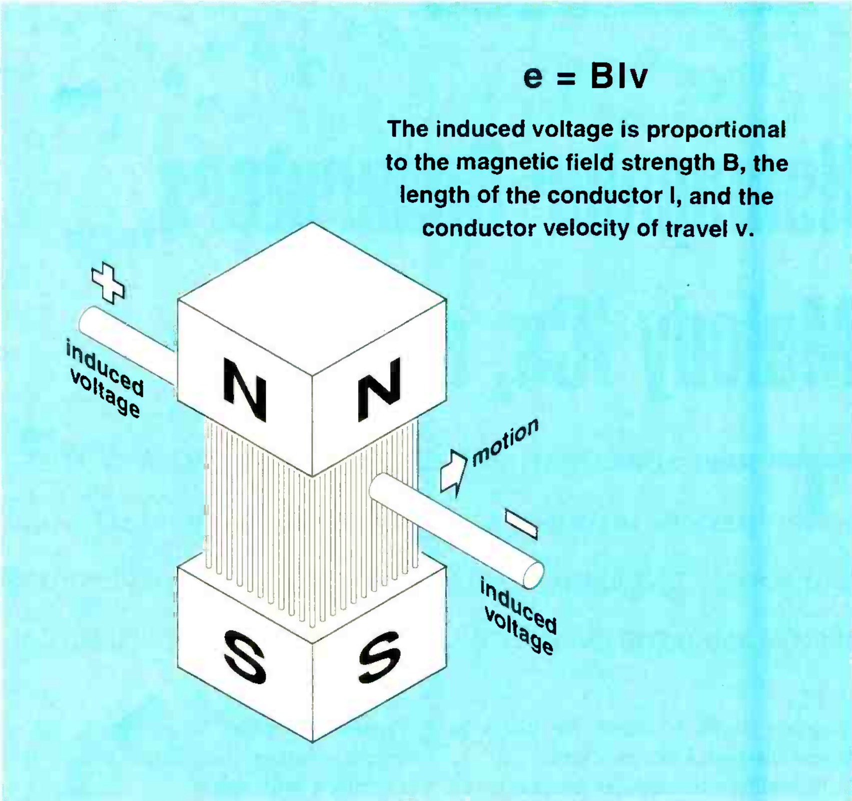

FIG. 1–The "Blv" VOLTAGE RULE for motors and generators.

Fig. 1. Mathematically, we have

$$e = Blv$$

which tells us that "the voltage induced in a wire depends upon how long the wire is, the strength of the magnetic field your wire is moving through, and the wire's velocity."

The usual demonstration here is to take a hollow coil of wire and connect it to a center zero micro-ammeter. As you move the magnet through your coil, you get a current resulting from the induced voltage going through the meter's resistance as per Ohm's law. But you get a current only when the magnet is moving. Entry swings the meter positive and exit will cause it to go negative. Reverse your poles and you reverse the polarity. The faster you go, the higher the peak induced voltage and the higher the current.

The law of winding force—Otherwise known as Fleming's Rule, it is illustrated here in Fig. 2. Again mathematically

$$f = Bli$$

Or "Whenever a current carrying conductor interacts with an external magnetic field, a force results at right angles to both the conductor and the field." That force is proportional to the strength of the magnetic field, the length of your conductor, and the current through your conductor, and goes in the direction specified by the "right-hand" rule. Motion will result when this force is not opposed. The process is reversible. That is, you can input a force to create a current or input a current to create a force.

Note that work is done only when a force moves through a distance. When your conductor is allowed to move, an opposing voltage is also produced by our previous e=Blv rule. This is known as the back emf or as the counter emf. In the absence of any mechanical motor load, the back emf will very nearly cancel out the input voltage, resulting in very little current at low loading. As any mechanical loading increases, the back emf magically drops, increasing the current exactly as needed for energy conservation.

The major difference between a motor and a generator is that you'll input the rotary motion and extract current with a generator while you input current and extract a rotary motion with any motor. Indeed, because of back emf, a motor generates and a generator "motororates".

The Homopolar Generator

Now, let's go back to where we started this month. Figure 3 shows us an ancient and unusual piece of machinery called a homopolar generator, which is also sometimes called an acyclic generator.

Note that there is only one air gap involved. One oddball shaped magnet can be used, having one north pole and one south pole. In the setup shown, the poles are circular but have a small shaft access hole in their centers. Curiouser and curiouser.

A disk shaped conducting rotor is placed in the air gap. As the disk is spun, a radial DC current is produced. The strength of that current depends upon the disk speed and the strength of the magnetic field. The current is collected by one or more slip rings on the outer edge of the disk.

The homopolar generator has some very unusual properties. It is the only known electromechanical generator that is able to produce a true direct-current output. More popular two-pole generators have to commutate, or selectively switch into sequential AC winding peaks to get an apparent DC output at the terminals.

The homopolar generator always produces very low voltages and very high currents. A mid-sized machine might output eight volts at a current of 20,000 amperes.

Incidentally, about that 20,000 amperes—a slip ring with a 0.001-ohm resistance will drop 20 volts and must be able to dissipate 400,000 watts, about three times what your generator can produce. And remember that you need two sets of slip rings. Thus, the enormous currents lead to monumental wiring and slip ring losses, so much so that any practical homopolar generator almost always ends up extremely inefficient.

Also consider that the high currents must be used "nearby," or the bus-bar "wires" will gobble up nearly all of the remaining energy that the slip rings may have decided to leave you with. In comparison, much less copper and less iron is required in simpler structures for any traditional higher voltage and lower current multipole generator. And obtaining a DC output is no big deal with today's cheap rectifiers and synchronous rectification.

In short, a homopolar generator is simply a machine that applies conventional laws of physics to inefficiently generate low DC voltages at high currents in complex and physically larger devices at much higher costs.

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There have been other variations upon homopolar generators, some of which used spinning magnets. As far as I know, the version I've shown here is one of the scant few to ever see any commercial use.

I strongly suspect the main reason that homopolar generators find favor with the free-energy crowd is because of the utterly simplistic ease with which errors of measurement and/or interpretations can be made. High currents are extremely tricky to measure; a rather special Kelvin connection is required. Their strong magnetic fields also tend to directly interact with some meter movements. Nonlinearities, temperature effects, and phase shifts are all guaranteed to cause you problems, as are big time misinterpretations of what is really coming down.

Still, there are a few remaining legit manufacturers of homopolar generators. Mostly for "exotic" (though I have to wonder "compared to what?") applications that require enormous but brief currents. That includes rail-gun research, super-magnet studies, specialized welders, or electrochemistry applications.

One source for custom homopolar generators is Parker Kinetic Designs. Currents as high as five million amperes can be found in their product line.

"Six Click" Display PostScript!

I've long been a fan of the superb PostScript computing language—a general purpose language that has suddenly gotten a lot easier to use. The holy grail here has been a pair of windows

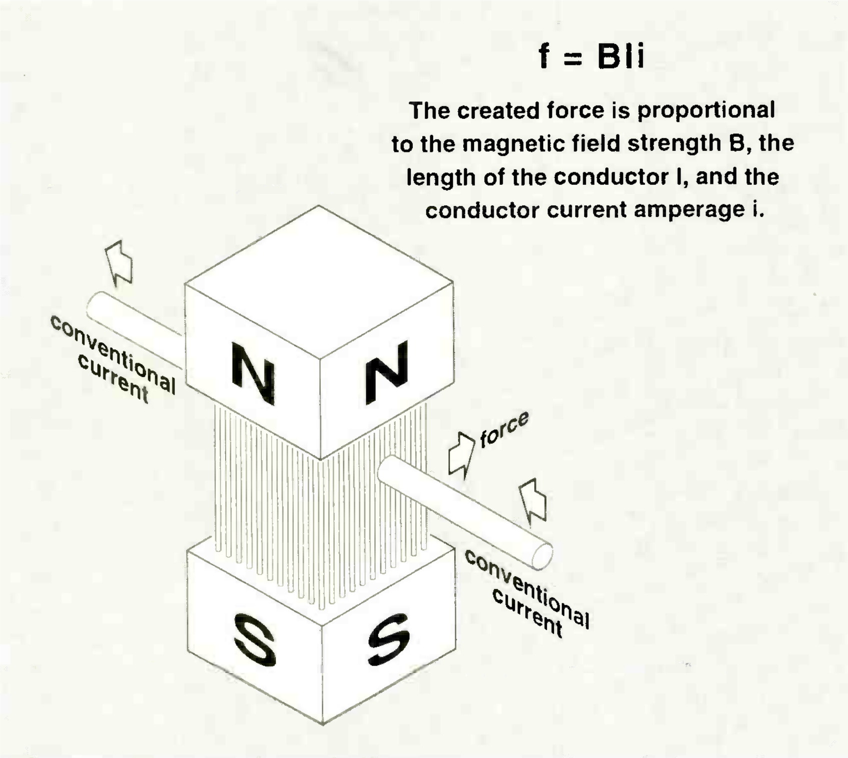

FIG. 2—THE "Bli" FORCE RULE for motors and generators.

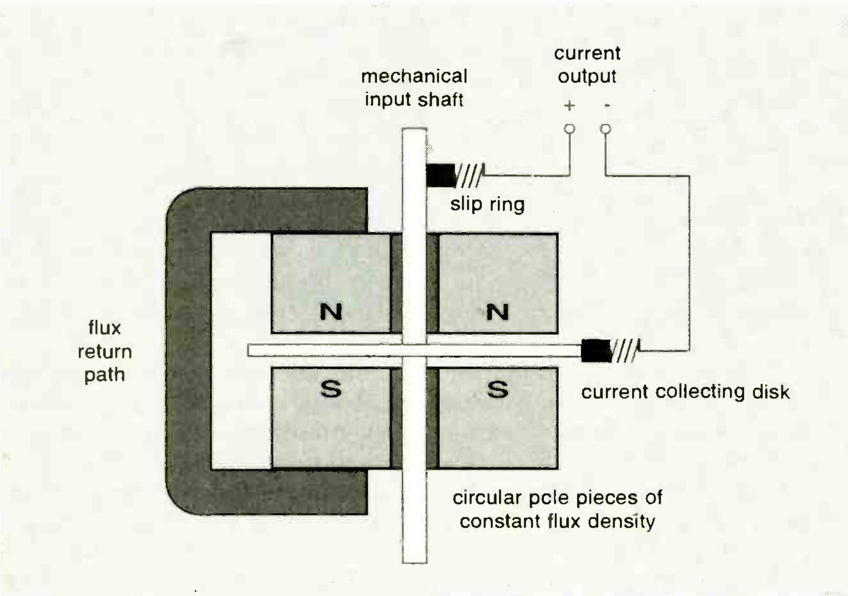

FIG. 3—THE HOMOPOLAR GENERATOR offers a true DC output, quite low voltage, and extremely high output currents. Typical applications are largely restricted to uses where tens of thousands or even millions of amperes of current might be required.

on a PC—you change your source code in one window, and your graphical or other output instantly responds on the other.

Well, we are not quite there yet, but we have gotten close enough that PostScript is now fast and fun to use. The two key secrets: Adobe's Acrobat Distiller is an outstanding PostScript computer, and Adobe's Acrobat Exchange quickly gives you a full on-screen PC visual display that's magnifiable and anti-aliased.

Thanks to those, you are within six clicks of having access to your very own PC-based display PostScript. Here are the six secret steps involved:

1—Save source modifications to disk
2—Exit Exchange
3—Select work folder
4—Drag source into Distiller
5—Exit Distiller
6—Drag PDF file into Exchange

More details on using PostScript as language are in DISTLANG.HTML and the POSTFLUT.PDF on my www.tinaja.com Web site. More on the six mouse clicks themselves in, of all places, SIXCLICK.HTML.

You don't quite have all the more obscure commands of a true display PostScript, and we are not quite real time, but typical turnaround is less than ten seconds. Since errors only give you a stack dump, you might want to substitute free (but otherwise not as good) GhostScript instead if a view-plot-till-the-mistake capability is absolutely needed. Scads more PostScript-as-language examples are on my Web site.

Melody ICs and Speech Modules

A lot of you have been asking for more information on melody and voice integrated circuits. I've shown a few places to go for those as this month's research sidebar.

There's two basic types of chips here: The first are tiny pre-recorded chip-on-board devices you can use in everything from greeting cards to model railroads. The second are the larger one-time use or re-recordable modules, often based on Information Storage Device (ISD) chips. Most of the melody IC modules are sourced in China, with Honsitak Enterprises being a typical supplier. Both Seiko Epson and LSI/ CSI also offer those in several experimenter friendly packages. I've summarized a few of the more interesting Seiko parts in Fig. 4.

Hallmark is, of course, one big retailer of the final products. Your leading source for low cost experimenter kits is a foreign firm called DIY Electronics. Marlin Jones and Circuit Specialists are two US distributors. I've also shown some of these kits in Fig. 4.

All you need for a circuit is a coin cell or two, a simple switch that is often a finger of card stock between two contacts, and a piezo buzzer or a small speaker. You get the best sound quality with chips optimized for real speakers. Certain chips offer inputs that let you select which of several sounds will be output.

(Continued on page 64)

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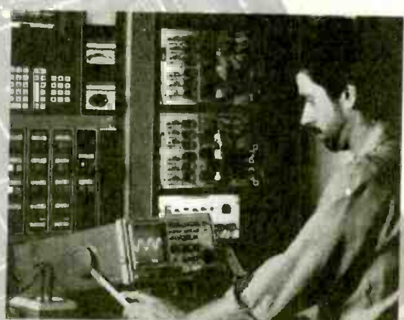

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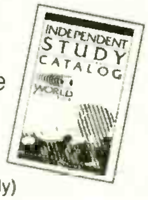

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TECH MUSINGS

continued from page 60

Chips from SEIKO EPSON–	
SVM7910	16 pin dip, 64 notes, tone or chime
SVM7922	4 pin sop, 64 notes, external amplifier
SVM7931	14-pin dip, 64 notes, speaker output
SVM7943	16-pin dip, 512 notes, piezeo or buzzer
SVM7954	16-pin dip, 64 notes, piezeo or buzzer
SVM7962	24-pin sop, 127 notes, speaker output
SVM7973	18-pin dip, 640 notes, high quality
SVM7992	16-pin dip, 512 notes, speaker output
SVM7903	8-pin dip, 60 notes, speaker or piezeo
Recordable speech chips from ISD–	
ISD1000	16 to 20 seconds, dip or soic
ISD1100	10 to 12 seconds, dip
ISD1200	10 to 12 seconds, dip or soic
ISD1400	16 to 20 seconds, dip or soic
ISD2500	32 to 120 seconds, dip, soic, or tsop
ISD33000	1 min to 4 min, dip, soic, or tsop
Kits from DIY ELECTRONICS–	
SG1M	– Four train sounds
SG2M	– Cellular phone sounds
SG3	– Sixteen door chimes
SG4	– Three sirens and machine gun
SG5	– Ding dong door chime
SG6	– Melody IC in TO92 package
SG7	– "Love Story" melody card
SG8	– Sixteen second voice recorder
SG9	– Ten second ISD voice recorder
SG10	– Hen, cat, cow, dog animals
SG11	– Siren sound generator
SG12	– Gun and bomb sounds
SG13	– "Happy Birthday" melody card
SG14	– Three Christmas carols card

FIG. 4—SEVERAL MELODY IC chips and kits.

One useful source of custom cards and modules is Clegg Industries. For recordable sound modules, try Eletech, who call themselves the point-of-purchase ad experts. They have an IR model for permanent ad displays, an EP series that's built into a small picture frame, and a LC "disposable" low cost series. Some of those are one time recordable, while others are reusable as needed. Activation can be by pushbutton or by full motion sensing.

Competitors include Sentinel and Ozen Sound Devices. RadioShack has the ISD chips that these modules are often based on. One industry association is AVIOS, otherwise known as the American Voice Input/Output Society. One very good Far-East industry directory is available as *Electronics* magazine from Asian Sources. They also have a free product-locator CD available. One trade journal where lots of ads for recordables appear is *POP & Sign Design*.

Tell you what, let's make a contest out of all this. An Incredible Secret Money Machine II will be awarded for the dozen or so best new uses for those chips, with an all expense paid (FOB Thatcher, AZ) "tinaja quest" to be awarded for the best of all.

MELODY IC AND SOUND MODULE RESOURCES

Asian Sources
1020 Church St.
Evanston, IL 60201
(847) 475-1900

American Voice I/O Society
PO Box 20817
San Jose, CA 95160
(408) 323-1783

Circuit Specialists
PO Box 3047
Scottsdale, AZ 85271
(800) 528-1417

Clegg
19220 S Normandie Ave.
Torrance, CA 90502
(310) 542-1600

Eletech
16019 Kaplan Ave.
Industry, CA 91744
(818) 333-6394

Hallmark Cards
25th & McGee Trfwy
Kansas City, MO 64108
(816) 274-5111

Honsitak Enterprises
5F 494 S3 Chung Shan Rd.
Shinchung City, Taipei
(8862) 9010513

LSI/CSI
1235 Walt Whitman Rd.
Melville, NY 11747
(516) 271-0400

Marlin P Jones
Box 12685
Lake Park, FL 33403
(407) 848-8236

Ozen Sound Devices
6 Grace Ave.
Suite 201
Great Neck, NY 11021
(516) 482-4825

P-O-P & Sign Design
7400 Skokie Blvd.
Skokie, IL 60077
(708) 675-7400

Seiko Instruments
2990 W Lomita Blvd.
Torrance, CA 90505
(310) 517-7770

New Tech Lit

There's an utterly amazing C. A. Ordez paper in the *American Journal of Physics*, #64v4 April 1996 p479-481 in which a nitrogen powered car is shown to give you the same energy density as the very best of today's EV batteries at potentially less than four percent of the total system cost! Yes, nitrogen.

From Texas Instruments, there's a new *Logic Selection Guide* and *Databook CD*. From Qualcomm, comes a *Synthesizer Products Data Book*.

Lindsay Publications has recently re-released a 1937 Sylvania vacuum tube *Technical Manual*. While the cover clearly says twenty-five cents, I suspect he really expects $10.95 for it.

From Newnes, there's a Jon Hagen introductory text on *Radio Frequency Electronics*, and a thick Colin Bayless power engineering text on *Transmission and Distribution in Electrical Engineering*.

Shelf upon shelf of fascinatingly fictitious pseudoscience titles are now stocked in depth by Adventures Unlimited. And lots more on pseudoscience can now be found at www. tinaja.com/ pseudo01.html.

New trade journals for this month include *NC Shop Owner*, *Industrial Computing*, and *PC Portables*. Free piezofilm sensor samples are available from Amp Piezo. These make dandy microphones. Free laser-compatible engraving plastics samples can be obtained from the Rowmark folks.

For most individuals and smaller scale startups most of the time, any involvement with patents is virtually certain to end up as a net loss of your time, energy, money, and sanity. Find out why in my *Case Against Patents* package. Also shown are my tested and proven alternatives. It is available as per my nearby Synergetics ad. I have also just posted the secrets of busting a $650 patent as a new file BUSTPAT.PDF at www.tinaja.com. Also new are the secrets of bringing PostScript to PICs, as POSTFLUT.PDF. Plus there's my new Infopack service that quickly gets you cost-effective research.

As usual, most of the mentioned items should appear in either the "Names & Numbers" or the "Melody IC Resources" sidebars. Always check there before you call our US technical helpline shown in the Need Help? box. Let's hear from you. EN

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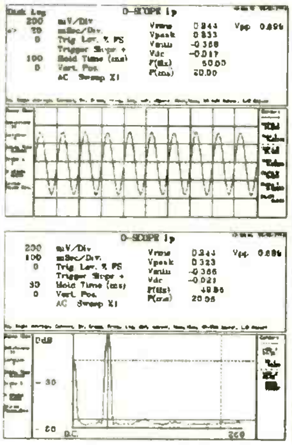

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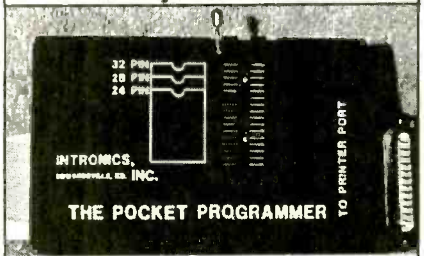

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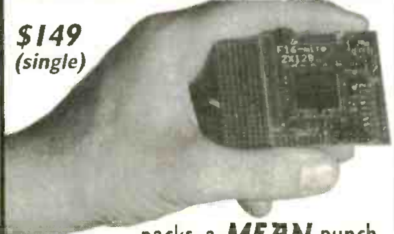

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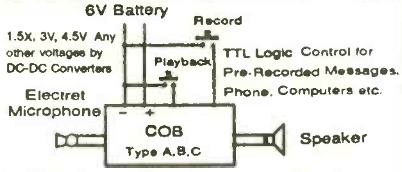

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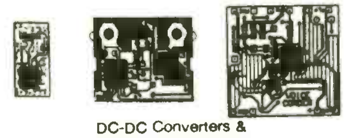

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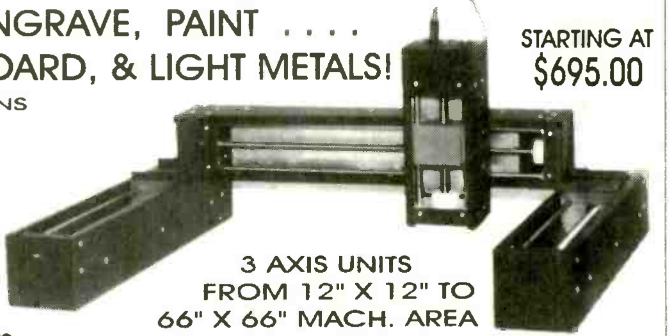

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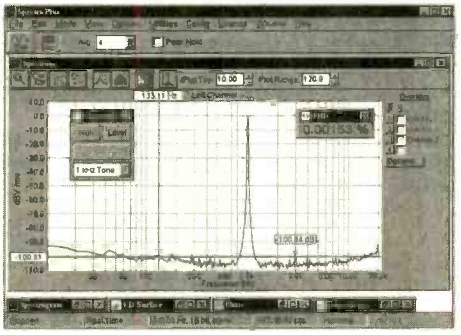

Applications

- Distortion Analysis
- Frequency Response Testing
- Vibration Measurements
- Acoustic Research

System Requirements

- 486 CPU or greater
- 8 MB RAM minimum
- Win. 95, NT, or Win. 3.1 + Win.32s
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Single-Sided, 1oz. Copper Foil on Paper Phenolic Substrate

CAT NO	DESCRIPTION	PRICE EACH 1	10	50
PP101	100mm x 150mm/3.91" x 5.91"	$2.55	$1.90	$1.70
PP114	114mm x 165mm/4.6" x 6.6"	2.98	2.45	1.98
PP152	150mm x 250mm/5.91" x 9.84"	5.40	3.98	3.60
PP153	150mm x 300mm/5.91" x 11.81"	6.15	4.48	4.10
PP1212	305mm x 305mm/12" x 12" NEW!	12.78	10.65	8.52

Single-Sided, 1oz. Copper Foil on Fiberglass Substrate

CAT NO	DESCRIPTION	PRICE EACH 1	10	50
GS101	100mm x 150mm/3.91" x 5.91"	$ 3.90	$2.98	$2.60
GS114	114mm x 165mm/4.6" x 6.6"	4.80	3.49	3.20
GS152	150mm x 250mm/5.91" x 9.84"	8.69	5.98	5.78
GS153	150mm x 300mm/5.91" x 11.81"	10.20	7.20	6.80
GS1212	305mm x 305mm/12" x 12" NEW!	18.88	15.73	12.59

Double-Sided, 1oz. Copper Foil on Fiberglass Substrate

CAT NO	DESCRIPTION	PRICE EACH 1	10	50
GD101	100mm x 150mm/3.91" x 5.91"	$ 5.07	$3.68	$3.38
GD114	114mm x 165mm/4.6" x 6.6"	5.95	4.29	3.99
GD152	150mm x 250mm/5.91" x 9.84"	10.47	7.39	6.98
GD153	150mm x 300mm/5.91" x 11.81"	11.95	8.69	8.30
GD1212	305mm x 305mm/12" x 12" NEW!	22.09	18.35	14.68

Developer

This product is used as the developer on our positive photo-resist printed circuit boards. Includes instructions. 50 gram package, mixes with water, makes 1 quart.

CAT NO	DESCRIPTION	PRICE EACH 1	10	25
POSDEV	Positive Developer	$ .95	$ .80	$ .50

Etching Tank

This handy etching system will handle PC boards up to 8" x 9", two at a time. Ideal for etching your PCB's! System includes an air pump for etchant agitation, a thermostatically controlled heater for keeping etchant at optimum temperature and a tank that holds 1.35 gallons of etchant. A tight fitting lid is also supplied to prevent evaporation when system is not being used. Typical etching time is reduced to 4 minutes on 1oz. copper board!

REDUCES ETCHING TIME!

CAT NO	DESCRIPTION	PRICE
12-700	Etch Tank System	$37.95

Fantastic DMM Offer!!!

Don't let the price fool you. This meter is a digital multimeter designed for engineers and hobbyists. Equipped with 5 functions and 19 ranges. Each test position is quickly and easily selected with a simple turn of the FUNCTION/RANGE selector rotary switch.

Rubber Boot Included

Our Best Offer Ever on a High Quality Full Sized DMM

General

Display: 3-1/2 Digit LCD, 21mm Figure Height with Automatic Polarity
Overrange Indication: 3 Least Significant Digits Blank
Temperature for Guaranteed Accuracy: 23°C±5°C RH<75%
Temperature Ranges:
Operating: 0°C to 40°C (32°F to 104°F)
Storage: -10°C to 50°C (14°F to 122°F)
Power: 9V Alkaline or Carbon-Zinc Battery(NEDA1604)
Low Battery Indication: BAT on Left of LCD Display
Dimensions: 188mm long x 87mm wide x 33mm thick
Net Weight: 400g

DC Voltage (DCV)

Range:	Resolution:	Accuracy:
200mV	100µV	
2000mV	1mV	
20V	10mV	±(1%rdg+2dgts)
200V	100mV	
1000V	1V	

Maximum Allowable Input: 1000V DC or Peak AC.

DC Current (DCA)

Range:	Resolution:	Accuracy:
200µA	100nA	
2000µA	1µA	
20mA	10µA	±(1.2%rdg+2dgts)
200mA	100µA	
10A	10mA	±(1.2%rdg+2dgts)

Overload Protection: mA Input .2A/250V fuse.

AC Voltage (ACV)

Range:	Resolution:	Accuracy:
200V	100mV	±(1.2%rdg+10dgts)
750V	1V	

Frequency Range: 45Hz-450Hz
Maximum Allowable Input: 750V rms
Response: Average Responding. Calibrated in rms of a Sine Wave.

$19.00 any qty

Resistance (Ω)

Range:	Resolution:	Accuracy:
200Ω	100mΩ	
2000Ω	1Ω	
20KΩ	10Ω	±(1.2%rdg+2dgts)
200KΩ	100Ω	
2000KΩ	1KΩ	
20MΩ	10KΩ	±(2%rdg+10dgts)

Maximum Open Circuit Voltage: 2.8V

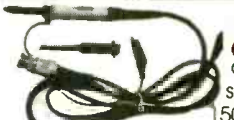
Diode Test

Measures forward voltage drop of a semiconductor junction in mV test current of 1.5mA Max.

ohFE Test

Measures transistor hFE.

CAT NO	DESCRIPTION	PRICE
9300G	Rugged High Quality DMM with Rubber Boot	$19.00



Switchable Scope Probe Sets

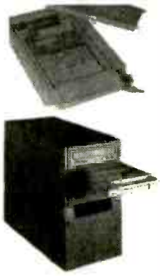
(Selectable X1/Ref/X10) These high quality scope probe sets are for oscilloscopes up to 60MHz (model HP9060) or 150MHz (model HP9150). Both sets include a handy storage pouch and include an IC test-hook adapter for the probe. The BNC connector rotates to avoid cable tangle or kink. Cable length is 1.4 meters.

CAT NO	DESCRIPTION	PRICE EACH 1	10	100
HP-9060	Scope Probe Set DC~60MHz	$16.49	$14.49	$11.58
HP-9150	Scope Probe Set DC~150MHz	24.95	21.95	18.62

Etching Chemicals/Ferric Chloride

A dry concentrate that mixes with water to make 1 pint of etchant, enough to etch 400 sq. inches of 1oz board.

CAT NO	DESCRIPTION	PRICE EACH 1	5
ER-3	Makes 1 pint	$3.50	$2.75



Removeable Hard Drive Racks

The ideal solution for protecting highly sensitive data. Or, buy one computer and allow individual users to keep their hard drive with their own applications and set-ups. Just turn the system off, lift the handle and the hard drive pops right out. Key lock included to avoid accidental or unauthorized removal. Includes hard drive activity LED's. Rack includes mounting hardware, keylock, front panel LED, convenient pull out handle. Made from high impact ABS plastic. Fits in 5.25" bay.

Features: ***• Ideal for Hard Drive Portability • Solve Software Data Security Issues • Carry Your Hard Drive Between Home and Office • Each User Can Have His or Her Personal Hard Drive***

CAT NO	DESCRIPTION	PRICE
SpecialHDRACK-IDE	For IDE Hard Drive	$14.95

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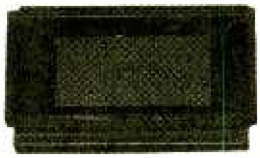
Digital Panel Meters (LCD & LED)



Don't let the prices fool you. These digital panel meters are not surplus, so even if you design them into an ongoing manufactured product, you can be assured of continued availability. These high quality digital panel meters are decimal point selectable with guaranteed zero reading at zero volts input.

Applications Include:

- Voltmeter
- Thermometer
- pH Meter
- dB Meter
- Watt Meter
- Current Meter
- Capacitance Meter
- LUX Meter
- LCR Meter
- Other Industrial & Domestic Uses

PM-128: 3-1/2D LCD Digital Panel Meter

PM-129: 3-1/2D LED Digital Panel Meter

Features

- 200mV Full Scale Input Sensitivity
- PM-128 - Single 9VDC Operation
- PM-129 - Single 9VDC Operation
- Decimal Point Selectable
- PM-128 - 13mm Figure Height
- Automatic Polarity Indication
- Guaranteed Zero Reading for 0 Volt Input
- High Input Impedance (>100Mohm)

Specifications - PM-128/PM-129

Maximum Input	: 199.9mV DC
Maximum Display	: 1999 counts (3-1/2 Digits) w/Automatic Polarity Indication
Indication Method	: PM-128 - LCD Display PM-129 - LED Display
Measuring Method	: Dual-Slope Integration A/D Converter System
Overrange Indication	: "1" Shown in the Display
Reading Rate Time	: 2-3 Readings per sec.
Input Impedance	: >100 Mohm
Accuracy	: +-0.5% (23+-5°C, <80% RH)
Power Dissipation	: PM-128 - 1mA DC PM-129 - 60mA DC
Decimal Point	: Selectable w/Wire Jumper
Supply Voltage	: PM-128 - 9V DC PM-129 - 9V DC
Size	: 67mm x 44mm

3-1/2 Digit LCD 3-1/2 Digit LED 4-1/2 Digit LCD

PM-328: 4-1/2D LCD Digital Panel Meter

Features

- 200.00mV Full Scale Input Sensitivity
- Single 9V DC Operation
- Decimal Point Selectable
- 11mm LCD Figure Height
- Automatic Polarity Indication
- Low Battery Detection and Indication
- High Input Impedance (>100 Mohm)

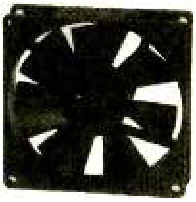
Specifications - PM-328

Maximum Input	: 199.99mV DC
Maximum Display	: 19999 counts (4-1/2 Digits) w/Automatic Polarity Indication
Indication Method	: LCD Display
Overrange Indication	: "1" Shown in the Display
Input Impedance	: >100 Mohm
Accuracy	: +-0.05% (23+-5°C, <80% RH)
Power Dissipation	: 1mA DC
Decimal Point	: Selectable w/Wire Jumper
Supply Voltage	: 9V DC
Size	: 67mm x 44mm

AS LOW AS $5.25 ea.

CAT NO	DESCRIPTION	PRICE EACH 1	10	25	100	250
PM-128	3-1/2 Digit LCD Panel Meter	$ 9.90	$ 7.09	$ 6.40	$ 5.86	$ 5.25
PM-129	3-1/2 Digit LED Panel Meter	11.49	9.54	8.67	7.95	6.95
PM-328	4-1/2 Digit LCD Panel Meter	19.88	16.40	14.90	13.66	11.93

Ball Bearing 12V DC Fans



These High Quality Fans feature Ball Bearings and Brushless DC Motors. All of them are designed to meet UL, CSA & VDE Standards. Design these fans into power supplies, computers or other equipment requiring additional air flows for heat removal. These fans are regular Circuit Specialists stock items — they are not surplus.

INDUSTRY BEST PRICING!

CAT NO	PRICE EACH 1	10	25	100
CSD 4010-12	$ 9.88	$ 6.38	$5.48	$4.87
CSD 6025-12	9.38	5.91	5.41	4.71
CSD 8025-12	8.88	5.85	5.19	4.49
CSD 9225-12	8.95	6.14	5.29	4.59
CSD 1225-12	11.45	8.96	7.82	6.85

Specifications

CAT NO	DIMENSIONS (MM)	RATED VOLTAGE (V)	START VOLTAGE (V)	INPUT CURRENT (A)	AIR FLOW (CFM)	STATIC PRESSURE (INCH-H_2O)	SPEED (RPM)	NOISE LEVEL (dB)	WEIGHT (g)
CSD 4010-12	40x40x10mm	12	7	0.06	5.1	0.19	5,500	26	20
CSD 6025-12	60x60x25mm	12	5	0.13	13.7	0.165	4,500	28	65
CSD 8025-12	80x80x25mm	12	5	0.16	37.8	0.177	3,000	31	80
CSD 9225-12	92x92x25mm	12	5	0.32	42	0.18	2,800	37	95
CSD 1225-12	120x120x25mm	12	5	0.35	62	0.180	2,500	42	135

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We stock high quality 60/40(Sn%/Pb%), .031" and 63/37, .031" diameter. This is prime JIS certified solder that we maintain as a regular stock item (It is not "Left-overs, Rejects or Surplus") and you can buy it from us at a fraction of the price that you are used to.

Tired of Paying Inflated Prices for Solder?

CAT NO	DESCRIPTION	PRICE EACH 1	10	25
RH60-1	1-lb. Spool, .031", 60/40	$ 6.90	$ 5.96	$ 5.30
RH63-1	1-lb. Spool, .031", 63/37	6.95	6.10	5.41
RH60-4	4.4-lb. Spool, .031", 60/40	24.00	21.90	17.92
RH60-TUBE	6-oz. Tube, .031", 60/40	.99	.89	.79

CCD Camera - IR Responsive

As Low As $85!!

This black and white monochrome CCD Camera is totally contained on a PCB (70mm x 46mm). The lens is the tallest component on the board (27mm high from the back of the PCB) and it works with light as low as 0.1 lux. It is IR Responsive for use in total darkness. It comes with six IR LED's on board. It connects to any standard monitor, AUX or video input on a VCR or through a video modulator to a TV. Works with a REGULATED 12V power supply (11V-13V). Hooks up by connecting three wires: red to 12V, black to ground (power & video) and brown to video signal output.

Power Supply Regulating Kit for CA-H34 This simple kit is designed to fit onto the back of the CA-H34 CCD camera. It resolves the problem of hooking up the camera to an UNREGULATED supply (which damages the camera) by providing safe regulated power from any 12V-14V DC supply. It also provides regulated 12V DC from a 12V AC source.

CAT NO	DESCRIPTION	PRICE EACH 1	5
CA-H34A	PCB Mounted IRCCD Camera	$99.00	$85.00
A34	Power Supply Regulating Kit	$6.95	-----

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STR-30130	SANKEN	1	2.66
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Specifications: Vertical deflection: • Bandwidth: DC coupled (DC to 20MHz normal), AC coupled: (10Hz to 20MHz normal) • Deflection factor: 5mV/div to 5V/div in 10 calibrated steps of 1-2-5 sequence • Rise time: 17.5ns or less

Horizontal deflection: • Time Base A: 0.2µs to 0.2S/div in 19 calibrated steps. 1-2-5 sequence • Uncalibrated continuous control between steps of at least 1: 2.5.

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Manuf # OS-9020G
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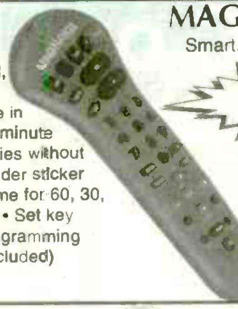

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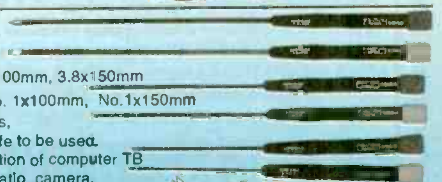

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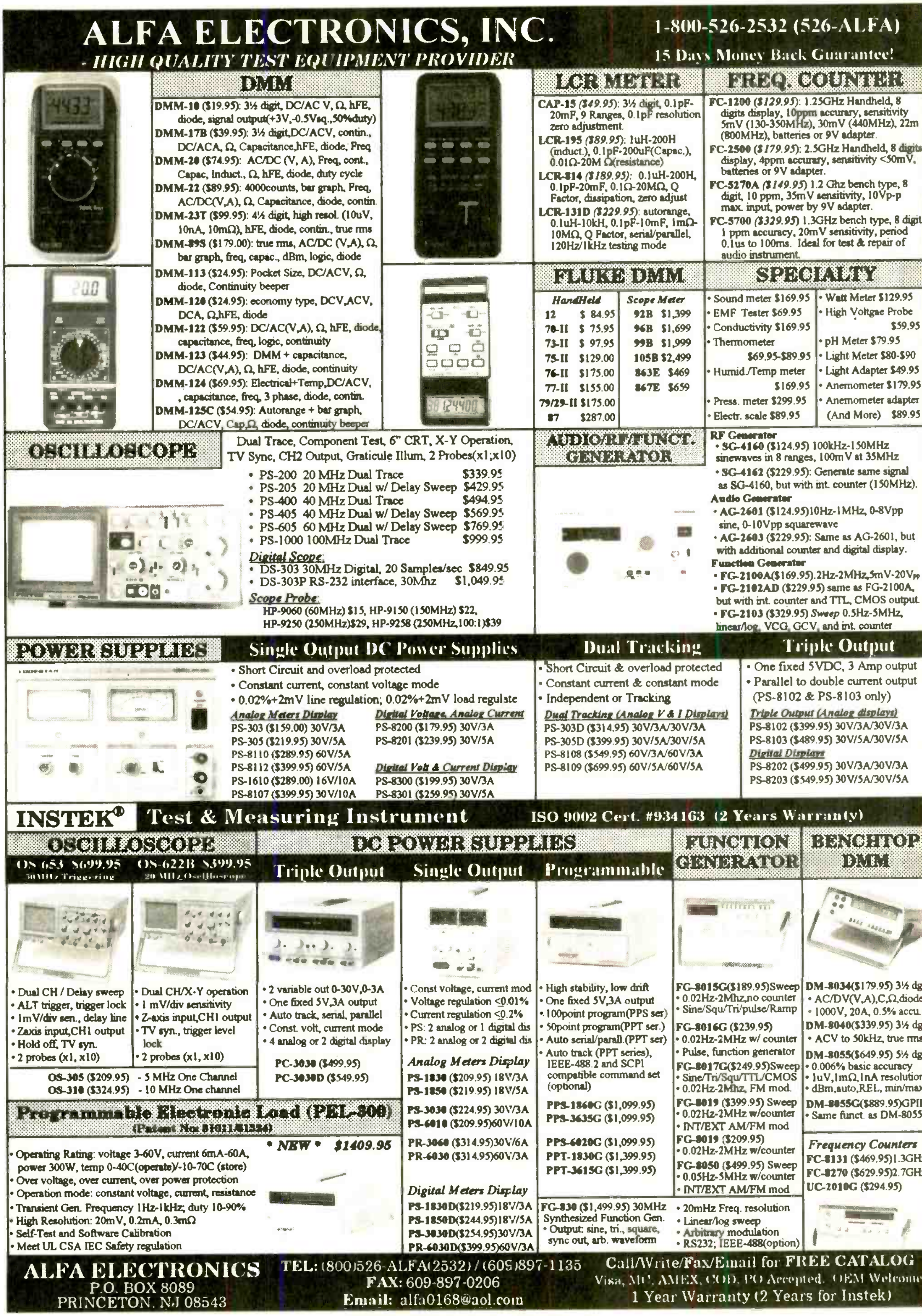

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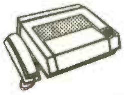

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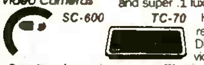

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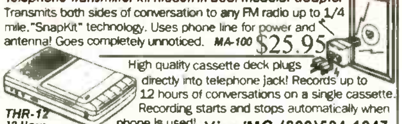

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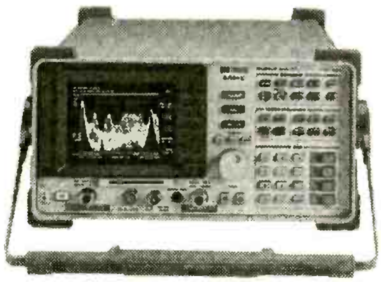

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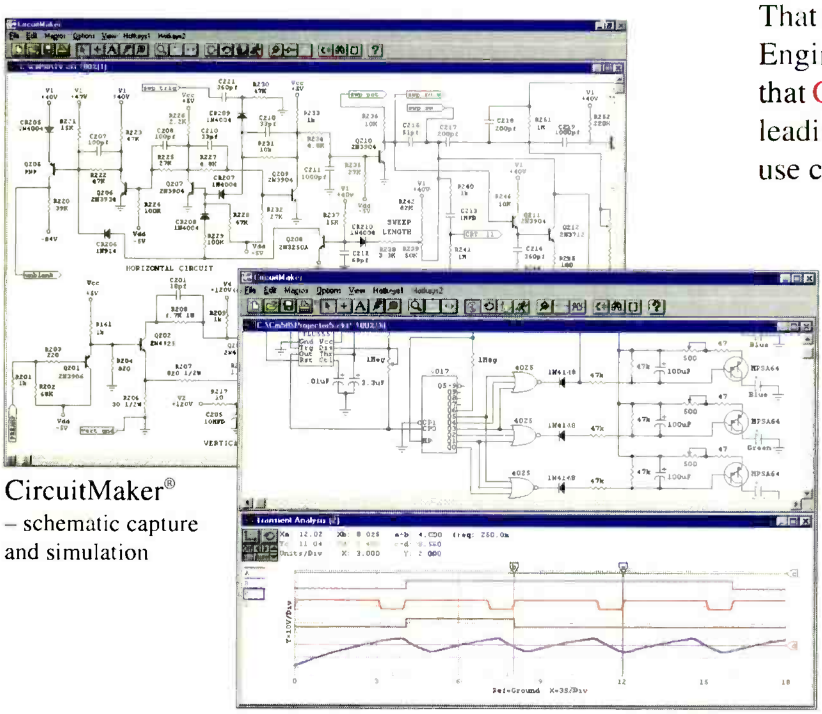

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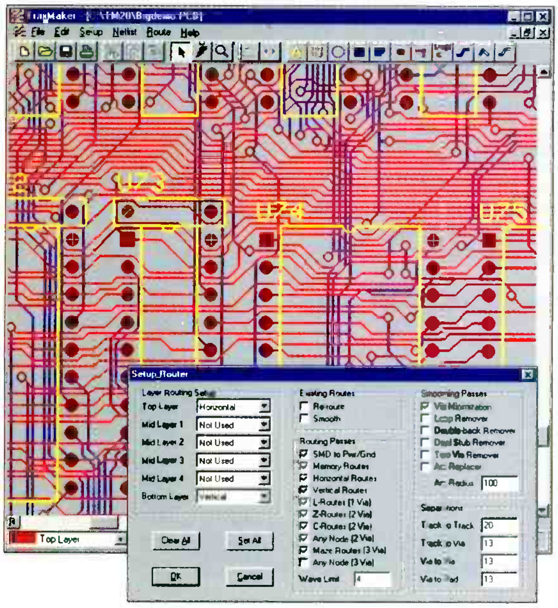

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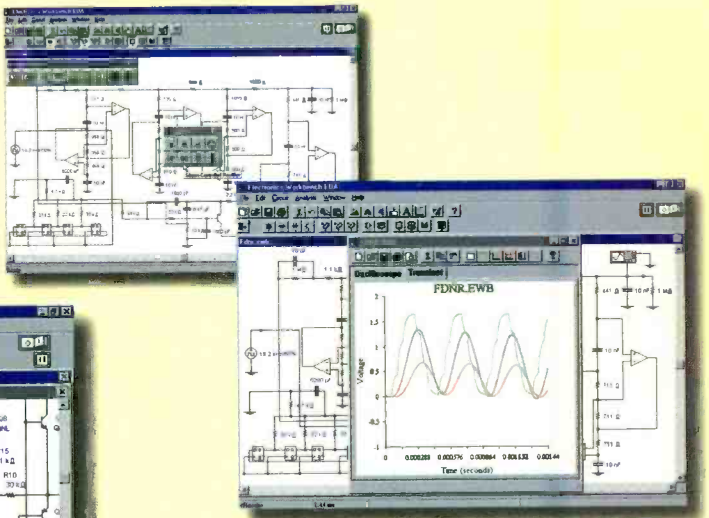

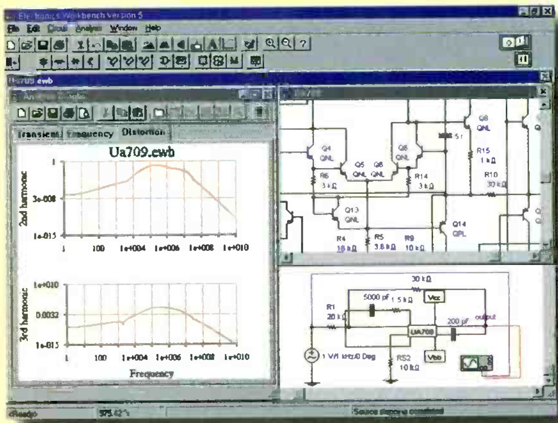

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