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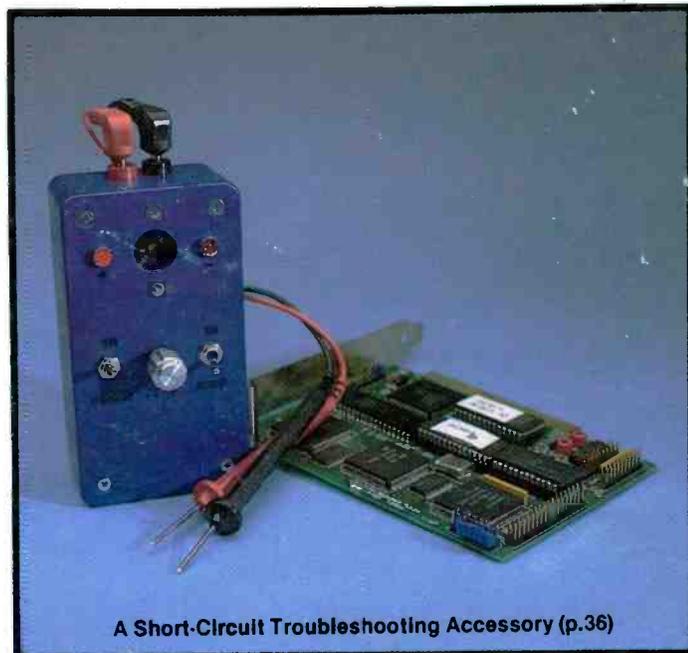
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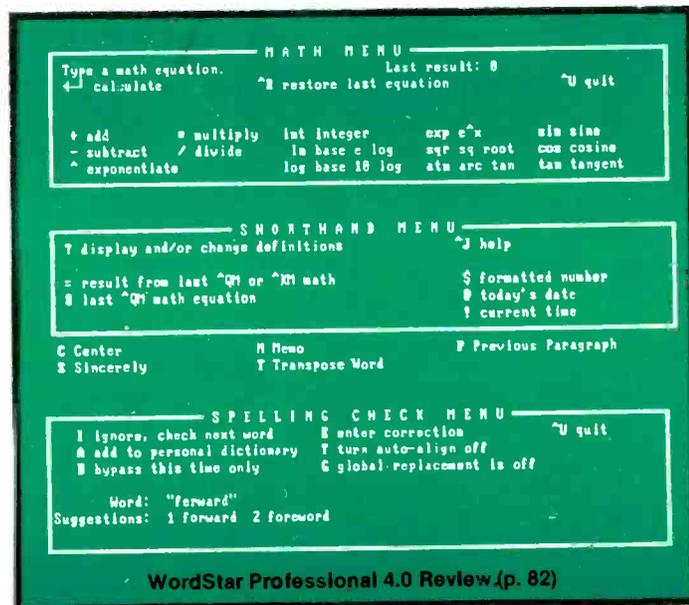


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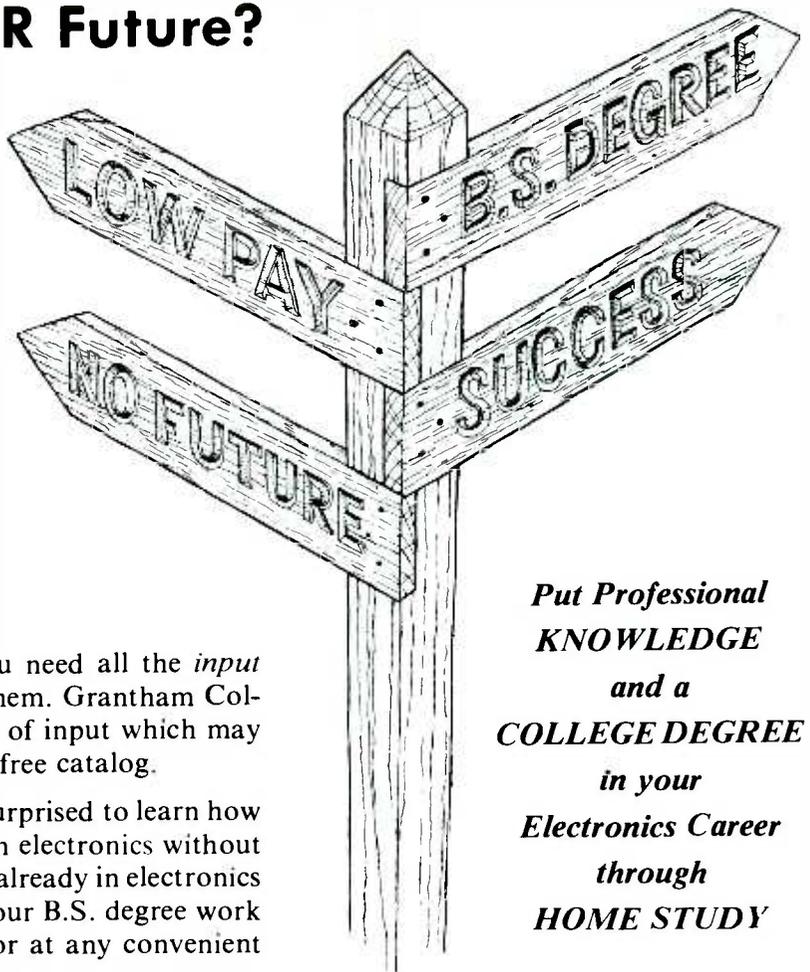
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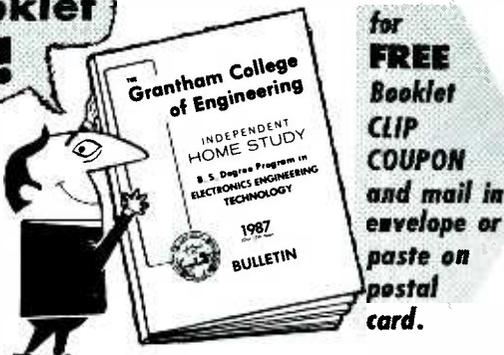
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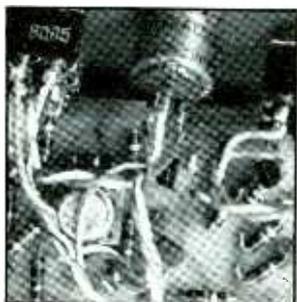
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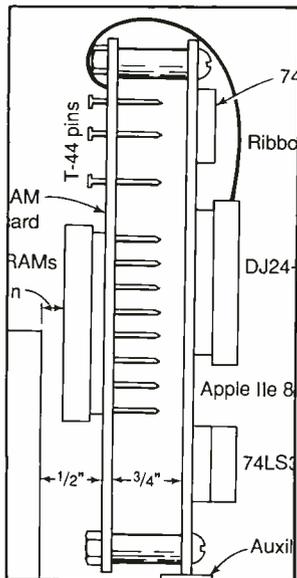
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# EDITORIAL

## Taking The Slow Road

In our fast-moving technological society, new developments are not always quickly applied. There's often good reason for this, though sometimes it's despairing.

As an example, higher education in the technical fields has always been far behind the real world. This was underscored in a recent Prentice-Hall electronics text's preface, where the co-author, James Cox, notes that after spending weeks teaching community-college students about audio-amplifier discrete circuits, a student told him that he plans to build the final 5-watt audio amplifier circuit. The author recounts that he unthinkingly responded that it would be insane to build it when integrated circuits are available to us today. Observing the bewildered look on the student's face, he realized how ridiculous it is to spend valuable class time on obsolete circuits.

Regrettably, it takes a lot of time to develop and introduce a new curriculum. In electronics and computers, where technology moves so swiftly, there will therefore always be an enormous time lag between what's taught and what's used in the real world, though the gap could be closed somewhat.

Industry itself frequently moves ahead very slowly many times because they don't want to upset deeply rooted technology that so much equipment is based on. A case in point is the archaic RS-232C, the third revision of our serial communications interface standard. RS-422, a newer standard, is faster and can operate over a much greater distance. But all the modems out there are designed for RS-232C, so there it remains for now.

In another instance, we have the ever-popular 5-volt supply for transistor-transistor-logic (TTL) devices that has been a standard for a decade, with other devices designed to work with this operating voltage too. Previously, 15 volts was the standard, commonly used with MOS devices. Now, however, even the lower 5 volts threatens the reliability of some modern ICs due to its heating and electric

field effects on more tightly packed circuit elements.

A new operating voltage standard is in the making to overcome this problem: 3.3 volts. This is about as low as one can get TTL devices to operate dependably. But since there are so many devices now dependent on 5 volts that don't work well with lower voltages, such as MOS devices, it's likely that 3.3-volt supplies will move ahead slowly and will work side by side with 5-volt supplies for years to come. But down the road will be the need for 2.0-volt supplies as chip elements become denser and denser.

How soon will other new technology take root when a large, established base of products and accompanying media is there? We'll find out soon enough when Super VHS systems hit our shores by the end of the year. With new videocassette machines and new video tape that promises up to 430 lines of horizontal resolution, which exceeds broadcast TV's 330 lines, what will its effect be on the current crop of machines? (This means, however, that slower-speeds that use up less tape will produce maximum resolution on ordinary TV sets.) Plans are afoot for these video recorders to have a switch that enables them to record the present format, though with the super-density video tape. You can bet that the buying transition to the higher-quality format won't be heavy at first, but as prices drop (estimates are that they'll be about 25% higher than the high-end machines now sold), at some point the run toward the new system could start.

Taking the slow road isn't all that bad in most instances. One can't just dump the old and move to the new without some delay as momentum, if it happens at all, builds up.

## Part Source

• “Upgrading a Radio Shack ‘Bare Bones’ Color Computer” in the September 1986 issue was very good. I’ve done all the upgrades mentioned in the article except for installation of the retrofit video monitor adapter. The author used a Universal Video Plus but failed to give an address for the company. Could you please help me?

Michael Rowley  
Sunland, CA

Interested readers can contact ComputerWare, Box 668, Encinitas, CA 92024 and request its latest catalog, which lists several different adapters from which to choose.—Ed.

## Project Modifications

• Eager to build the “Stand-Alone EPROM Programmer” that appeared in the February and March 1987 issues of *Modern Electronics*, I decided to purchase the boards from the supplier given in the Parts List. These are professional-

quality boards, with plated-through holes. The problem is that the recommended 3M ZIF sockets won’t fit. Is there a remedy?

I noted also that the part number given for the hex thumbwheel switches (S1 and S2) appears to be incorrect. It is actually the number for a *decimal* thumbswitch.

R. Frederickson  
Denver, CO

*We’ve been informed by the board supplier that the problem is the result of solder plating that slightly fills the holes in the board. To remedy it, simply push the tip of a scribing tool or awl into each hole from both sides of the board to “open” them slightly. Work gently but firmly. The slightly enlarged holes will still give a tight fit, but if you push forcefully but carefully, you will be able to seat the sockets. Incidentally, you are advised to use only the 3M ZIF sockets recommended in the Parts List.*

*You’re correct about the numbering for the thumbwheel switches. The correct Unimax number is SF-54 for the normal-*

*ly open BCD switch required. The end-plate number is SR-EP.—Ed.*

• In the Fig. 2 schematic of the “Inexpensive Wireless Headphones” (Feb. 1987) no polarity marking is given for C7 and C8, though the Parts List calls for electrolytic capacitors? Is this an error? If not, where can I buy the electrolytic capacitors called for in the Parts List?

S. Szewc  
Bronx, NY

*The Parts List is in error; C7 and C8 are ordinary disc capacitors—not electrolytics.—Ed.*

• Please note that C2 in Fig. 4 of my “Audio/Video Distribution Amplifier” (*Modern Electronics*, March 1987) is shown connected backwards.

Jack Cunkelman

• In my article “Introduction to Thyristors” (April 1987), please transpose the on-state and off-state labels for Fig. 1, Fig. 2, and Fig. 4.

Dan Becker

## Copy Worldwide Short-wave Radio Signals on Your Computer

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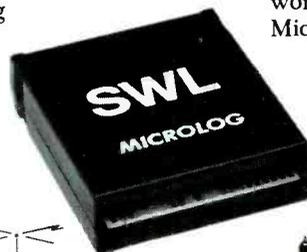
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**CD VIDEO SYSTEM.** Philips introduced the first Compact Disc Video system, which plays 5" CD Video "singles," 5" audio compact discs, and 8" and 12" video discs. It'll be marketed under the Magnavox brand in the fall of '87. The 5" single will hold five minutes of combined digital audio and analog video material, and 20 minutes of digital audio that can be played on any CD player. Magnavox's "combi" player is expected to be priced like mid- to high-end CD players, while CD-V discs will sell for about \$10. The player has a motorized disc-loading tray with recesses for the three disc sizes.

**ELECTRONIC POOL OR SPA WATER TESTER.** A water quality analyzer called "Aquasense" (805-569-1731) provides instant tests of a pool's or spa's water chlorine and pH on its battery-powered display. Sensors mounted in the recirculation line relay water condition automatically to the display unit, while corrective results from adding chemicals can be viewed. Retail price is \$350.

**MARANTZ IS BACK.** Audio pioneer Saul Marantz, who was a leader in high-end audio electronics many years ago, has joined with electronics designer John Curl to form a new stereo components company, the Lineage Corporation. Its first series of components include an amplifier, preamplifier, CD player and a receiver, each of which will retail for less than \$2,000 per component. The line, which is called investment-grade audio components, is still obviously high-end.

**OPEN MAC HARDWARE.** With the new Apple Macintosh computers being internally expandable, Vector Electronic Co. quickly jumped on the new opportunity and announced a series of eight hardware products, which include five prototyping boards and three extender boards. The boards are said to use high-speed, high-density packaging technology, ranging in price from \$64.50 to \$300.

**TRAINING PACKAGES.** Audio cassettes and video cassettes have become entrenched for home study purposes. Now, Motorola Semiconductor has developed a self-paced audio cassette course to train design engineers or programmers. Its MTTA1 course covers the company's MC68000 microprocessor, while the MTTA2, which contains three tapes (4½-hours long), shows how to use the enhanced MC68020. Both are said to highlight the same technical information as formal instructor-led courses. For more information, call 1-800-521-6274....On the video end, Micro-Video Learning Systems, has transformed "Running MS-DOS," a Microsoft Press book, into a video-based training package. The two-hour video, that includes a workbook and data diskette, is priced at \$495 in VHS or Beta format. (Call 1-800-231-4021.)

**CUSTOM LASER PRINTER FONTS.** GNU Business Information Systems, Ramsey, NJ, offers a selection of 200 fonts for LaserJet, LaserJet Plus and LaserJet Series II printers, which have been limited to the standard set of 26 cartridges from Hewlett-Packard. The cartridges are priced from \$199 for ones loaded with up to four standard fonts, with additional fonts loaded at \$45 per.

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The new Fox scanner frequency directories will help you find all the action your scanner can listen to. These new listings include police, fire, ambulances & rescue squads, local government, private police agencies, hospitals, emergency medical channels, news media, forestry radio service, railroads, weather stations, radio common carriers, AT&T mobile telephone, utility companies, general mobile radio service, marine radio service, taxi cab companies, tow truck companies, trucking companies, business repeaters, business radio (simplex) federal government, funeral directors, veterinarians, buses, aircraft, space satellites, amateur radio, broadcasters and more. Fox frequency listings feature call letter cross reference as well as alphabetical listing by licensee name, police codes and signals. These Fox directories are \$14.95 each plus \$3.00 shipping. State of Alaska-RL019-1; State of Arizona-RL025-1; Buffalo, NY/ Erie, PA-RL009-2; Chicago, IL-RL014-1; Cincinnati/ Dayton, OH-RL006-2; Cleveland, OH-RL017-1; Columbus, OH-RL003-2; Dallas/Ft. Worth, TX-RL013-1; Denver/Colorado Springs, CO-RL027-1; Detroit, MI/ Windsor, ON-RL008-2; Fort Wayne, IN/Lima, OH-RL001-1; Hawaii/Guam-RL015-1; Indianapolis, IN-RL022-1; Kansas City, MO/ KS-RL011-2; Long Island, NY-RL026-1; Louisville/Lexington, KY-RL007-1; Milwaukee, WI/Waukegan, IL-RL021-1; Minneapolis/St. Paul, MN-RL010-2; Nevada/E. Central CA-RL028-1; Oklahoma City/ Lawton, OK-RL005-2; Orlando/Daytona Beach, FL-RL012-1; Rochester/Syracuse, NY-RL020-1; San Diego, CA-RL018-1; Tampa/St. Petersburg, FL-RL004-2; Toledo, OH-RL002-3. Regional directories which cover police, fire ambulance & rescue squads, local government, forestry, marine radio, mobile phone, aircraft and NOAA weather are available for \$19.95 each. RD001-1 covers AL, AR, FL, GA, LA, MS, NC, PR, SC, TN & VI. RD002-1 covers IL, IN, KY, MI, OH & WI. For an area not shown above call Fox at 800-543-7892 or in Ohio 800-621-2513.

## Regency® HX1500-MA

List price \$369.95/CE price \$218.95  
**11-Band, 55 Channel • Handheld/Portable**  
**Search • Lockout • Priority • Bank Select**  
**Sidelit liquid crystal display • EAROM Memory**  
**Direct Channel Access Feature • Scan delay**  
Bands: 29-54, 118-136, 144-174, 406-420, 440-512 MHz.  
The new handheld Regency HX1500 scanner is fully keyboard programmable for the ultimate in versatility. You can scan up to 55 channels at the same time including the AM aircraft band. The LCD display is even sidelit for night use. Includes belt clip, flexible antenna and earphone. Operates on 8 1.2 Volt rechargeable Ni-cad batteries (not included). Be sure to order batteries and battery charger from the accessory list in this ad.

## Bearcat® 100XL-MA

List price \$349.95/CE price \$178.95/SPECIAL  
**9-Band, 18 Channel • Priority • Scan Delay**  
**Search • Limit • Hold • Lockout • AC/DC**  
Frequency range: 30-50, 118-174, 406-512 MHz.  
Included in our low CE price is a sturdy carrying case, earphone, battery charger/AC adapter, six AA ni-cad batteries and flexible antenna. Order your scanner now.

### \*\*\* SPECIAL SAVINGS COUPON \*\*\*

#### \*\*\* FREE DURACELL® Batteries Included \*\*\*

#### \*\*\* Free local frequency directories \*\*\*

Save even more with this special coupon. As long as your order is prepaid by money order, you'll get extra special pricing on items listed in this coupon. In addition, if you order a Bearcat 50XL or Regency HX1500 scanner with this coupon, you'll get a free set of Duracell batteries which we recommend for best performance. If you buy a Regency Z60 or Z45 scanner using this coupon, you'll get a free Fox frequency directory worth \$14.95. This coupon must be included with your prepaid order. Credit cards and quantity discounts are excluded from this offer. Offer valid only on prepaid orders mailed directly to Communications Electronics Inc., P.O. Box 1045 - Dept. M3, Ann Arbor, Michigan 48106-1045 U.S.A. Coupon expires July 31, 1987. Coupon may not be used in conjunction with any other offer from Communications Electronics Inc. Be sure to add shipping & handling fees listed in this ad (add \$3.00 for shipping free books or batteries).

RH250B-M3 Regency 25 W. VHF Transceiver	\$299.95
RH600B-M3 Regency 60 W. VHF Transceiver	\$388.95
RU150B-M3 Regency 15 W. UHF Transceiver	\$399.95
UC102-M3 Regency 1 W. VHF 2 channel trans.	\$119.95
HX1500-M3 Regency 55 channel scanner	\$217.95
Z60-M3 Regency 60 channel scanner	\$158.95
Z45-M3 Regency 45 channel scanner	\$148.95
BC100XL-M3 Bearcat 16 channel scanner	\$177.95
BC800XL-M3 Bearcat 40 channel scanner	\$278.95
INF1-M3 Regency Informant scanner	\$249.95
BC210XW-M3 Bearcat 20 channel scanner	\$168.95
BC50XL-M3 Bearcat 10 channel scanner	\$113.95
RD55-M3 Uniden Radar Detector	\$97.95

### \*\*\* SPECIAL SAVINGS COUPON \*\*\*

## Bearcat® 800XLT-MA

List price \$499.95/CE price \$289.95/SPECIAL  
**12-Band, 40 Channel • No-crystal scanner**  
**Priority control • Search/Scan • AC/DC**  
Bands: 29-54, 118-174, 406-512, 806-912 MHz.  
The Uniden 800XLT receives 40 channels in two banks. Scans 15 channels per second. Size 9 1/4" x 4 1/2" x 1 1/2".

### OTHER RADIOS AND ACCESSORIES

Panasonic RF-2600-MA Shortwave receiver	\$179.95
RD55-MA Uniden Visor mount Radar Detector	\$98.95
NEW! BC70XL-MA Bearcat 20 channel scanner	\$169.95
BC 145XL-MA Bearcat 16 channel scanner	\$98.95
BC 140-MA Bearcat 10 channel scanner	\$89.95
BC 210XW-MA Bearcat 20 channel scanner	\$169.95
BC-WA-MA Bearcat Weather Alert™	\$38.95
PC22-MA Uniden remote mount CB transceiver	\$99.95
PC55-MA Uniden mobile mount CB transceiver	\$59.95
NEW! R1080-MA Regency 30 channel scanner	\$118.95
NEW! R1090-MA Regency 45 channel scanner	\$148.95
NEW! IN1-MA Regency Informant scanner	\$289.95
UC102-MA Regency VHF 2 ch. 1 Watt transceiver	\$124.95
P1405-MA Regency 5 amp regulated power supply	\$69.95
P1412-MA Regency 12 amp reg. power supply	\$164.95
MA549-MA Drop-in charger for HX1200 & HX1500	\$84.95
MA518-MA Wall charger for HX1500 scanner	\$14.95
MA553-MA Carrying case for HX1500 scanner	\$19.95
MA257-MA Cigarette lighter cord for HX12/1500	\$19.95
MA917-MA Ni-Cad battery pack for HX1000/1200	\$34.95
SMMX7000-MA Svc. man. for MX7000 & MX5000	\$19.95
B-4-MA 1.2 V AAA Ni-Cad batteries (set of four)	\$9.95
B-8-MA 1.2 V AA Ni-Cad batteries (set of eight)	\$17.95
FB-E-MA Frequency Directory for Eastern U.S.A.	\$14.95
FB-W-MA Frequency Directory for Western U.S.A.	\$14.95
ASD-MA Air Scan Directory	\$14.95
SRF-MA Survival Radio Frequency Directory	\$14.95
TSG-MA "Top Secret" Registry of U.S. Govt. Freq.	\$14.95
TIC-MA Techniques for Intercepting Comm.	\$14.95
RRF-MA Railroad frequency directory	\$14.95
EEC-MA Embassy & Espionage Communications	\$14.95
CIE-MA Covert Intelligent. Elect. Eavesdropping	\$14.95
A60-MA Magnet mount mobile scanner antenna	\$35.95
A70-MA Base station scanner antenna	\$35.95
USAMM-MA Magmount VHF/UHF ant. w/ 12 cable	\$39.95
USAK-MA 3/4" hole mount VHF/UHF ant. w/ 17' cable	\$35.95
USATLM-MA Trunk lip mount VHF/UHF antenna	\$35.95

Add \$3.00 shipping for all accessories ordered at the same time.  
Add \$12.00 shipping per shortwave receiver.  
Add \$7.00 shipping per scanner and \$3.00 per antenna.

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MODEL TS-2

MODEL HX 1500

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**NEW**

**Only NRI gives you a 27" high-resolution stereo color TV you build to prepare you for today's video servicing careers.**



**Become one of America's most sought-after technicians . . . put your talents and spare time to work for you in the "explosive-growth" world of home entertainment electronics.**

Train in state-of-the-art video/audio servicing and become a fully qualified service professional the uniquely successful NRI way. It's hands-on training, at home . . . designed around the latest electronic equipment you build and keep as part of your training. You start from scratch and "discover by doing." You conduct key experiments . . . perform vital tests . . . build your own systems . . . and do it all at the pace that suits you best.

There's no stopping the incredible boom in consumer electronics. Soaring sales, new and improved video products, entirely new technologies have opened up new opportunities for the trained technician as never before.

Now at \$26 billion in annual sales, the consumer electronics industry is creating a whole new servicing, installation, and repair market. This year, TV sales alone are expected to hit 16.2 million units. Every day, sales of home



VCRs, a product barely conceived of 10 years ago, reach 20,000 units. Every day!

And the revolution has spread to the business sector as tens of thousands of companies are purchasing expensive high-tech video equipment used for employee training, data storage, even video conferencing.

## The Video Revolution Is Just Starting

Already, disc players can handle audio CDs and laser video discs. And now there are machines that will accommodate laser computer disks as well. Camcorders are becoming smaller, lighter, and more versatile . . . 8 mm video equipment produces high-resolution pictures and digital audio. By 1990 our TVs will become interactive computer terminals, giving us entertainment, information, and communications in one sophisticated video/computer/audio system.

## Join the Future or Be Left Behind

Can you see the opportunity? The servicing and repair market that's there already . . . and the enormous future need created by the millions upon millions of electronic devices yet to come? If you're looking for a high-potential career . . . if you'd like to start in a field that's still open for the independent technician . . . even if you'd like to find a way to make extra money while you work, look into NRI at-home training.

## Start Right and Be No Stopping You!

Working in video/audio servicing is the perfect way for you to get into the new explosive consumer electronics market at home in your spare time at your own pace. No classrooms, no night school

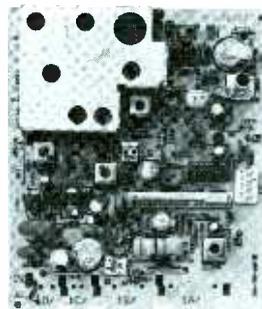
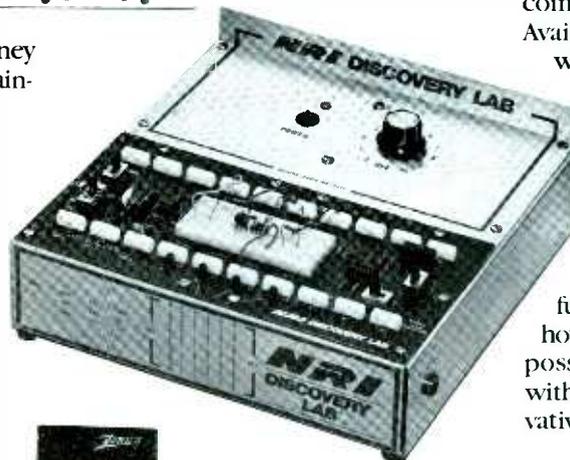
because you've never had electronics training, NRI prepares you with a thorough grounding in fundamentals . . . a foundation you build on to achieve advanced electronics skills. With a firm understanding and hands-on experience built into your exclusive training method, you can take your own way to take advantage of the new opportunities opening up every day.

## Totally Integrated Hands-On Training

Your training is built around "learning by doing," right from the start. It includes important experiments and projects with your professional digester. You assemble the Heath/Zenith NRI Discovery Lab and perform a complete range of demonstration experiments in the process.

## Hands-On Training As You Build a 27" Stereo TV

In just hours you assemble an exceptional state-of-the-art TV receiver using easy to follow, step-by-step instructions. During this assembly process, you learn to identify and work with components and circuits used in actual commercial circuitry. Then through tests, adjustments, and experiments you quickly master professional troubleshooting and bench techniques.



NRI's commitment to you goes beyond providing you with equipment appropriate to the latest technology. Of equal importance is our dedication to training techniques that let you master TV, video and audio troubleshooting and repair quickly and easily. Best of all, we ensure that in the learning process you acquire the very skills that will make you a professional service technician on the job.

NRI has purposely designed your training around equipment that has the same high-tech circuitry you'll encounter in commercial equipment. That means your training is real-world training. And *that's* unique.

## Inside Your TV

This new state-of-the-art Heath/Zenith 27" TV included with your training has all the features that allow you to set up *today* your complete home video center of the future. Flat screen, square corners, and a black matrix to produce dark, rich colors. Cable-compatible tuning, built-in stereo decoder to give you superb reproduction of stereo TV broadcasts . . . even a powerful remote control center that gives you total command of video and audio operating modes.

## Your NRI Training Has Another Special Element

Also built into your training is the enormous experience of NRI development specialists and instructors. Their long-proven training skills and enthusiasm come to you on a one-to-one basis.

Available for consultation and help whenever you need it, your instructors ensure your success both during your course and after graduation.

## Step Into the Future Today

The richest reward you gain from your NRI video/audio training is a firm grip on the future. Your knowledge and know-how provide you with the soundest possible foundation for keeping up with the rapidly evolving, highly innovative video industry.

## Send For Free Catalog

Now is the time to act. Send the post-paid card to us today. You'll receive our 100-page catalog free. It's filled with all the facts you'll want to know about our training methods with full details on the equipment you'll use and keep as part of your hands-on training. You'll see how our more than 70 years of experience in uniquely successful at-home career training makes us the leading technical school today. (If someone has already used the card, write to us at the address below.)

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Washington, DC 20016



For more information on products described, please circle the appropriate number on the Free Information Card bound into this issue or write to the manufacturer.

## Personal Weather Station

A "personal" weather station that is claimed to be as accurate and to offer as many features as those found in industrial systems costing ten times as much, has been announced by Technology Marketing Inc. (Lake Oswego, OR). The "PC Weather" system turns an IBM PC, XT, AT or compatible computer into a sophisticated weather monitoring and analysis system. It comes with its own anemometer and wind-vane assembly,

two temperature probes, a half-slot card and display software.

Functions include wind speed and direction, barometric pressure, inside and outside temperature and wind-chill factor. The supplied software is menu-driven. It is background resident and can be accessed from the computer's keyboard, even from within a spreadsheet or word processor. An on-board alarm alerts you when certain user-defined weather conditions are met. Because PC Weather is externally powered by an ac adapter, it continues to monitor weather conditions and sounds the alarm even when the host computer is turned off.

An optional rain gauge is available. \$349.95; \$69.95 per option.

CIRCLE NO. 108 ON FREE INFORMATION CARD



## High-Power Battery Belt

A new battery belt from Multi Video Productions (Baldwin, NY) is claimed to have the highest capacity and to be the only such product on the market that has a digital display that gives the user a running account of power used. It can be used with all portable equipment that requires a 12-volt dc source of power. The 15-lb. belt is worn around the waist. It has a 16.6-ampere-hour capacity at a 2-hour rate and is rated to deliver a full 2 hours of running time with a 100-watt lamp load.

Features include: a built-in low-battery warning that tells the user when the belt is near the end of its



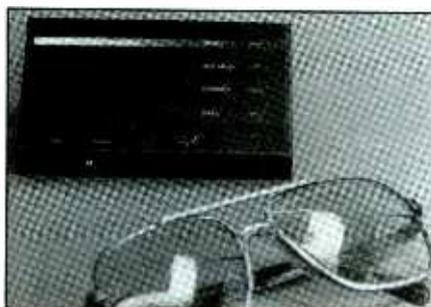
useful charge; a series of sealed lead-acid gel cells; short-circuit and polarity protection; and a weather-resistant housing. It is designed to connect to virtually any 12-volt dc-powered equipment with available custom cables.

CIRCLE NO. 109 ON FREE INFORMATION CARD

## Mini 1200-Baud Modem

Though it is only about the size of an audio cassette (4¼" × 2¾" × 5/8") and weighs just 3 ounces, Novation's new Parrot 1200™ Hayes-compatible mini modem offers 300/1200-baud telecommunications. Featuring a microprocessor-controlled management system, the new modem uses only the power available from the host computer's RS-232 serial port. Neither batteries nor an external ac power supply is needed.

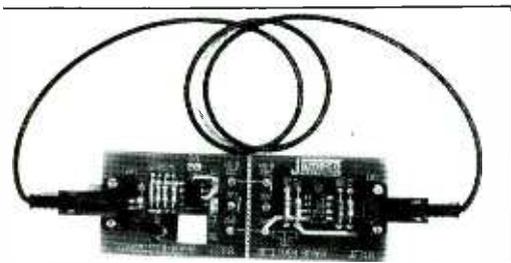
Drawing power only when required, Parrot 1200 remains on



stand-by until activity is detected. It then automatically and instantly switches on to whatever mode is needed. Features include: 0 to 300 and 1200 bits/second communication rate; asynchronous data format;

full duplex operation; built-in auto self-test, analog loop-back, local digital loop-back and remote loop-back testing; Touch Tone® and pulse dialing with automatic answer; dialtone, busy, ringback, MCI and Sprint tone detection; built-in speaker with volume control; and AT-standard (Hayes) command format. Options include an adapter, cable and software. Starter kits are available for IBM PCs and compatibles, Apple Macintosh and Commodore computers. \$119.

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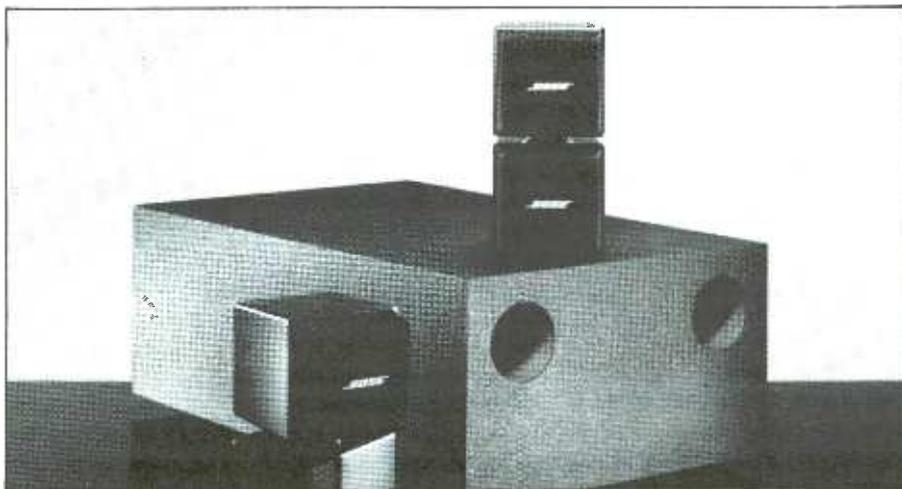
### ***Fiber-Optics Experimenter Kit***

New from Jameco is the Model JE310 Fiber-Optics kit, designed as an educational system to give students, hobbyists and engineers hands-on experience with fiber-optics technology. It features separate transmitter and receiver circuit boards with separate test-point checks of

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### ***New Speaker System Design***

Bose's new Model AM-5 Acoustimass Speaker System is a three-part loudspeaker system that can be hidden from view. Smaller than a quart



milk container and weighing about as much as a standard telephone, each two-cube speaker array handles mid and high frequencies. An Acoustimass module that is about the size of a typewriter (20" x 12" x 8") produces bass and can be positioned anywhere in a room.

Contained within each small cube is a 2½" wide-range driver. Left- and right-channel speakers each contain two such arrangements. Each cube pair swivels a full 360 degrees to pro-

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vide whatever balance of direct and reflected sound is right for the listener and room. The Acoustimass module contains two 6" low-frequency drivers that fire into two internal chambers. The front of each driver's cone sends sound into a ported chamber tuned to 90 Hz, while the rear of each driver cone fires into a second ported chamber tuned to 45 Hz. This new technology produces low-frequency energy by launching into the listening room the mass of air contained in each chamber's port, rather than directly from the cone itself. The result is less cone motion that reduces harmonic distortion in lower octaves. \$699.

signals on each, as well as a built-in oscillator for circuit testing. (The boards come as a single assembly that can be snapped apart without the need for a cutting tool.) Included in the kit are all components needed for assembling the transmitter and receiver sections, all necessary fiber-optic cables and connectors, and full assembly and operating instructions. Use of modulated light in circuits is growing rapidly due to the absence of RF and EM interference, elimination of crosstalk and less signal attenuation as compared to hard wiring. The kit requires only a separate 6-to-9-volt dc power source to operate. \$19.95.

### ***"Fast-Talking" Tape Recorder/Player***

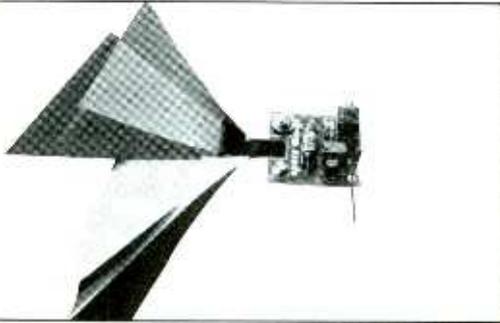
Fastrac™ is a new General Electric cassette tape recorder/player that features Variable Voice Control (VSC™) microcircuitry that enables playback of standard recordings at up to two times normal speed with minimal distortion of voice quality. Because both the speed and pitch of the tape can be controlled manually, as tape speed increases, pitch can be lowered to restore intelligible sound. Regular recordings can be made with the VSC switch set to off. Conven-



ience features include: Variable Voice Activation and a built-in microphone for hands-free operation; three-digit tape counter; a LED that indicates battery condition and record mode; protective carrying case; and three-way power capability. Fastrac can be powered by four AA cells (not included), an ac/dc adapter (included) or a vehicle electrical system via an optional car adapter. For economy, it is recharge-capable with an optional NiCd battery pack. \$109.95.

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## NEW PRODUCTS...



### Space-Age Robotics Kit

"Space Wings" from Mondo-tronics (Cupertino, CA) is claimed to be the world's first robotic kit that moves without motors. Resembling a large butterfly, Space Wings owes its locomotion to a shape-memory

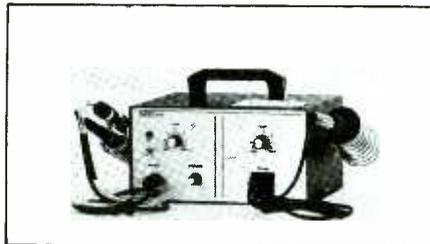
nickel-titanium alloy wire called Bio-Metal. When activated electrically, the BioMetal wire contracts by up to 5% of its length and with a pull of up to 10 ounces. When electrically heated, the BioMetal wire contracts and gently closes Space Wings' wings. When unpowered, the wire relaxes and opens the wings. Space Wings flap six times per minute and has a rated life of millions of cycles.

The Space Wings kit comes with BioMetal wire, all needed electronic components, wing material and full assembly instructions. The kit can be assembled in about an hour, even if the builder has no electronics experience. \$19.95.

CIRCLE NO. 114 ON FREE INFORMATION CARD

### Soldering/Desoldering Station

Sibex's Model S-2 combines temperature-controlled soldering and desoldering into one portable unit. This new tool incorporates a spike-free temperature-controlled desoldering tool and an internal vacuum pump similar to that used in the company's Model S-1TC station. In addition, it features a temperature-controlled outlet on the front panel into which a standard soldering pencil or iron can be plugged. The solid-state control system utilizes variable dc voltage for spike-free soldering. Everything from a miniature soldering pencil that draws very little power for deli-



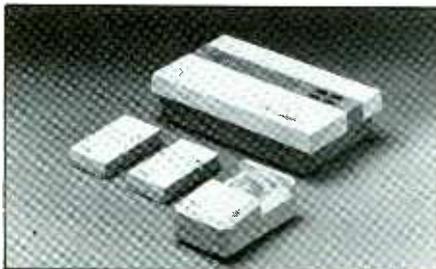
cate soldering to hefty 150-watt irons can be plugged into the station.

Featured with the Model S-2 are separate holders for the desoldering and soldering tools, a built-in tip cleaning pad, a cleaning tool and spare vacuum filters. A soldering pencil or iron is not included. \$289.95.

CIRCLE NO. 115 ON FREE INFORMATION CARD

### Home Security System

Heath Zenith has announced a new home security system the Model SS-5910, that installs in minutes and needs no wires to interconnect the sensors and control console. The sys-



tem can use an unlimited number of passive infrared sensors for wireless monitoring as well as contact sensors to monitor doors and windows. The IR sensors detect heat and motion. A total of eight different zones can be monitored. Control unit features include a tamper-proof alarm that sounds if an attempt is made to disable it; turn-off only with the included key-lock switch or remote controller; and a "panic" alarm mode that sounds the alarm immediately when triggered in an emergency or to signal the need for help.

CIRCLE NO. 116 ON FREE INFORMATION CARD

### Board-Based Logic Analyzers

BitWise Designs' (Troy, NY) modestly priced Logic 20/8 and Logic 10/8 high-performance board-based logic analyzers occupy one slot in an IBM PC or compatible computer. Used for digital prototyping and random logic design projects, they are capable of sampling at up to 10 or 20 MHz. Each comes with software that allows hardware applications to be built on the same computer that runs the logic analyzer. An external pod samples eight data points with less than 1 ns of channel-to-channel skew. An on-board comparator allows a trace to begin, end or be centered on any fully or partially specified 8-bit trigger word. Specific selected states can be collected. Minimum sampling period is 50 ns. Trace size is 8 bits by 256 words. Samples can be synchronous with an external clock for state analysis or asynchronous with an internal variable-speed clock for timing analysis. The external clock has a 5-ns minimum pulse width and a 2-ns setup time. The internal clock provides variable rates from 40 Hz to 20 MHz.



Included software contains built-in help functions and remains resident in the host computer's main memory without affecting other programs being run. It permits specification of trace type and labeling of data points and display of collected data in timing-diagram or state-table form. A key feature is its ability to interact with the computer's disk drives. \$695 20/8; \$495 10/8.

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# COMPUTER PARTS GALORE

## IBM COMPATIBLE WIRED CARDS



**HEXPACK \$79.95**  
A workalike copy of the famous AST sixpack with all its features: 384K, RAM, clock, Cal Serial. Parallel now only \$79.95

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A copy of the ever popular PERSYST card 100% IBM compatible, with RGB, + composite color & monochrome outputs.

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The Hercules clone with par printer.

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The MULTI I/O has all Disc control, clock, cal, game, serial, parallel Total I/O. \$84.95

**FARADAY DRIVE \$29.95**  
FARADAY, the card that runs 1-4 drives in internal daisy chain fashion.

**KRAM \$159.95**  
An exact clone of the famous JRAM card. We did our own software and schematics. Very good for RAM, disc, etc.

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DISKETTE, book & schematic.

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The std parallel printer card.

**GAME \$24.95**  
The std 2 port game I/O card.

**RS232 \$34.95**  
The dual port RS-232 card for COM-1 & 2 one of our best cards.

**CLOCK \$34.95**  
Clock/calendar card.

**RS232 + CLOCK \$44.95**  
A nice card with 2 RS232 ports and a clock/calendar on board.

**384K \$59.95**  
A close grid of 64K RAM to upgrade an older PC or early clone.

**576K \$64.95**  
A small card with 2 rows of 256K RAM and 1 row of 64K to upgrade 64K PCs.

**I/O + 2 \$64.95**  
The I/O + 2 is a very effective card for saving slots. Clock, cal, serial, parallel, game I/O in 1.

**1.2M/360K DRIVE CARD \$89.95**  
360K/1.2M XT/AT Dual drive card. A clever card for the XT or AT, it will run 1.2M or 360K drives, mated or two identical ones. Very good for up/down transfer of data from AT/XT archives, hard drive fast back-up etc. Really flies with the program called FASTBACK.

**EPROM PROGRAMMER**  
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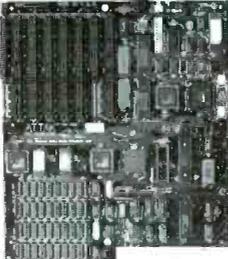
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# Battery Basics

*An inside look at different battery types and guidance on which ones are best for particular applications*

By Brent Gloege

Once used largely to power flashlights and toys, much of our state-of-the-art electronics now hinges on small-battery technology. In addition to old standbys, the regular zinc-carbon cell and heavy-duty zinc-chloride cell, there are alkaline, lithium, mercury, nickel-cadmium, and lead batteries.

There are also "button cells" used to power watches, hearing aids, calculators, and other tiny electronics. These are available not only in many of the above battery types, but also in two additional types, silver-oxide and zinc-air.

With all of these choices available, which battery do you choose for what application? Are rechargeables always best? Do alkalines really save you money over regular zinc-carbon cells? Let's take a look at the important properties of batteries and see which type of cell works best for each application.

## Battery Characteristics

The first distinction to be made between batteries is whether they are rechargeable or can be used only once—what is commonly referred to as secondary vs. primary cells. Except for nickel-cadmium and lead batteries, all of the batteries we will be discussing are primary batteries; they cannot be recharged. (Some batteries can be "refreshed," a very limited form of recharging, but refreshing is not practical unless done under carefully controlled conditions.) There are also some new re-



chargeables on the horizon, such as rechargeable lithium cells, which are not yet widely available on the consumer market.

It takes about a dozen parameters to characterize a battery. Let's go through each to see what they mean.

The first parameter, listed in Table I, is the battery's voltage. Voltage is determined by chemical reaction that takes place in the cell. Common zinc-carbon cells generate approximately 1.5 volts when new. Alkaline and mercury cells are about the same.

Table I. Battery Discharge Curves

	Carbon-zinc	Zinc-chloride	Alkaline	LITHIUM	
				MnO <sub>2</sub>	Solid
	1.5V	1.5V	1.5V	3V	2V
Discharge (V)					
	Most sloping	More sloping	Sloping	Flat	Flat
ENERGY DENSITY IN WATT-HOURS PER POUND/WATT-HOURS PER CUBIC INCH	20/2	40/3	45/4	100-150/ 6.5-10	50/6-8

Nickel-cadmiums (NiCds) are slightly lower, at 1.2 volts, and lead and lithium are somewhat higher, at 2 volts (3 volts for the MnO<sub>2</sub> lithium watch batteries).

Voltage stated on a battery is the "nominal voltage." The actual voltage depends on two factors. First, a battery is not a perfect voltage source since it has internal resistance. Thus, voltage varies with the amount of current being drawn. Second, internal resistance of a battery increases with age, causing voltage at the battery's terminals to drop as the battery is discharged.

The "Discharge Curve" graph shows how voltage of each type of battery varies through its life cycle. For instance, while zinc-carbon cells start out at a little over 1.5 volts, they steadily drop in voltage as they are being used. Nickel-cadmium batteries, on the other hand, start out a little lower, at about 1.2 volts, but stay pretty much at that voltage until they are almost completely discharged. Manufacturers of battery-operated equipment know that zinc-carbon cells fall even lower than 1.2 volts toward the middle of their life, and so usually design their equipment to be able to operate at that voltage. That is why NiCds can usually be used to directly replace zinc-

carbon cells; their voltage starts out low, but remains at that level during most of their discharge cycle.

The third parameter given in Table I is energy density. Technologically speaking, this is the most important parameter of a battery, though often some other factor, such as maximum current, shelf life, or cost, will be the overriding consideration in selecting a battery.

Batteries that have flat discharge curves have fairly easily determined energy densities because their voltage sharply falls at the ends of their lives. Batteries with sloping discharge curves have less special values for their energy densities because their voltage gradually falls off; the lower a voltage your device can tolerate, the greater the amount of energy you can get from the battery.

Energy density can be given in both energy (in watt-hours) per weight (in pounds) and per volume (in cubic inches). When building a battery-powered device from scratch, a designer is sometimes more concerned with how much volume the batteries will take up and sometimes more concerned with how much weight they will add. However, in cases where the container size is predetermined, whether it's a D cell, C cell, AA cell or something

else, it is usually not important how much the cell weighs, just how much energy we can get out of that specific size battery.

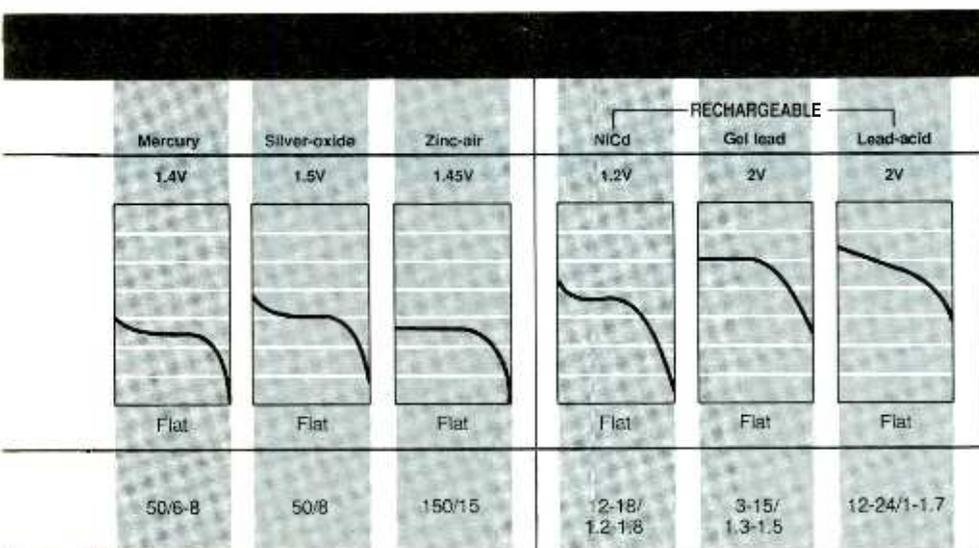
Energy densities for batteries range from about 12 watt-hrs per pound and 1 watt-hr per cubic inch for lead-acid cells, to over ten times that amount, 150 watt-hrs per pound and 15 watt-hrs per cubic inch, for zinc-air cells. Energy densities sometimes vary within battery type. For instance, alkaline battery designs have been constantly improving, with jumps as high as 30% or more with each generation.

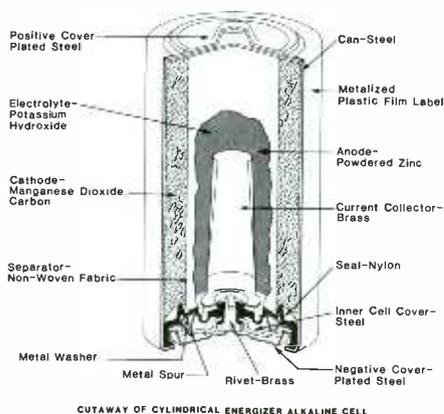
Since material in nickel-cadmium batteries is so expensive, most manufacturers have been only partly filling their C- and D-type cells with electrolyte to keep their relatively high prices as low as possible. Even if the NiCd's don't have as long a life per charge as an alkaline cell, however, they can be recharged an almost unlimited number of times.

Now that the ground has been established, manufacturers are starting to introduce "hi-density" NiCd batteries—ones filled with electrolyte. Some of these have as much as four times the energy density as their low-density cousins (although it is still less than half that of the newest alkaline cells).

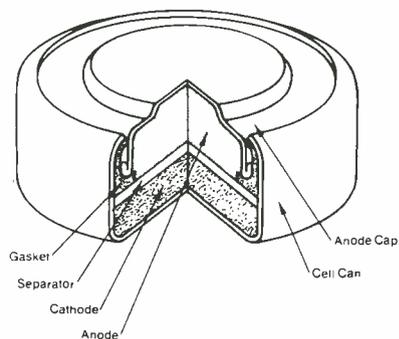
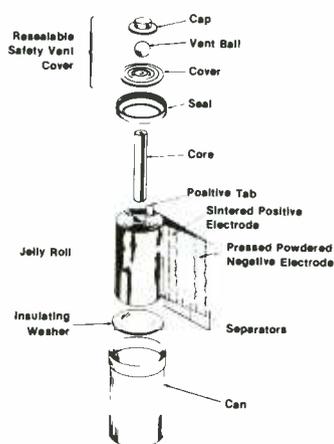
Table II lists the physical properties of the various types of batteries. The left-hand column shows the common battery size name (AA, C, D, etc.) along with actual volume in parentheses. To the right is the weight of each type of battery in their various sizes (not all batteries are available in all sizes). Where data is not applicable, NA is noted. This information is useful when designing equipment from scratch, where volume and/or weight of batteries may be important.

Table III shows ampere-hour (amp-hr) capacity of the various batteries. The amp-hr capacity simply tells you how many hours the battery will supply a certain current. For in-





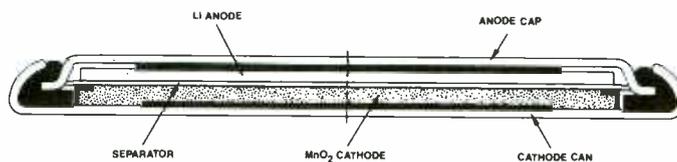
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3 VOLT LITHIUM MINIATURE CELLS

stance, if a battery has a rating of one amp-hr, it means you can draw one amp out of it for one hour before it is discharged; or 1/2 amp out for 2 hours; or 2 amps out for 1/2 hour, and so on. Theoretically, at least.

In reality, things are a little more

complicated. Like many other battery parameters, the amp-hour capacity of a battery also has some variables. For instance, the ampere-hour capacity of a battery is higher at lower discharge rates. Thus, you can get more power out of a battery by draw-

ing a small amount of current from it for a long time than you can by drawing a large amount of current for a short time. However, if you let the battery "rest," you can usually draw

*(continued on page 22)*

Table II. Physical Parameters (Weight in ozs)

Size Vol (in. <sup>3</sup> )	Zinc Chloride			Lithium			Zinc Air			Rechargeable		
	Carbon Zinc	Zinc Chloride	Alkaline	MnO <sub>2</sub>	Solid	Mercury	Silver Oxide	Zinc Air	NiCd reg/Hi	Gel Lead	Lead Acid	
Button (0.01-0.12)	.02-.25	NA	.02-.25	.02-.25	NA	.02-.25	.02-.25	.02-.06	NA	NA	NA	
9V (1.3)	1.2	1.30	1.6	NA	NA	1.80	NA	NA	1.25	NA	NA	
AAA (0.2)	0.3	0.33	0.4	0.46*	NA	NA	NA	NA	0.36	NA	NA	
AA (0.5)	0.6	0.71	0.8	0.6*	NA	1.03	NA	NA	.75/1.0	NA	NA	
C (1.5)	1.5	1.80	2.3	1.7*	NA	NA	NA	NA	1.8/2.5	NA	NA	
D (3.2)	3.0	3.70	4.7	NA	NA	5.90	NA	NA	2.3/5.3	6.4	NA	
6V (30)	22.0	22.0	30.0	NA	NA	NA	NA	NA	NA	26.0	6-60 lbs	
12V (60-800)	50.0	NA	NA	NA	NA	NA	NA	NA	NA	10-40 lbs	15-50 lbs	

\*Similar size for comparison only. Voltage too high (3V) for this size cell.

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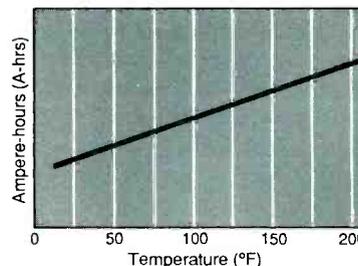
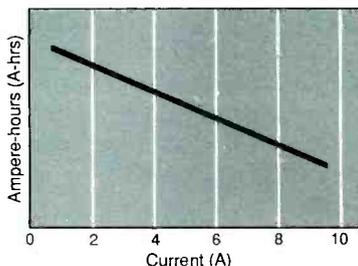
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Table III. Amp-Hrs (at both low and high discharge rates)

	Carbon Zinc	Zinc Chloride	Alkaline	Lithium		Mercury	Silver Oxide	Zinc Air	Rechargeable		
				MnO <sub>2</sub>	Solid				NiCd reg/Hi	Gel Lead	Lead Acid
Button	.03-.12	NA-	0.04-0.2	0.07-0.2	NA	0.02-0.3	0.01-.21	0.07-0.40	NA	NA	NA
9V (10mA)	0.30*	0.40	0.50	NA	NA	0.75	NA	NA	0.08	NA	NA
(50mA)		0.20	0.30			0.58			0.065		
AAA (20mA)	0.40*	0.60	0.80	1.0	NA	NA	NA	NA	0.19	NA	NA
(300mA)		0.40	0.50						0.15		
AA (20mA)	0.80	1.3	2.0	2.5	NA	2.5	NA	NA	0.55	NA	NA
(400mA)	0.30	0.7	1.2	1.5					0.45		
C (20mA)	2.5	3.0	6.0	7.75	NA	NA	NA	NA	1.35/2.0	NA	NA
(400mA)	0.70	2.0	4.5	5.0					1.1/1.6		
D (40mA)	5.0	8.0	11.0	NA	NA	14.0	NA	NA	1.4/4.3	2.7	NA
(700mA)	1.0	4.0	8.0						1.1/3.5	2.5	
6V (200mA)	7.0	9.0	14.0	NA	NA	NA	NA	NA	NA	6.5	50-125
(700mA)	4.0	6.0	9.5								
12V (5A)										5-50	30-100
(10A)											25-90
(15A)	**	NA	NA	NA	NA	NA	NA	NA	NA		20-80
(20A)											15-75
(25A)											10-70
(200A)											2-15

\* This battery cannot put out this current for extended periods.

\*\* Data not available



the remaining energy out of it later. Also, the amp-hour rate of a battery is temperature dependent. At low temperatures, the rating will be lower and at high temperatures it will be commensurately higher.

The amp-hr capacity of a battery is actually a form of energy density in a more useful form. The relationship between amp-hours, voltage, energy density, battery weight and volume is simply:

$$\frac{\text{amp-hrs} \times \text{voltage}}{\text{battery volume}}$$

= energy density per volume

and

$$\frac{\text{amp-hrs} \times \text{voltage}}{\text{battery weight}}$$

= energy density per pound

Table IV is very important in certain applications. It gives the maximum current a battery can provide. This is essentially a measurement of how much current will flow if you "short-circuit" the battery.

In most applications, maximum current available is not important. But in applications such as battery-powered tools, a battery may have to produce very high currents occasionally. Maximum current range from one amp for small zinc-carbon batteries to almost one thousand amps for larger lead batteries.

The maximum current a battery can generate also has two variables.

The lower the temperature, the lower this number will be, and vice-versa. And the more discharged the battery is, the lower the number will be. Thus, depending on how you test, you will get different values for this number.

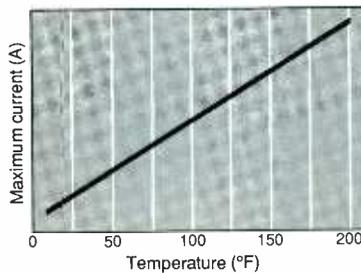
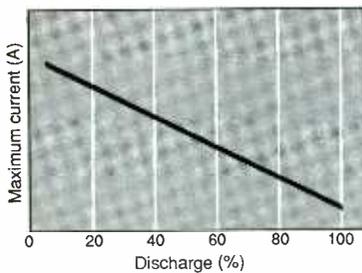
Maximum current can also be given as an internal resistance, since:

$$\text{internal resistance} = \frac{\text{battery voltage}}{\text{maximum current}}$$

A battery's internal resistance is the least intuitive battery parameter, but is the key to many of the variables that we have encountered with batteries. Internal resistance is the

**Table IV. Maximum Current (Amps)**

	Carbon Zinc			Lithium		Mercury	Silver Oxide	Zinc Air	Rechargeable		
	Zinc	Zinc Chloride	Alkaline	MnO <sub>2</sub>	Solid				NiCd reg/Hi	Gel Lead	Lead Acid
Button	<< 0.05	NA	0.02	0.3	NA	0.02-0.5	0.02	.005-.012	NA	NA	NA
9V	0.8	0.8	10.0	NA	NA	*	NA	NA	1	NA	NA
AAA	4.0	4.0	8.0	*	NA	NA	NA	NA	1	NA	NA
AA	4.0	5.0	12.0	0.15	NA	*	NA	NA	5	NA	NA
C	5.0	7.0	13.0	0.3	NA	NA	NA	NA	10	NA	NA
D	6.0	9.0	15.0	NA	NA	*	NA	NA	10	200	NA
6V	8.0	9.0	30.0	NA	NA	NA	NA	NA	NA	50	200-1000
12V	6.0	NA	NA	NA	NA	NA	NA	NA	NA	800	200-1000



\* Data not available

much better. For instance, gelled electrolyte lead cells can operate over a temperature range of -75 to +140 degrees F, and solid lithium cells are good over the range of -40 to +250 degrees F.

Batteries also vary enormously in their "shelf life"—how long they will remain ready to be used if left unused. Shelf life of some batteries is temperature dependent. If these are exposed to temperatures outside of a specified range, their life can be considerably shortened. This must be taken into account when estimating battery life. Within their temperature range, most batteries will have a longer shelf life if stored at lower temperatures.

Another way of expressing a battery's life is the rate of loss of charge. Some batteries, like lithium cells, have a very low rate of loss—on the order of only 1% per year. Others, like nickel cadmium, have a very high loss—from 10 to 30% per month (if NiCds weren't rechargeable, they probably wouldn't be on the market). Again, the temperature will affect the rate of loss of charge. Lower temperatures will lower the loss rate and higher temperatures will raise it.

Batteries' maximum life varies from a couple of years for zinc-car-

opposition to flow of electrical current within the battery, and is what prevents a battery from being a theoretically ideal voltage source.

This is the property that makes a battery's voltage vary with the amount of current drawn ( $V = I \times R$ ). Since internal resistance increases with age and with lower temperatures, it is also a property that makes the battery's voltage, maximum current, and amp-hour capacity vary with the battery's age and temperature.

Table V gives the internal resistance of all batteries whose manufacturers list it.

Notice that the internal resistance of a battery not only varies with the type, but also with its size. The larger the battery, the lower its internal resistance, and thus the greater the maximum current, as you would expect.

Table VI shows the temperature range and shelf life of the various battery types.

While a battery's performance

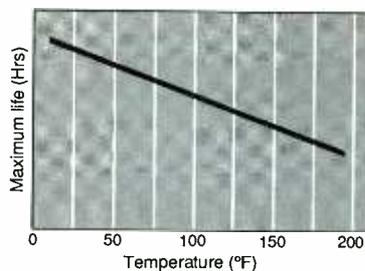
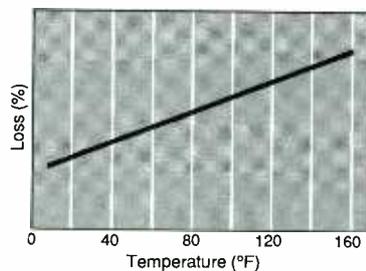
varies with the temperature, there is also a minimum and maximum temperature in which it may be stored, and a minimum and maximum temperature in which it may be used. Usually, the latter range is narrower than the former.

If a battery is stored at a temperature that's too low, its electrolyte may freeze and destroy the battery. If the battery is stored at too high a temperature, chemicals in the battery may decompose or react with each other, using up the battery's stored chemical energy.

The working temperature of a battery is often narrower because the chemical reactions that generate the electrons are slowed down when temperature drops too low. Zinc-carbon batteries are a good example of this. They are pretty useless at temperatures below freezing (0°F) because chemical reaction will be too slow to generate very many electrons. When operating at temperature extremes, there are batteries available that do

Table V. Internal Resistance in ohms (fresh battery at room temperature)

				Lithium		Mercury	Silver Oxide	Zinc Air	Rechargeable		
	Carbon Zinc	Zinc Chloride	Alkaline	MnO <sub>2</sub>	Solid				NiCd reg/Hi	Gel Lead	Lead Acid
Button	*	NA	100.0	8-12	NA	3-80	100	3-5	NA	NA	NA
9V	35.0	35.0	3.0	NA	NA	*	NA	NA	9.0	NA	NA
AAA	0.7	0.5	0.4	*	NA	NA	NA	NA	1.2	NA	NA
AA	0.5	0.4	0.3	*	NA	*	NA	NA	0.24	NA	NA
C	0.4	0.3	0.2	*	NA	NA	NA	NA	0.12	NA	NA
D	0.3	0.2	0.15	NA	NA	*	NA	NA	0.12	0.01	NA
6V	0.8	0.7	0.2	NA	NA	NA	NA	NA	NA	0.02-0.03	0.01
12V	2.0	NA	NA	NA	NA	NA	NA	NA	NA	0.01	0.01



\*Data not available

bon cells to about twenty years for solid lithium cells. Nickel-cadmium batteries have the unusual characteristic that their shelf life will almost always run out before their number of charge/discharge cycles have been exceeded.

In Table VII, we will look at a few properties which are meaningful only for the rechargeable batteries—nickel-cadmium, deep-cycle lead-acid, and gelled-electrolyte lead batteries.

Rechargeable batteries vary in the amount of time they require for recharging. This actually depends more on the particular model of battery than the type. For instance, there are NiCds that recharge in 16 hours, 3 hours, and 1 hour. The first entry in Table VII shows the various charge times for the three different types of rechargeable batteries.

Most of the batteries sold separately for consumer use take about 16 hours to fully recharge. Batteries that are sold as part of a tool vary from a very slow 30 hour charge to a very quick 1 hour charge.

The rechargeables also vary in the number of recharge cycles they have. This is shown in the second entry in Table VII.

In the case of NiCd batteries, they have virtually an unlimited number of cycles during their lifetime because the battery's maximum life is usually exceeded long before the number of recharge cycles is reached.

Lead batteries are more complex. The deeper they are discharged, the fewer number of recharge cycles they will have. If discharged almost completely, lead batteries can have as few as 200 cycles. But if discharged only 25% each time, they can give as many as 2000 cycles.

Rechargeable batteries have a few other characteristics to consider, as shown in the last three entries in Table VII.

Rechargeables are sometimes fussy about how they are charged or discharged. Most nickel-cadmium cells do not perform as well if they are only partially discharged before recharging. They are not damaged, but

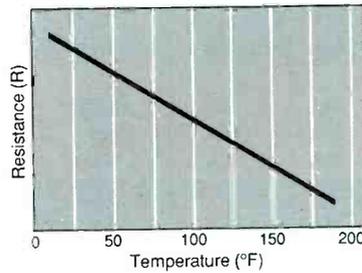
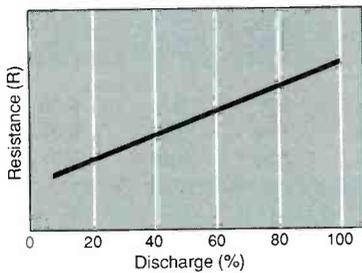
they do "remember" how much they were used before recharging, and tend to act as if that is all the capacity that they now have. This can be cured by cycling them completely a few times. (The best way to use NiCd batteries is as follows: If your batteries are not yet completely discharged, but you need to have a fully charged set for the next time you will use them, leave the device turned on until the batteries are discharged, and then recharge them. You are not wasting a recharge cycle as NiCds have more recharge cycles than can be used in their lifetime.)

Lead cells have no memory, and so do not care if they are only partially discharged. In fact, they will give a greater number of recharge cycles if only partially discharged. But they, too, are fussy about how they are recharged. If not recharged immediately after use, they will have a *shorter* than expected life span.

The last peculiarity of rechargeable batteries is their possible susceptibility to damage by *reverse polarity*—a condition which can occur when a set of batteries is accidentally left on until *completely* discharged. The vulnerability to this depends on the particular model of battery. In general, NiCd's and lead-acid batteries are more vulnerable than gel-lead batteries.

**Table VI. Temperature (°F)**

				Lithium			Rechargeable				
	Carbon Zinc	Zinc Chloride	Alkaline	MnO <sub>2</sub>	Solid	Mercury	Silver Oxide	Zinc Air	NiCd reg/Hi	Gel Lead	Lead Acid
Storage	-40 + 120	-40 + 160	-40 + 120	-40 + 140	*	-40 + 140	-40 + 140	-40 + 140	-40 + 140	*	*
Use	+20 + 130	0 + 160	-20 + 130	-40 + 140	-40 + 250	-15 + 130	32 + 130	0 + 140	-5 + 115	-75 + 140	*
<b>Charge Loss at 70 °F (%/month)</b>											
	0.7%	0.7%	0.4%	0.1%	0.1%	0.8%	0.25%	0.25%	10-30%	2-3%	*
<b>of Original Charge at 70 °F</b>											
Yrs											
%	99%	99%	99%	99%	99%	99%	99%	99%	70-90%	97%	*
1	92%	92%	95%	98%	98%	90%	97%	97%	*	*	
2	85%	85%	90%	95%	95%	80%	94%	94%			
3	77%	77%	85%	93%	93%	70%	90%	90%			
4	70%	70%	80%	90%	90%	60%	86%	86%			
10	NA	NA	NA	75%	75%	NA	NA	NA			
Max. Life (yrs)	3-5	3-5	4-6	5-10	20	*	*	.15**	3-5	3-8	2-6



\*Data not available  
 \*\*Battery should be used within 60 days after opening (may be stored sealed for several years)

**Table VII. Rechargeable Battery Properties**

	NiCd	Gel Lead	Lead Acid
Charge Time:			
Regular	16	12	30
Fast	3	2	
Quick	1	1	
Cycles:			
100%	1000	200	**
50%	1000	500	
25%	1000	1000-2000	
Memory	Yes*	No	No
Recharge Immediately?	No	Yes	Yes
Reverse Polarity?	Yes*	No	Yes

\*Some of the newest NiCd batteries reportedly eliminated these defects  
 \*\*Data not available from manufacturers

The last, and obviously major consideration for all batteries is their cost. As Table VIII shows, one can look at the cost in several ways.

There is the initial cost of the battery, of course. As you might expect, this is often the only cost people consider. Usually, a better consideration is the cost per watt-hour of power. Often, batteries that are more expensive to buy initially are actually cheaper to use. This must be taken into account when calculating the cost of rechargeable batteries. While much more expensive to buy initially, they are far more economical than conventional batteries in the long run if used often.

Note that in many cases, one battery type may be more economical

for a light load, and another type more economical for a heavy load. Often, the more expensive battery types are most economically used for heavy loads. Notice also that, within a given battery type, the larger the battery, the less expensive per watt hour it generally is to use.

Discounts on popular batteries will affect both the initial and cost per watt-hr., of course. Only "list" prices are considered in Table VIII.

So which battery do you choose?

If you need batteries for a non-critical or low-current application, then regular zinc-carbon or heavy-duty zinc-chloride batteries may be the best choice.

If you will be using a device that will have the same batteries remain-

**Table VIII. Battery Cost**

*				Lithium					Rechargeable		
	Carbon Zinc	Zinc Chloride	Alkaline	MnO <sub>2</sub>	Solid	Mercury	Silver Oxide	Zinc Air	NiCd reg/Hi	Gel Lead	Lead Acid
<b>Button</b>											
Initial	0.50	NA	0.90	1.75	NA	0.50	1.00	0.80	NA	NA	NA
light	6.50	NA	6.00	5.75	NA	1.60	3.30	1.30	NA	NA	NA
heavy	**	NA	**	**	NA	**	**	**	NA	NA	NA
<b>9V</b>											
Initial	0.60	1.00	2.00	NA	NA	5.00	NA	NA	10.00	NA	NA
light	0.22	0.28	0.45	NA	NA	0.75	NA	NA	0.02	NA	NA
heavy	NA	0.55	0.75	NA	NA	0.95	NA	NA	0.03	NA	NA
<b>AAA</b>											
Initial	0.25	0.35	0.75	5.00	NA	NA	NA	NA	2.00	NA	NA
light	0.40	0.40	0.60	3.30	NA	NA	NA	NA	0.01	NA	NA
heavy	**	0.60	1.00	NA	NA	NA	NA	NA	0.02	NA	NA
<b>AA</b>											
Initial	0.30	0.40	0.80	8.00	NA	2.00	NA	NA	2.00	NA	NA
light	0.25	0.20	0.30	2.10	NA	0.53	NA	NA	0.01	NA	NA
heavy	0.65	0.40	0.40	3.50	NA	NA	NA	NA	0.01	NA	NA
<b>C</b>											
Initial	0.35	0.55	1.25	11.00	NA	NA	NA	NA	3/5	NA	NA
light	0.10	0.12	0.14	0.95	NA	NA	NA	NA	0.01	NA	NA
heavy	0.35	0.18	0.18	1.50	NA	NA	NA	NA	0.01	NA	NA
<b>D</b>											
Initial	0.35	0.55	1.25	NA	NA	10.00	NA	NA	3/7	6.00	NA
light	0.05	0.05	0.08	NA	NA	0.48	NA	NA	0.01	0.01	NA
heavy	0.25	0.10	0.10	NA	NA	NA	NA	NA	0.01	0.01	NA
<b>6V</b>											
Initial	3.00	4.00	11.00	NA	NA	NA	NA	NA	NA	20.00	15-90
light	0.07	0.07	0.13	NA	NA	NA	NA	NA	NA	0.01	0.01
heavy	0.12	0.11	0.19	NA	NA	NA	NA	NA	NA	0.01	0.01
<b>12V</b>											
Initial	10.00	NA	NA	NA	NA	NA	NA	NA	NA	30-70	40-90
light	NA	NA	NA	NA	NA	NA	NA	NA	NA	0.01	0.01
heavy	NA	NA	NA	NA	NA	NA	NA	NA	NA	0.01	0.01

\* Initial (average list price w/o discounts)  
 Light (cost per watt-hour with light load)  
 Heavy (cost per watt-hour with heavy load)

\*\* This battery is not suitable for heavy loads

ing in it for long periods of time, as in the case of an emergency flashlight or a camera, then alkaline batteries would be a better choice. This is especially true if the device is expected to perform under temperature extremes, for extended periods of time, with high reliability, or with high output current capabilities. Rechargeable batteries would be inappropriate in this case because you would never recover the initial cost, and the rechargeable's lower energy

density and relatively high self-discharge will give you less time per battery charge.

If, for a special application, you need a lot of power in a small size, look into the lithium cells. While they are very expensive, and are most commonly available only in odd sizes, they are just the ticket for special high-energy-density applications.

If you need an enormous amount of economical power, look at the deep-cycle lead-acid motorcycle or car-sized batteries. They are the most powerful rechargeable batteries currently available.

If you will be using the device on an infrequent but regular basis, say, once a month, then gelled electrolyte lead batteries would be the best choice (you may not always have the option in this case because the gelled lead batteries are not as readily available in various sizes as are nickel-cadmium batteries).

If you use batteries frequently and heavily (discharge them deeply), NiCd's are the clear choice. Since most prefer to be cycled deeply, you should match the amount of drain that you put on them with their capacity. If you only discharge them to

the point that the regular NiCd's will go, then they would be the most economical choice; if you need more time than the regular NiCd's can provide per charge, then you should select the "Hi-Capacity" NiCd's.

Finally, if you are regularly using a lot of batteries, you might find it useful to convert entirely to a rechargeable system. Therefore, if you will be using the batteries for less frequent, shallow discharges, choose gelled electrolyte lead batteries. If you will be using batteries for frequent, deep cycles, choose NiCd batteries. The following shows where each battery is at its best.

Charge	Use	
	Infrequent	Frequent
Deep	Lead	NiCd
Shallow	Lead	Lead

It might seem surprising that NiCd's have the advantage in only one out of the four possible situations, since NiCd's are the most common type of rechargeable battery. But its use is also the most common for rechargeable batteries—namely, frequent, deep cycling.

When using rechargeable batteries, you will need to have back-up batteries for when your batteries are recharging. There are two methods of providing backups. If you won't be using a lot of batteries, it is most economical to use alkalines as the backup batteries; when used only while your main batteries are charging, they should provide years of service. If you plan to have a lot of rechargeable batteries in use, or a smaller set in constant use, it will pay to have your backup batteries rechargeable, too. All you need is one additional set of each size that you are using. Whenever a set of batteries runs out of power, replace them with your spare set and place the drained set in the recharger. This way, you will get the most efficient use out of your recharger, too.

As far as which type of charger to use, if you are using only a few bat-

teries of only one size, consider using one of the dedicated chargers (for instance, one which will recharge four AA cells at a time). If you will be using different sizes of batteries, you should consider one of the general rechargers that will recharge four to eight or more batteries of different sizes at a time.

By selecting the right battery for the right job, you will find that you will get the most out of your battery dollars, and always have fresh batteries on hand.

The author wishes to express his appreciation to the following for providing much valuable information: Duracel, Gates Energy Products, General Electric, Mallory, Globe Battery, National, Panasonic, Saft, Yuasa, and special thanks to B.G. Merritt of Union Carbide (Eveready).

*Photographs are courtesy of Union Carbide.*

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# How To Use EPROMs for Non-Memory Applications

*Creating complex digital logic circuits with EPROMs simplifies electronic designing*

By John D. Anderson

EPROMs are usually considered to be just computer memory devices. However, they can be programmed to suit other digital functions. All you need is an EPROM programmer. Add a knowledge of how programmable read-only memory devices work, which we'll explore here, and you'll

be able to create your own custom-designed digital ICs to plug into an electronic circuit . . . right in your own workshop.

To prove how easy it is to use EPROMs that aren't in the traditional computer memory bailiwick, we'll describe three such applications that can be implemented with judicious programming, the keyboard translator, keyboard controller and stepper-

motor controller circuits shown here, all actual working circuits, illustrate only a few of the possible ways an EPROM or PROM can be programmed to suit a specialized application. Applications beyond these are limited only by your imagination and technical ability.

You will note that the three circuits presented here use the 2716 EPROM as the custom-design ele-

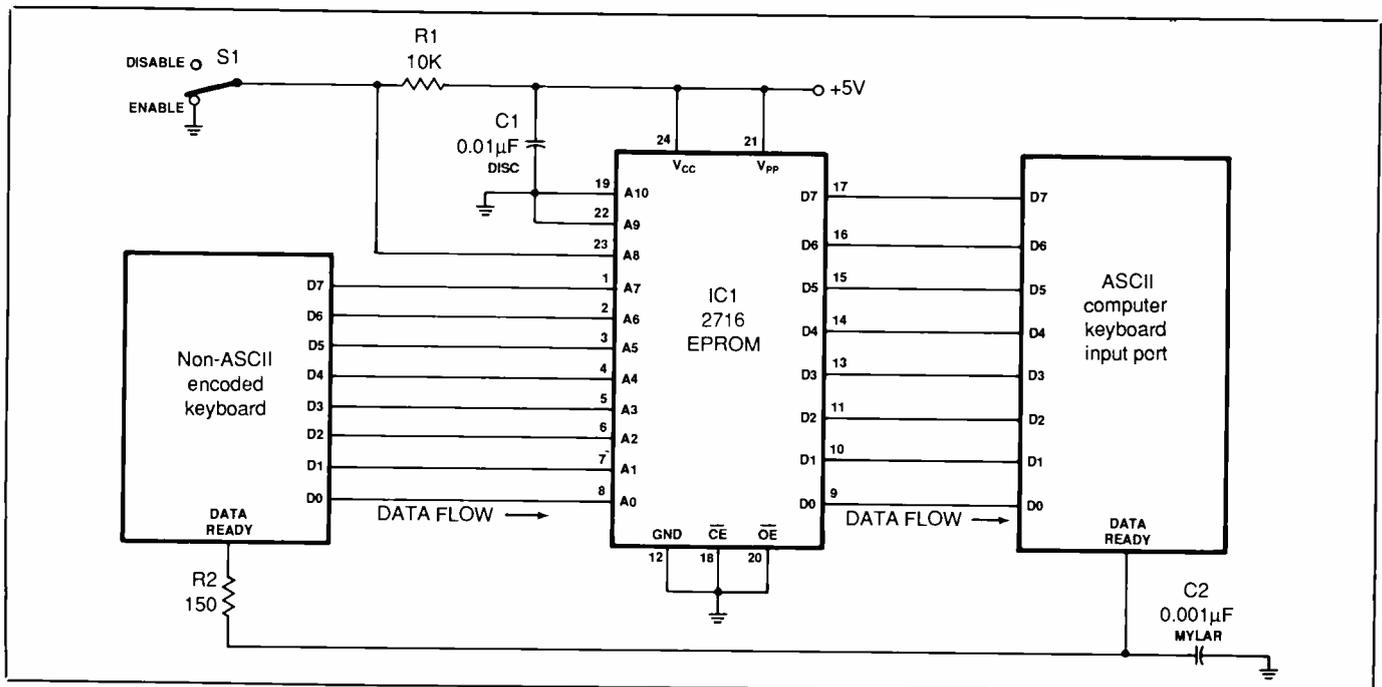


Fig. 1. A keyboard-translator circuit.

**Table 1. Programming Data for Keyboard Interface\***

Key Pressed	Keyboard Output (EPROM Address*)	EPROM Output	Computer "sees" ASCII Character
A	00000000	01000001	A
B	00000001	01000010	B
C	00000010	01000011	C
D	00000011	01000100	D
etc.	etc.	etc.	etc.

Address lines A8, A9 and A10 are tied low. \*Partial table listing; see text for details.

2716 EPROM and the EPROM's data output lines to the computer's keyboard input port. A simple resistor/capacitor network is included in the circuit to delay the KEY PRESSED strobe pulse to compensate for the 450-nanosecond data delay through the EPROM.

Table 1 shows a partial listing of the data to be programmed into the EPROM to turn it into a keyboard translator. Switch *SI* on address line A8 permits the translation function to be enabled and disabled. In Table 1, you can see that when address line A8 is high, the 8-bit data word coming out of the EPROM on data lines D0 through D7 is the same as the 8-bit address word being supplied by the keyboard. This makes the translator "transparent" to the keyboard and computer. (Because only the lower 512 bytes of the EPROM need be programmed, address lines A9 and A10 are tied low.) You should draw up a complete ASCII table and fill in the required output data. This table will prove to be very helpful as you program the EPROM and later

ment. This EPROM was selected only because of its low cost and ready availability. In actuality, just about any other EPROM or PROM could be used if you happen to have them on hand.

In all three circuits, the EPROM is forced into the "read" (output-only) mode by hard-wiring pins 18 and 20 low and pin 21 high. This arrangement causes the EPROM to output a programmed data word on data-output lines D0 through D7 for every address word that appears on address-input lines A0 through A10. Technically speaking, we're turning a

computer memory chip into a programmable logic array, or PLA.

### Keyboard Translator

Figure 1 shows how a 2716 EPROM can be used as an interface between a nonstandard encoded typewriter keyboard and a computer that requires ASCII-type keyboard coding. (Computer builders take note—maybe you *can* use those bargain-basement keyboards after all.) This circuit is easy to build. You simply connect the output lines of the keyboard to the address inputs of the

**Table 2. Programming Data for Keyboard Encoder/Latch**

EPROM Address Input										EPROM Output								
A10	A9	A8	A7	A6	A5	A4	A3	A2	A1	A0	D7	D6	D5	D4	D3	D2	D1	D0
S8	S7	S6	S5	S4	S3	S2	S1	Feedback			Encoder Output			Not used		Feedback		
0	0	0	0	0	0	0	0	0	0	0	0	0	X	X	0	0	0	
0	0	0	0	0	0	0	0	0	0	0	0	0	X	X	0	0	1	
0	0	0	0	0	0	0	0	0	0	0	0	1	X	X	0	1	0	
0	0	0	0	0	0	0	0	0	0	0	0	1	X	X	0	1	1	
0	0	0	0	0	0	0	0	0	0	0	1	0	X	X	1	0	0	
0	0	0	0	0	0	0	0	0	0	0	1	0	X	X	1	0	1	
0	0	0	0	0	0	0	0	0	0	0	1	1	X	X	1	1	0	
0	0	0	0	0	0	0	0	0	0	0	0	0	X	X	0	0	0	
0	0	0	0	0	0	0	1	X	X	X	0	0	X	X	0	0	1	
0	0	0	0	0	1	X	X	X	X	X	0	1	X	X	0	1	0	
0	0	0	0	1	X	X	X	X	X	X	0	1	X	X	0	1	1	
0	0	0	1	X	X	X	X	X	X	X	1	0	X	X	1	0	0	
0	0	1	X	X	X	X	X	X	X	X	1	0	X	X	1	0	1	
0	1	X	X	X	X	X	X	X	X	X	1	1	X	X	1	1	0	
1	X	X	X	X	X	X	X	X	X	X	1	1	X	X	1	1	1	

X = Don't Care. Since D3 and D4 are not used in basic circuit, data here can be either a 0 or a 1 with no change in circuit operation.

on for debugging the circuit should this become necessary.

### Keyboard-Controller System

An EPROM can also be used as a priority encoder/latch for an eight-switch keyboard, as shown in Fig. 2. (This type of circuit is commonly used in video and audio selector systems.) The circuit outputs and holds a 3-bit binary word that corresponds to the last keyswitch pressed. If two or more keyswitches are held down simultaneously, the circuit outputs the code for the highest-priority (highest-numbered) one.

Figure 2 shows how to wire the EPROM into a digital feedback configuration, with data output lines D0, D1 and D2 driving address input lines A0, A1 and A2, respectively. These feedback lines provide the encoder's latch (memory) function. Resistor/capacitor networks R1/C1, R2/C2 and R3/C3 on feedback lines A0/D0, A1/D1 and A2/D2, respectively, prevent circuit "racing" (unstable output caused by unstable, fast-changing feedback lines). The 3-bit encoder output is provided on data output lines D5, D6 and D7. Data lines D3 and D4 aren't used here but could be programmed for other outputs, such as a KEY PRESSED signal or an expanded 5-bit encoder output.

Data words to be programmed into the EPROM are detailed in Table 2. As long as no key is pressed, the data output doesn't change because the feedback input word to the EPROM generates the same feedback output word from the EPROM. Hence, the data output is "locked" into a stable state (for simplicity, each 3-bit feedback word corresponds to the same 3-bit data output word).

A key must be pressed to change the output data word. Pressing any keyswitch pulls a corresponding address line high and forces the EPROM to output a different data word. Releasing the key causes the

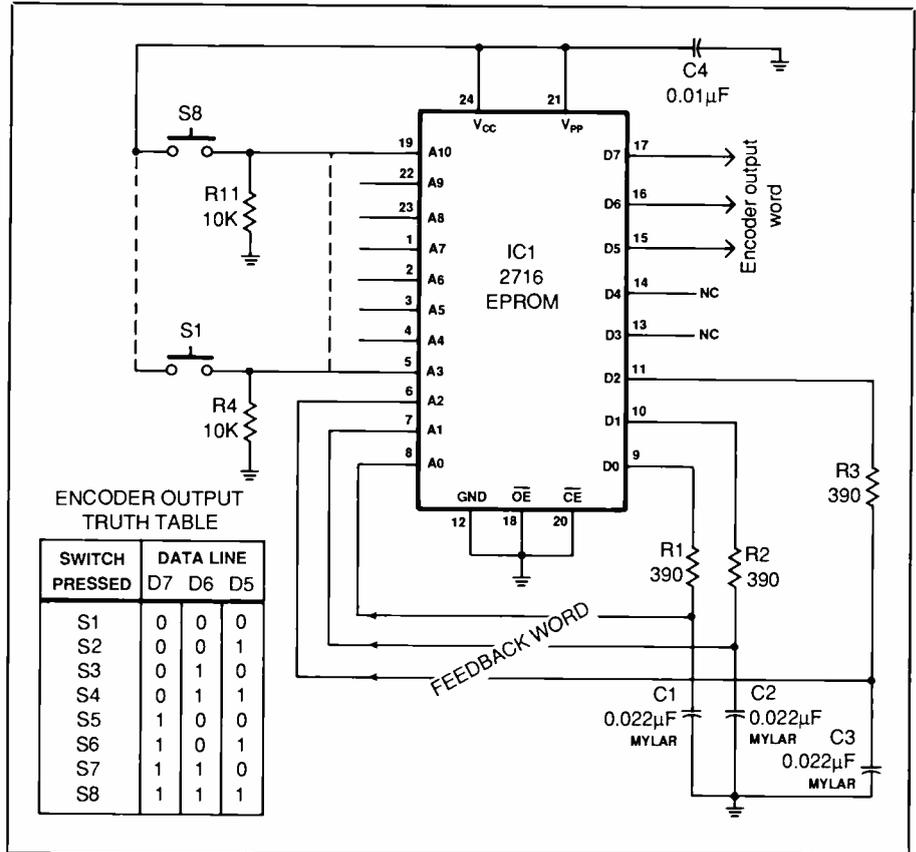


Fig. 2. A keyswitch encoder with feedback.

feedback lines to lock the new data word on the EPROM output.

Although the Fig. 2 circuit provides a basic switch-debounce function, short noise spikes may appear on the output data word as switch contacts bounce as they're open and closed. The noise generated by contact bouncing can appear because the EPROM output data word is undefined while the address input lines are changing. If you note a noise problem as you operate this circuit, you can eliminate it by bypassing the affected data lines to ground with 0.001-microfarad disc capacitors. Since they already pass through the resistor/capacitor network, the feedback lines don't require bypassing.

### Stepper-Motor Controller

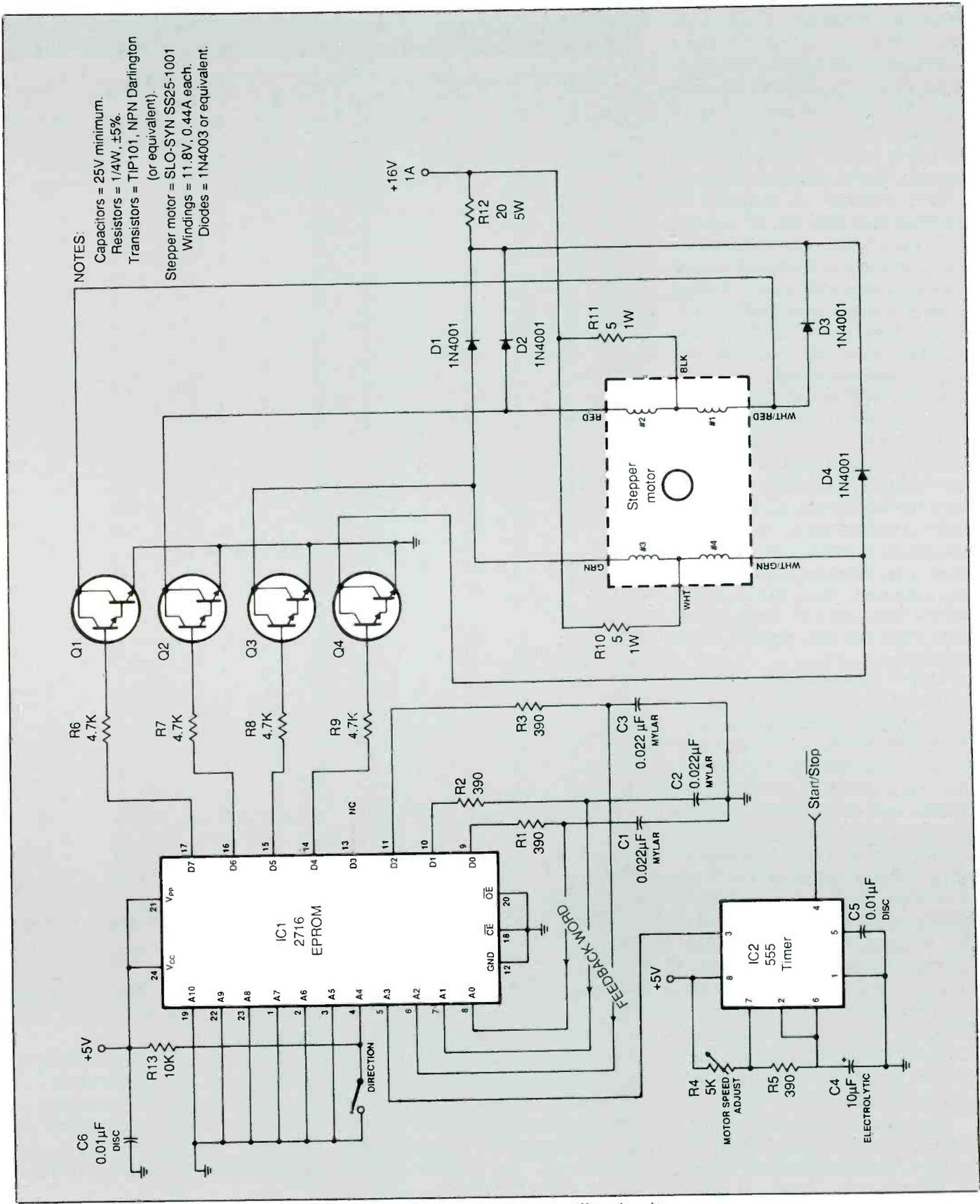
Figure 3 shows how an EPROM can be used to generate the timing signals required for controlling a four-phase

stepper motor. Table 3 details how each winding of the motor must be turned on and off to cause the stepper shaft to rotate one step in a given direction. This table is typical for most 4-winding stepper motors.

In Fig. 2, EPROM data lines D4 through D7 switch on and off Darlington transistor amplifiers Q4 through Q1 through current-limiting

Table 3. Stepper-Motor

Winding Energizing Sequence			
Winding Number			
1	2	3	4
OFF	ON	ON	OFF
OFF	ON	OFF	ON
ON	OFF	OFF	ON
ON	OFF	ON	OFF
cycle repeats			
For clockwise rotation, read down; for counterclockwise rotation, read up.			



NOTES:  
 Capacitors = 25V minimum.  
 Resistors = 1/4W, ±5%.  
 Transistors = TIP101, NPN Darlington (or equivalent).  
 Stepper motor = SLO-SYN SS25-1001  
 Windings = 11.8V, 0.44A each.  
 Diodes = 1N4003 or equivalent.

Fig. 3. A stepper-motor controller circuit.

resistors *R9* through *R6*. In turn, these transistors control the current flow to the stepper motor individually for each of its windings. Resistors *R10*, *R11* and *R12* and diodes *D1* through *D4* suppress transient switching spikes generated by the motor's highly inductive windings. Digital feedback is provided by EPROM data lines D0, D1 and D2. Data line D3 isn't used in this circuit, but it could be programmed to provide another output signal. A clock generator built around a 555 IC provides pulses to the EPROM. The EPROM moves the motor shaft one step for each clock pulse.

When using an EPROM as a sequence generator driven from an external clock, it's important to arrange the output data so that only *one* feedback line changes state every time the clock input changes states (either a low-to-high or a high-to-low transition) to prevent two feedback lines from changing state at exactly the same time. Also, make sure the output data word is stable during both high and low periods of the clock pulse.

Table 4 shows the data to be programmed into the EPROM for the Fig. 3 circuit. Assume that the feedback lines A0/D0, A1/D1 and A2/D2 are at position 001, motor winding output signals D4 through D7 are at 0110, and the STEP and DIRECTION inputs A3 and A4 are both 0 (second line in Table 4). The address applied to the EPROM is 0000000001. (Address lines A5 through A10 aren't used in this application and are tied low to ground). The data word output is 01100001, which is the data word programmed into the EPROM for that address. At this point, the EPROM output is stable and unchanging because the feedback word (001) is causing the EPROM to output the same feedback word.

Now assume that STEP input A3 goes high. At the instant it does, the address applied to the EPROM input is 00000001001. (Keep in mind, though, that the capacitors on the

EPROM Address*					EPROM Output							
A4	A3	A2	A1	A0	D7	D6	D5	D4	D3	D2	D1	D0
Dir. Step		Feedback			#1	#2	#3	#4	**	Feedback		
<b>Clockwise Rotation</b>												
0	0	0	0	0	0	1	1	0		0	0	1
X0	0	0	0	1	0	1	1	0		0	0	1
0	1	0	0	1	0	1	0	1		0	1	1
X0	1	0	1	1	0	1	0	1		0	1	1
0	0	0	1	1	0	1	0	1		0	1	0
X0	0	0	1	0	0	1	0	1		0	1	0
0	1	0	1	0	1	0	0	1		1	1	0
X0	1	1	1	0	1	0	0	1		1	1	0
0	0	1	1	0	1	0	0	1		1	1	1
X0	0	1	1	1	1	0	0	1		1	1	1
0	1	1	1	1	1	0	1	0		1	0	1
X0	1	1	0	1	1	0	1	0		1	0	1
0	0	1	0	1	1	0	1	0		1	0	0
X0	0	1	0	0	1	0	1	0		1	0	0
0	1	1	0	0	0	1	1	0		0	0	0
X0	1	0	0	0	0	1	1	0		0	0	0
<b>Counterclockwise Rotation</b>												
1	0	0	0	0	1	0	1	0		1	0	0
X1	0	1	0	0	1	0	1	0		1	0	0
1	1	1	0	0	1	0	0	1		1	0	1
X1	1	1	0	1	1	0	0	1		1	0	1
1	0	1	0	1	1	0	0	1		1	1	1
X1	0	1	1	1	1	0	0	1		1	1	1
1	1	1	1	0	0	1	0	1		1	1	0
X1	1	1	1	0	0	1	0	1		1	1	0
1	0	1	1	0	0	1	0	1		0	1	0
X1	0	0	1	0	0	1	0	1		0	1	0
1	1	0	1	0	0	1	1	0		0	1	1
X1	1	0	1	1	0	1	1	0		0	1	1
1	0	0	1	1	0	1	1	0		0	0	1
X1	0	0	0	1	0	1	1	0		0	0	1
1	1	0	0	1	1	0	1	0		0	0	0
X1	1	0	0	0	1	0	1	0		0	0	0

X = Stable state. \*A5 thru A10 tied low to ground. \*\*Not used.

feedback lines don't allow the feedback word to change instantly.) For that address input, the EPROM outputs the data word 01010011, which means that the motor winding signal is now 0101, the motor has advanced one step, and the feedback word is 011. As feedback capacitor *C2* charges up, the address inputs change to 00000001011. For this address input, the EPROM outputs the

same data word, 01010011, and the output is stable as long as the STEP input is high.

When the STEP input changes from high to low, the EPROM address input changes to 00000000011. Now the output data word is 01010010, which means the motor winding signal is the same (0101) but

(Continued on page 91)

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# A Short-Circuit Detector

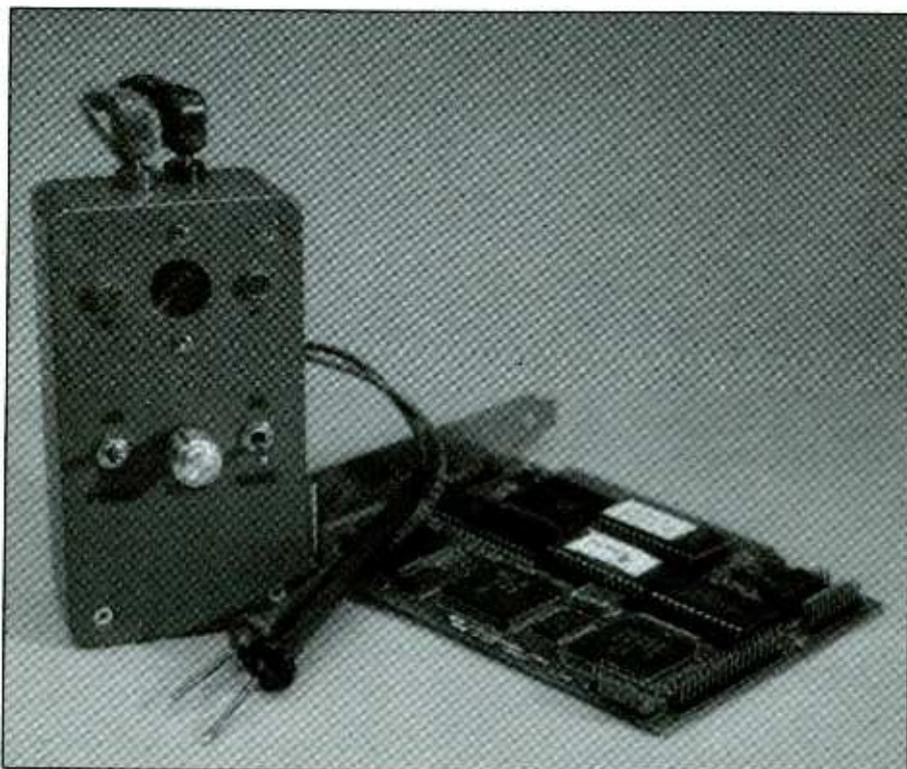
*Low-cost accessory simplifies locating short circuits in electrical and electronic systems*

By Lawrence M. Walden

Sometimes, one of the more difficult problems encountered in troubleshooting electrical and electronic equipment is that of locating short circuits, especially if it relates to a power supply. With no voltages available here and most circuits showing zero resistance on an ohmmeter, successful location of a short circuit can come at the end of a long session of guesswork. Fortunately, there are at least two practical methods of locating short circuits to eliminate the guesswork. One is with an expensive microvoltmeter, the other with a low-cost Short-Circuit Detector like the one described below.

Applying an external limited current to an ailing circuit and tracing its flow directly to the short circuit with either instrument (both are actually accessories that are designed to be used with an independent current source), puts the "science" back into troubleshooting. To do this safely, however, you need a current that's low enough to prevent the circuit from heating up and a high-gain amplifier to detect the small voltage drop across the lands and leads in series with the short. Since no current will flow except in the direct path to the short circuit, the amount of current used or detected isn't important.

Most ohmmeters set to their lowest resistance ( $\times 1$ ) scale will provide an appropriate current source for use with most printed-circuit board assemblies, as will a common 5-volt dc



power supply with a 150-ohm resistor in series with it. Currents available from ohmmeters can range from 50 to 300 milliamps, depending on make and model. A flashlight with its lamp in series with its battery, provides a current source that ranges from 200 to 500 milliamps. For high-power circuits, which include home and automotive electrical wiring, a battery and lamps that draw several amperes may be needed, provided heating doesn't occur during testing.

## About the Circuit

Shown in Fig. 1 is the complete schematic of the Short-Circuit Detector

accessory, including its dual 9-volt transistor battery power supply. The active elements that make up this circuit consist of high-gain operational amplifier *IC1*, small-signal transistors *Q1* through *Q4*, light-emitting diodes *LED1* and *LED2* and the piezoelectric "buzzer." External controls consist of power switch *S2*, audio on/off switch *S1* and zero-adjust potentiometer *R7*. Banana jacks *J1* and *J2* provide the input connectors for the test probes that are used with the accessory.

With *S1* and *S2* set to on and no input applied to pins 2 and 3 of *IC1* from the test probes (which are connected into the circuit under test), the

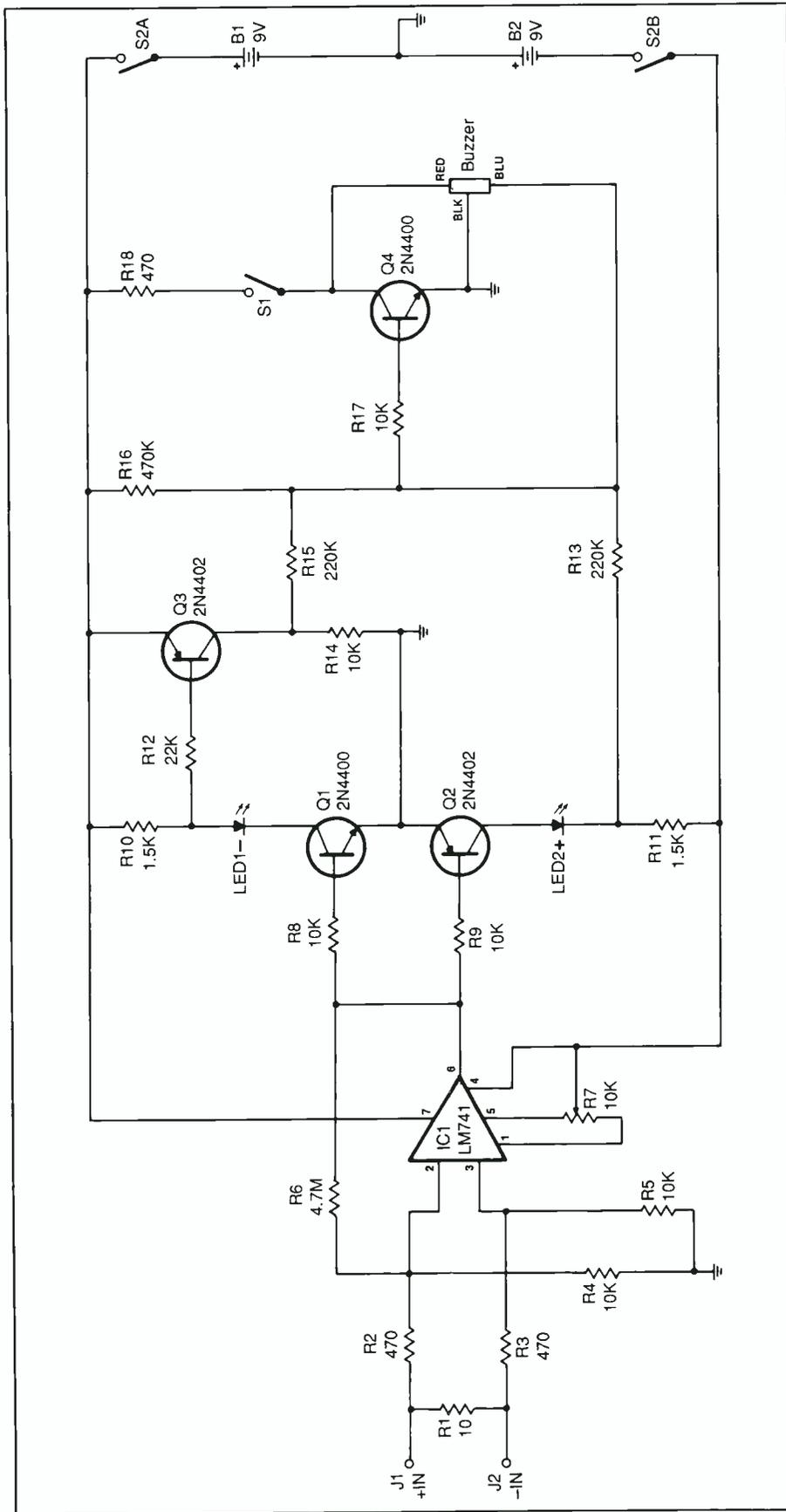


Fig. 1. This is the complete schematic diagram of the Current Detector.

### PARTS LIST

#### Semiconductors

IC1—LM741 operational amplifier  
 LED1, LED2—Panel-mount light-emitting diode (both red or one red and one green)

Q1, Q4—2N4400 or similar npn silicon transistor

Q2, Q3—2N4402 or similar pnp silicon transistor

#### Resistors (1/4-watt, 5% tolerance)

R1—10 ohms

R2, R3, R18—470 ohms

R4, R5, R8, R9, R14, R17—10,000 ohms

R6—4.7 megohms

R10, R11—1,500 ohms

R12—22,000 ohms

R13, R15—220,000 ohms

R16—470,000 ohms

R7—10,000-ohm, linear-taper panel-mount potentiometer

#### Miscellaneous

B1, B2—9-volt battery

Buzzer—Piezoelectric buzzer (Radio Shack Cat. No. 273-064 or similar)

J1, J2—Banana jack (one red, one black)

S1—Dpst slide or toggle switch

Printed-circuit board or perforated board and suitable soldering or Wire Wrap hardware; suitable enclosure (Radio Shack Cat. No. 270-222 or similar); 8-pin DIP IC socket for IC1 (see text); snap connectors for B1 and B2; test probes (see text); lettering kit; hookup wire; solder, etc.

Short-Circuit Detector is first zeroed with *R15* so that neither *LED1* nor *LED2* is on and no sound is emitted from the piezo buzzer. The Detector will now respond to a dc input of either polarity, with *LED1* lighting if the polarity is negative and *LED2* lighting if it's positive. Regardless of polarity, however, the piezo buzzer will sound when either LED comes on.

Input to the detector is coupled through *R2* and *R3* to the pins 2 and 3 inputs of *IC1*. Resistor *R1* is used in this circuit to prevent static-electricity-

ty pickup from the open test leads. The op amp operates as a high-gain amplifier, as is obvious from the high 4.7-megohm value of feedback resistor *R6*.

With no input applied to the circuit and both *S1* and *S2* closed, ZERO control *R7* is adjusted for a zero output at pin 6 of *IC1*. Both *Q1* and *Q2* will now be cut off so that no current flows through either LED, keeping both off. The arrangement of *Q3* and *Q4* in the circuit will also hold the buzzer silent. (With *Q1* and *Q2* held at cutoff, the base of *Q3* will be at +9 volts and the base of *Q4* will be at approximately -2 volts.)

Applying a positive input to *IC1* causes the pin 6 output to swing from the 0-volt potential when the circuit is zeroed to at least -6 volts. The magnitude of the negative-voltage swing will depend on the magnitude of the input to *IC1*. As the potential at pin 6 of *IC1* swings negative, *Q1* will remain in cutoff, but *Q2*, a pnp transistor, will be biased fully on. With *Q2* fully on, collector current from the negative side of *B2* will cause positive (+) indicator *LED2* to light. Under this condition, the junction of *R11*, *R13* and *LED2* will drop from -9 to -2 volts. This voltage drop causes the base of *Q4* to swing from negative to positive and, assuming AUDIO switch *S1* is closed, cause the buzzer to sound.

A negative input to *IC1* will cause the pin 6 output to swing from 0 to +6 volts or more, with the magnitude of the swing again depending on the magnitude of the input applied. This positive shift causes *Q2* to remain in cutoff, while npn transistor *Q1* turns on. With *Q1* fully on, negative (-) polarity indicator *LED1* will light and the junction of *R10*, *R12* and *LED1* will drop from +9 to +2 volts. Transistor *Q3* will now conduct and raise the potential across *R14* from 0 to +9 volts. With this +9 volts applied to *R15*, the base of *Q4* will swing from negative to positive and the piezo buzzer will sound.

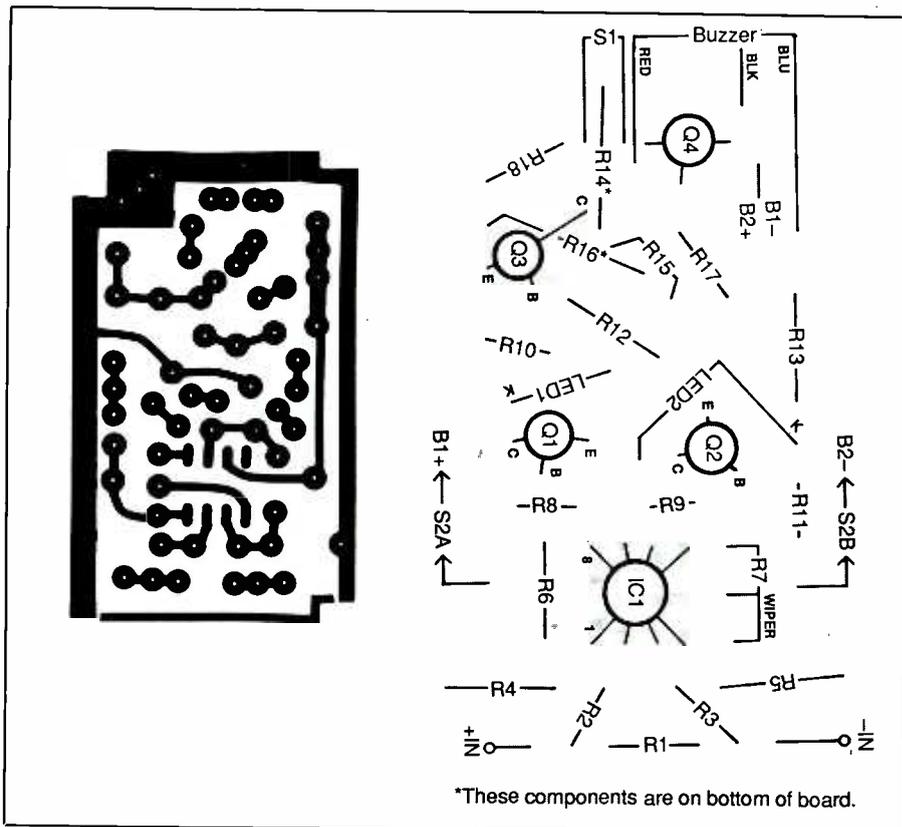


Fig. 2. Actual-size etching-and-drilling guide (left) is sized so that pc board you fabricate is sized to eliminate need for hardware to mount it inside recommended enclosure. Note in wiring diagram (right) that some components and all interconnecting wiring are to solder side of board.

Power drain of batteries *B1* and *B2* with the Short-Circuit Detector in its zero-balance condition is only about 1 milliamperes. Negative supply battery *B2* delivers approximately 6 milliamperes when a positive input is applied to the circuit. Current draw from positive supply battery *B1* is about 7.6 milliamperes with a negative input to the circuit. Additionally, *B1* must supply another 7 milliamperes or so when the piezo buzzer is sounding.

### Construction

Though the Short-Circuit Detector can be built using any of the traditional wiring techniques, printed-circuit board wiring is recommended. You can fabricate your own board using the actual-size etching-and-

drilling guide shown at the left in Fig. 2. Regardless of whether you use a pc board or perforated board and appropriate soldering or Wire Wrap hardware, you should use a socket for *IC1*.

Wire the board exactly as detailed in the wiring diagram at the right in Fig. 2. Make certain you mount the transistors with the proper basing and that you double check their numbers to be sure that you haven't transposed the npn and pnp devices before soldering their leads to the pads on the solder side of the board. Bear in mind that the LM741 operational amplifier is in a round "can"-type case, with its leads arranged in a circular pattern. Since you'll be using a DIP (dual in-line) IC socket, you must preform the IC's leads to conform with the DIP arrangement

before plugging it into the socket. Note, too, that *R14* and *R16* mount on the *solder* side of the board.

The only components that don't mount directly on the board are the piezo buzzer, ZERO control, LEDs, input jacks, batteries and switches. All but the batteries mount on the front panel of the enclosure in which the project is housed. The batteries fit into their own compartment inside the recommended enclosure (see Parts List), which is formed by a slide-in plastic, metal or circuit-board material panel. Interconnecting wiring between the pc circuit assembly and off-the-board components is accomplished with short lengths of hookup wire or, as in the case of the piezo buzzer, its own wire leads.

Machining of the front panel of the enclosure is very simple. All you need do is drill eight holes, as shown in the lead photo. Three holes are required for the piezo buzzer, two small ones for actual mounting and one larger one to allow the sound to project outward. The panel-mount LEDs and ZERO control each require only one mounting hole. The same goes for the switches. Simple round holes are needed for miniature toggle-type switches. If you use slide-type switches instead, cut rectangular slots for their toggles and drill two small holes for their mounting hardware.

After machining the front panel and before mounting the components in their respective locations, use a dry-transfer lettering kit or a tape labeler to label the front panel as shown in the lead photo. Then follow Fig. 1 to interconnect the components that are mounted on the front panel. Keep in mind that the two outer lug wires for *R7* go to holes that are side by side on the board. The wiper wire goes to the indicated *end* hole in the three-hole arrangement. Also, make certain when you wire the buzzer into the circuit that you connect its color-coded leads to

the appropriate points. Note that all interconnect wires go to the solder side of the circuit board. Then drill the holes for the input jacks in the bottom wall of the enclosure. Mount the jacks, and connect them into the circuit with short lengths of hookup wire.

You can use just about any type of pointed-probe test leads for this project. If you already have other instruments with pluggable test leads, you don't even have to buy new ones just for this accessory. However, make sure that the test leads you do use are color coded so that you can get proper polarity indication when using the Current Detector. Use red for + and black for -. You can mount a metal clip on one side of the project's enclosure to hold one probe so you can hold the project conveniently in your hand as you poke around in a circuit to locate short circuits.

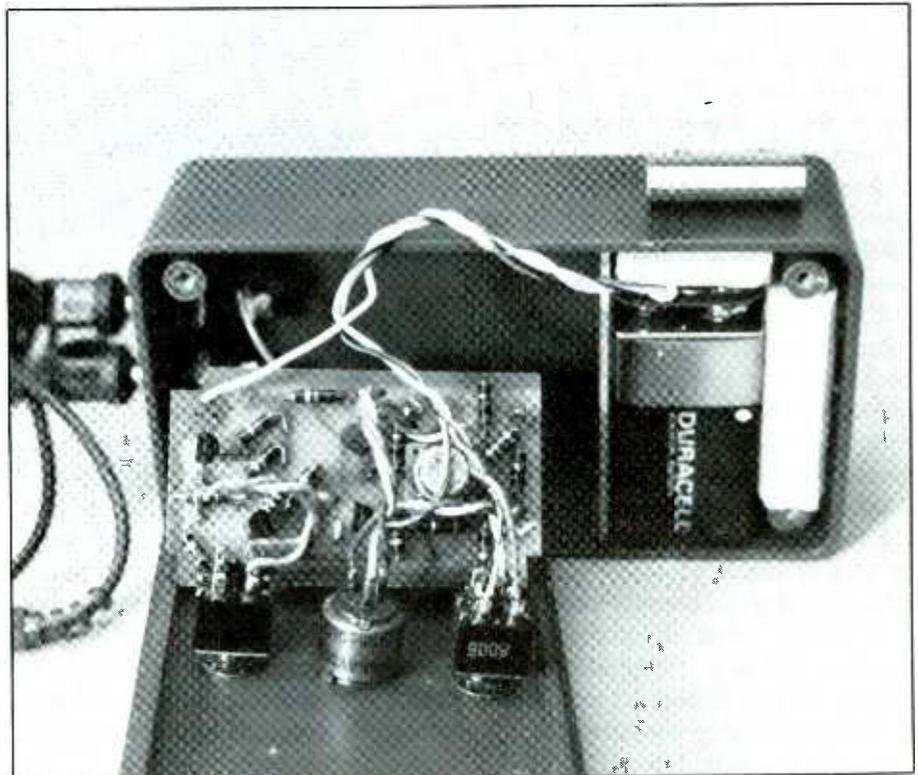
Figure 3 shows an interior view of the finished Short-Circuit Detector

in the recommended Radio Shack enclosure. As you can see, the circuit-board assembly, sized just right, fits into one pair of slot guides, the separator panel for the batteries in another. This eliminates the need to machine the enclosure for mounting hardware for these items.

### ***How to Check for Short Circuits***

Using the Short-Circuit Detector to locate short circuits in an electrical circuit or electronic assembly is very simple. Keep in mind, though, that the Detector is an "accessory" that's designed to be used in conjunction with a current source. As explained earlier, this current source can be an ordinary ohmmeter set to its lowest-resistance range, a flashlight circuit with its cells and lamp in series with the circuit under test, a low-voltage dc power supply with a series limiting resistor (150 ohms in series with 5 volts, for example), or a high-

*(Continued on page 96)*



*Fig. 3. Interior view of assembled project.*

# Telephone Memory Dialer

*This accessory economically converts any telephone into a 10-number memory dialer and can be installed internally or configured as a stand-alone unit*

By Anthony J. Caristi

**W**ith a new integrated circuit and a handful of external discrete components, you can convert any telephone—whether rotary or keypad dialer—into a 10-number memory dialer. To be described here is such an accessory that you can build in just a few hours. It's a simple, low-cost electronic device that provides true Touch Tone® dialing and features a built-in memory that allows you to store up to 10 of your most frequently called telephone numbers, each of which can contain up to 16 digits. With this capability, the project can store entire telephone numbers, including area code and the initial "1" required in some areas and on some services.

Powered directly from the telephone line, our Telephone Memory Dialer never needs batteries or ac line power to operate. The only time you might ever need batteries (in this case, a pair of AA cells) is if you build into the project the optional power backup circuit to maintain the numbers stored in memory when the Dialer is moved from one location to another. When used in this manner, the batteries will have a useful operating life roughly equal to their shelf life, which should average between 2 and 5 years. At all other times, the memory function is kept alive by a minute current of about 1 microampere or so from the telephone line.

You can build the Telephone Memory Dialer as a stand-alone unit or use it in combination with an ex-



isting telephone. If your present phone has an old-fashioned rotary dial that outputs pulses instead of tones, this project will inexpensively upgrade it to modern Touch Tone dialing. The circuit board on which the Dialer is assembled is small enough to fit inside many pushbutton telephones to convert them into memory phones.

In addition to its standard 10-number storage capability, the Telephone Memory Dialer has storage capacity for one more number that can be redialed as often as needed until you get through on a busy line.

This redial memory is automatically loaded with the last number dialed in the normal manner via the Dialer's keypad.

Our Telephone Memory Dialer is compatible with all telephone systems that operate with Touch Tone dialing and, when used as described, has no effect on normal telephone service.

## About the Circuit

At the heart of the Telephone Memory Dialer, shown schematically in Fig. 1, is telephone dialing chip *IC1*.

This integrated circuit contains all the circuitry (except the crystal) needed to produce valid Touch Tone frequency pairs. It also contains memory storage for up to 10 frequently called numbers and a redial memory buffer that retains in memory the last number dialed.

This IC interfaces to a common 3 × 4-matrix keypad (see Fig. 2) that has four row wires identified as r1, r2, r3 and r4 and three column wires identified as c1, c2 and c3. The \* and # buttons on the keypad are used to store and retrieve telephone numbers you've loaded into memory. The IC retains data with a current drain of just 1 microampere when the circuit is in its standby mode, permitting memory retention with only a minuscule current drawn from the telephone line.

A commonly available and inexpensive 3.58-MHz color TV burst frequency crystal, identified as XTAL in Fig. 1, is used by IC1 to generate the required Touch Tone frequency pairs. Frequency dividers on the chip provide the correct division ratios to produce the unique frequency pairs for each key closure of the keypad.

A diode bridge consisting of D1 and D4 assures that the correct dc polarity from the telephone line is applied to the circuit, regardless of the polarity of the voltage at the L1 and L2 input connectors. With R1 wired across power switch S1A as shown, sufficient memory-retention current is delivered to IC1 when S1 is opened to assure retention of the stored telephone numbers.

When S1 is closed (the Dialer is switched on), light-emitting diode LED1 and zener diode D5 ensure that the potential applied to IC1 is never more than 12 volts. In addition, current through LED1 provides a visual indication that the circuit has been activated. Note, however, that when the Telephone Memory Dialer is incorporated into an existing telephone instrument, LED1 is not used,

since the instrument itself will draw current from the telephone line when it is off-hook. In this case, D5 will not draw current.

When S1B is open (off position), IC1 will remain in the standby mode, since Q1 will not be conducting. Closing S1B forward biases Q1's base and causes the transistor to conduct. This pulls Q1's collector low (to 0 volt). This low condition, impressed on pin 15 of IC1, activates the chip. Then when any keypad button is pressed, the divider circuit inside IC1 will produce a valid Touch Tone frequency pair for that button, which will appear at pin 16 of the IC. Transistor Q2 then amplifies the pin 16 output from IC1 and places the tones on the telephone line for processing by the telephone network.

When dialing out a telephone number, the first digit pressed can not be a \* or #. These keys are reserved in the project for storing telephone numbers in memory and later recalling them. Though they can not be the first digit dialed, \* and # can be entered as valid keystrokes for any part of the remainder of the telephone number being dialed.

If a telephone number containing more than 16 digits is dialed, the redial buffer will be inhibited, though you can still dial out the full number. To redial a number stored in the redial buffer, all you need do is tap the # key twice. You can do this any number of times until you get through to the party you're calling. Just keep in mind that the number will automatically be canceled if you should key in a new number in the meantime. The last number keyed in automatically replaces the previous number in the redial buffer.

To store a telephone number in the Dialer's "permanent" memory, you first press the \* key and then the location in memory where you want to store the number. The selected memory location can be any single digit between 1 and 9 on the keypad. This "opens" that location, at which

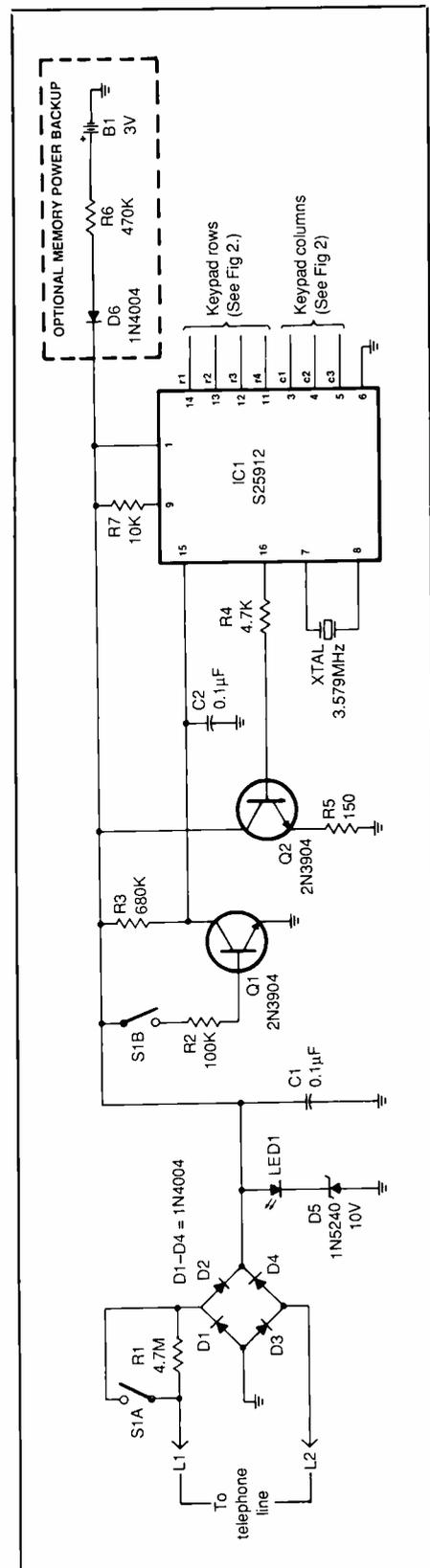


Fig. 1. Overall schematic diagram, minus keypad details for the Telephone Memory Dialer.

## PARTS LIST

### Semiconductors

D1 thru D4, D6—1N4004 or similar silicon diode

D5—1N5240 or similar 10-volt zener diode

IC1—S25912 (Gould/AMI) 10-memory DTMF telephone dialer

LED1—Red light-emitting diode

Q1, Q2—2N3904 or similar npn silicon transistor

### Capacitors

C1, C2—0.1 $\mu$ F, 25-volt disc

### Resistors (1/4-watt, 10% tolerance)

R1—4.7 megohms

R2—100,000 ohms

R3—680,000 ohms

R4—4,700 ohms

R5—150 ohms

R6—470,000 ohms (optional—see text)

R7—10,000 ohms

### Miscellaneous

B1—3-volt battery (2 AA cells in series; optional—see text)

S1—Dpst slide or toggle switch (required in stand-alone dialer only—see text)

XTAL—3.579-MHz color TV crystal  
Printed-circuit board or perforated board and suitable soldering or Wire Wrap hardware; socket for IC1; keypad (3  $\times$  4-key matrix or equivalent; Refac Electronics Corp. No. WRKB002BWM—see text); dual AA-cell holder; suitable enclosure (stand-alone units only); machine hardware; hookup wire; solder, etc.

**Note:** The following items are available from A. Caristi, 69 White Pond Rd., Waldwick, NJ 07463: pc board for \$6.25; S25912 IC for \$10.75; keypad for \$9.75. Add \$1.00 P&H. New Jersey residents, please add state sales tax.

time, you simply key in the desired number as when dialing that party. During the store operation, the Touch Tone frequencies will not be placed on the telephone line.

To recall a previously stored number from memory, simply press the

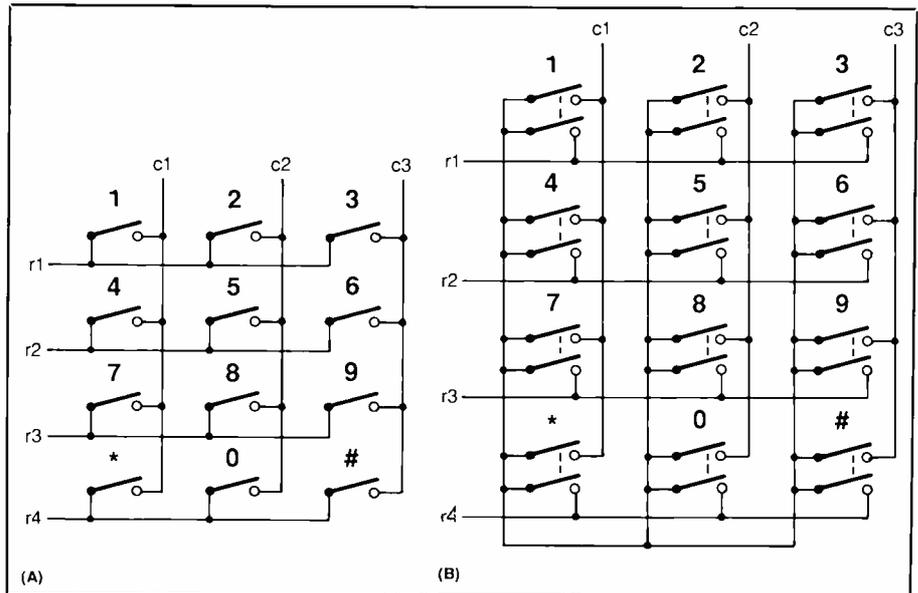


Fig. 2. Schematic details of acceptable keypads for use with project. Most common is matrix keypad shown in (A), though 2 of 7 to common keypad shown in (B) is also acceptable. Common wire on latter is not used.

#, followed by the key that corresponds to its location in memory.

### Construction

Before you proceed to building the project, decide on the configuration that suits your needs. You have a choice of three ways to go. You can build the Telephone Memory Dialer as a stand-alone unit that's complete in itself and is powered from the telephone line. You can build it as a stand-alone unit, still powered from the telephone line, but with memory backup power provided by a pair of AA cells that make the project transportable without loss of stored telephone numbers. Lastly, you can modify an existing telephone instrument, using either its matrix keypad or a substitute keypad and omit or incorporate the AA-cell memory-retention feature as desired and house the entire circuit inside the instrument.

Since there are many variations of telephone instruments on the market, it would be impossible to provide specific instructions to modify every one of them. However, the following general discussion should

be sufficient to get you started on the right track.

As with most other electronic circuits that don't require special component layout, conductor routing or both, the Telephone Memory Dialer can be assembled using just about any of the traditional wiring techniques. However, the simplest technique, and most preferable if you're planning on building the project into an existing telephone instrument, is to use a printed-circuit board. You can fabricate this board yourself, using the actual-size etching-and-drilling guide shown at the left in Fig. 3. Alternatively, you can purchase a ready-to-wire board from the source given at the end of the Parts List.

The construction procedure described from here on assumes the use of a pc board. If you've decided to use perforated board and suitable soldering or Wire Wrap hardware, you can easily make any adjustments in layout and wiring as needed.

Wire the board exactly as shown in the illustration pictured at the right in Fig. 3. Use a socket for IC1 and solder this into place before you plug

in the IC. Make sure you properly orient the IC, transistors, diodes and LED before you solder any leads to the pads on the soldering side of the board.

Most of the circuitry of the Telephone Memory Dialer is contained on the compact 2 3/4" by 1 1/4" pc board. This small assembly is compact enough to be concealed inside many existing telephone instruments. If you've decided to build a stand-alone unit, you'll need in addition to the basic pc circuit assembly a keypad, a light-emitting diode and a double-pole, single-throw switch to complete the circuit. All components required for the project are detailed in the Parts List.

When modifying an existing telephone instrument, the switch and LED aren't used. In most cases, you'll be able to utilize the existing keypad in the instrument. The keypad that must be used with this circuit can be either a matrix type that shorts one row wire to one column wire, as in Fig. 2(A), or closes two of seven wires to a common wire, as in Fig. 2(B).

When building a stand-alone unit,

be sure to use a telephone cord terminated in a modular plug to make the connection to the telephone line. This will make it easy to connect and disconnect the project to and from the telephone line. It is also an FCC requirement for ancillary equipment connected to the telephone line.

If you plan to modify an existing telephone instrument, you must first determine its keypad configuration. To do this disconnect the instrument from the telephone line. Then use an ohmmeter, set to its lowest range, to determine which wires short together for each button of the keypad. Once you know which wire pair shorts together for each key, you should be able to identify the row (r1 through r4) and column (c1, c2 and c3), as shown in Fig. 2.

Once you're satisfied that your keypad meets the circuit's requirements (if it doesn't, you'll have to substitute one that does), disconnect from the telephone circuit and label each wire. Now, referring to the drawing at the right in Fig. 3, connect each of these wires into the Telephone Memory Dialer's circuit according to the row and column design-

nators marked on the keypad wires and the holes in the board on opposite sides of IC1. Work carefully to avoid making any wiring errors at this stage. If you do make a wiring error, your telephone will send the wrong tone pairs out over the telephone line when you dial a number.

There are two circuits in the Telephone Memory Dialer that are operated automatically by the modified telephone instrument. These are the power-on function that's controlled via S1A and the chip-enable function that's controlled by S1B. Since S1 isn't used in the modified circuit, the telephone instrument's hookswitch will replace S1A and the telephone circuit will provide forward bias to Q1 (see Fig. 4).

Determine the location of the hookswitch inside the telephone instrument you're modifying. Some instruments have a double-pole hookswitch that breaks both the L1 and the L2 telephone-line connections. If yours is like this, you need concern yourself with only the pole that breaks the L1 connection.

When you've determined the location of the hookswitch connections in the instrument being modified, connect R1 (a 4.7-megohm resistor) across the normally closed contacts (the telephone's on-hook circuit). Then make the connections between your telephone circuit and the diode bridge in the Telephone Memory Dialer's circuit, as indicated in Fig. 4. (The dc polarity of the telephone line isn't a factor when wiring to the bridge circuit.)

With a dc voltmeter, set to a range that can conveniently indicate between 10 and 50 volts, determine what component or wire in the telephone instrument is at +5 to +12 volts when the phone is off-hook and is at 0 volt when it's on-hook. Make sure when making these measurements that you connect the voltmeter's negative probe to the telephone

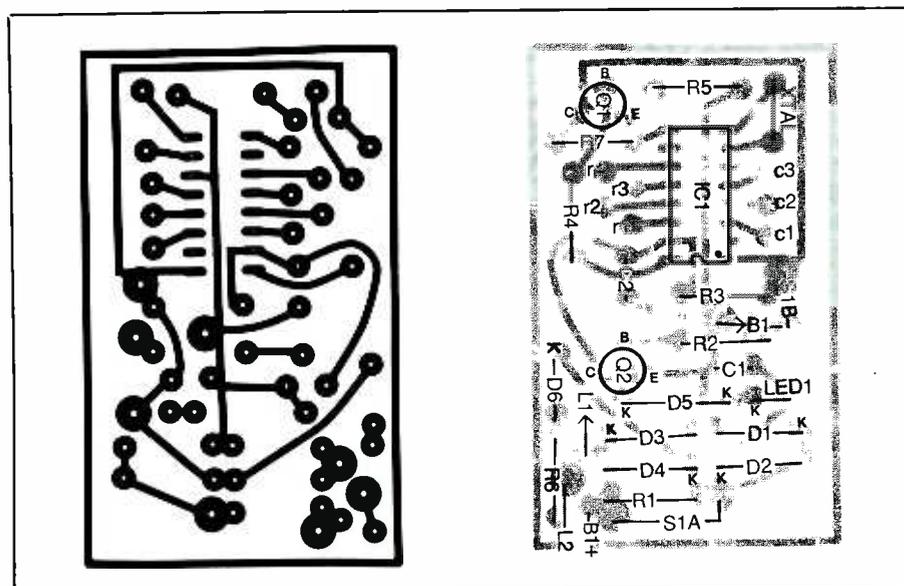


Fig. 3. Actual-size etching-and-drilling guide for pc board is shown at left, wiring diagram for board is shown at right.

(Continued on page 90)

# Memory Expansion For Apple IIe 80-Column Card

*Low-cost 64K retrofit board lets you take advantage of the "extra-memory" feature offered by some software*

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By D.N. Ellis

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I was very pleased with the performance and capabilities of my Apple IIe computer and its 80 Column Text Card—until the "Appleworks" integrated software package appeared on the scene. With Appleworks loaded into my computer, all I had left in the way of available user memory was 10K. That's when I missed the 55K of memory Appleworks makes available when an Extended 80 Column Text Card is used. Unfortunately, I had neglected to get the Extended 80 Column Text Card when I bought my computer.

Though I could have just purchased an Extended 80 Column Text Card to solve my dilemma, I didn't want my old card to serve as a constant reminder of my shortsighted economy. So I decided to see if I could upgrade my present text card. After close study of the hardware and a bit of brainstorming, I succeeded in devising a way to add a full 64K of RAM on a card that piggy-backs my standard 1K 80 Column Text Card. Now I have all the advantages of the Extended 80 Column Text Card at only a fraction of what it would have cost me to buy an Extended Card from Apple.

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## Some Details

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To maintain as much compatibility as possible with existing software and hardware, the designers of the Apple

IIe wove the IIe 80 Column Text Card design into the existing Apple II architecture. This was accomplished by using the same address space for the 80-column display as for the 40-column display and interleaving data from the existing 40 columns with another 40 columns of data from the 80 Column Text Card in the new Auxiliary slot. To accomplish this, new signals were created to enable the 80 Column Text Card when activated by software.

In the new scheme, the character generator and video output shift register are exercised at twice their original rate. The net effect is 80 columns of video display consisting of 40 of the original columns interspersed with the additional 40 columns from the 80 Column Text Card in the Auxiliary slot. The additional 40 columns of text occupy 1K of RAM on the 80-Column Text Card. On Extended 80 Column Text Cards, there's 64K of RAM. In 40-column mode, all 64K is available for program usage, while activation of the 80-column display mode reduces the extra available memory to 63K.

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## Making the Modifications

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To be able to substitute 64K of RAM for the existing 1K of RAM already on the Apple IIe 80 Column Text Card, you need detailed information about the Apple IIe Auxiliary slot signals, the 80 Column Text Card, and the 64K of RAM to be added. A

description of the Auxiliary slot signals is given in the *Apple IIe Reference Manual*, while a representative schematic diagram of the extra 64K of RAM to be added appears in the Apple IIe Extended 80 Column Text Card Supplement.

You can search out this information on your own, by physically probing the 80 Column Text Card with a continuity checker or by referring to the printed materials. However, to make your task easier, much of the information you need is provided in Fig. 1. This complete schematic diagram of the 80 Column Text Card shows the Auxiliary slot signals in the Apple IIe computer and the wiring of the on-board 1K of memory RAM. The Fig. 2 schematic diagram of the 64K Memory Expansion Upgrade circuit shows how the 2158B RAM IC on the 80 Column Text Card is replaced by a home-built board containing a bank of eight 4164 (64K × 1) dynamic RAMs (U1 through U8) that connect to the 80 Column Text Card via a ribbon cable. It also shows how a 16-pin jumper plug replaces a 74LS75 on the 80 Column Text Card and how a second 16-pin jumper plug replaces the 20-pin 74LS374.

This upgrade consists basically of the eight RAM chips that you Wire Wrap in sockets on a separate board that then "piggy-back" mounts on the existing 80 Column Text Card and interconnects to it via the ribbon cable/plug assembly. The new card

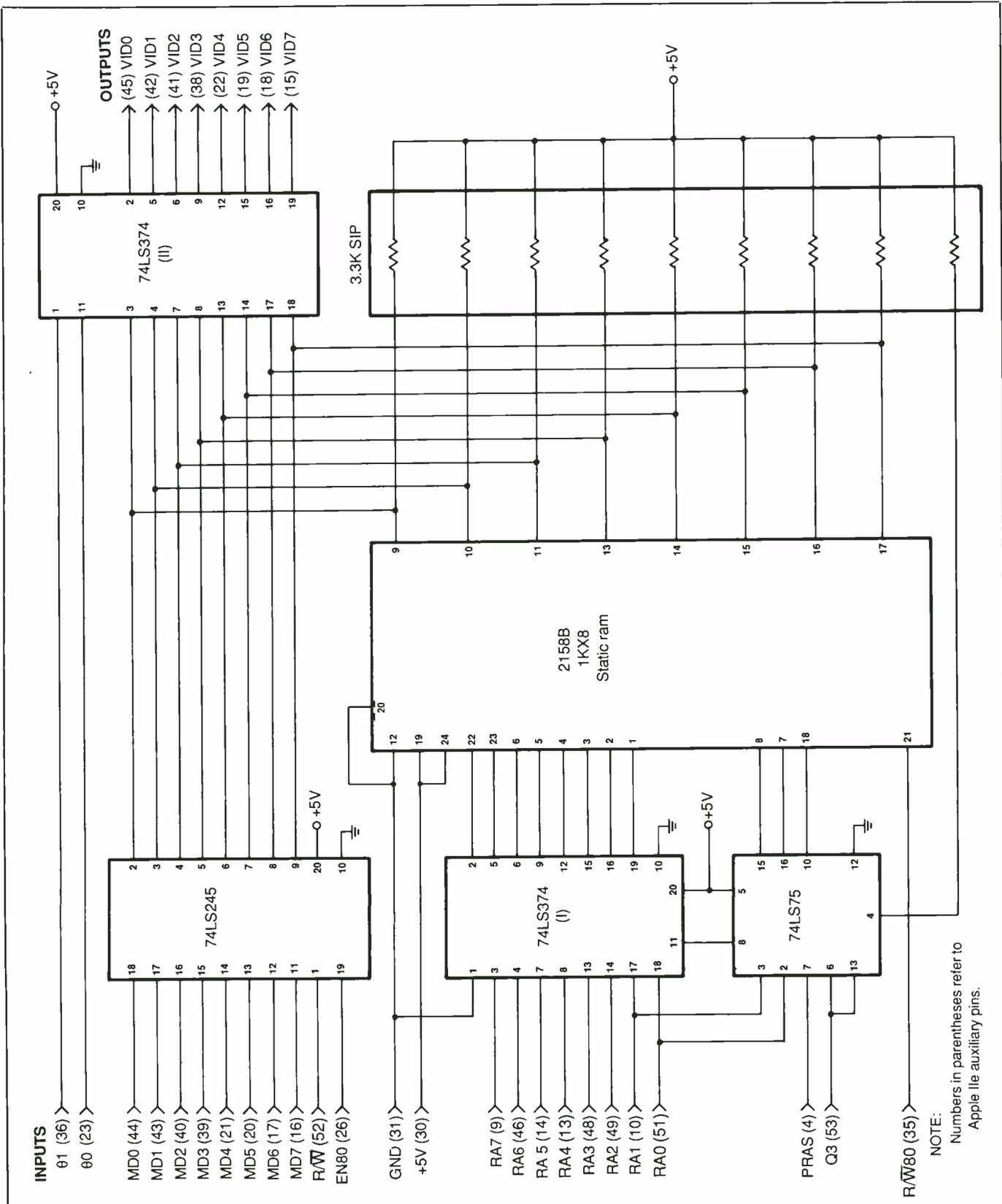
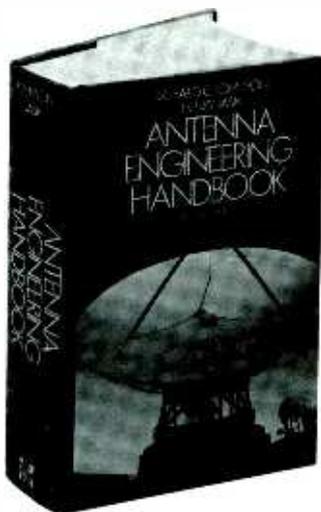


Fig. 1. Schematic details of standard Apple IIe 80 Column Text Card, including bus signal assignments.

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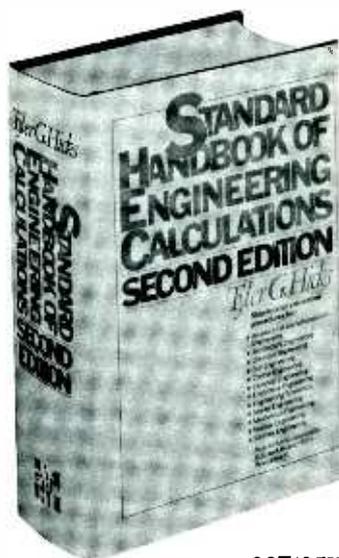
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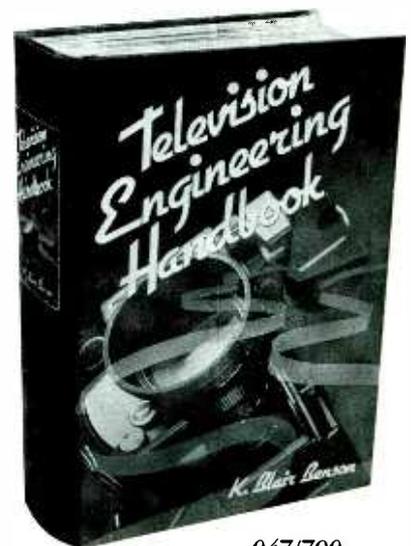
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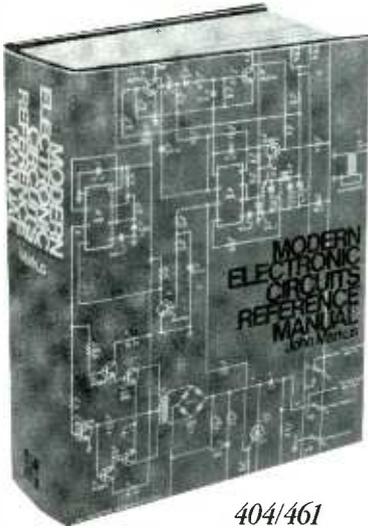
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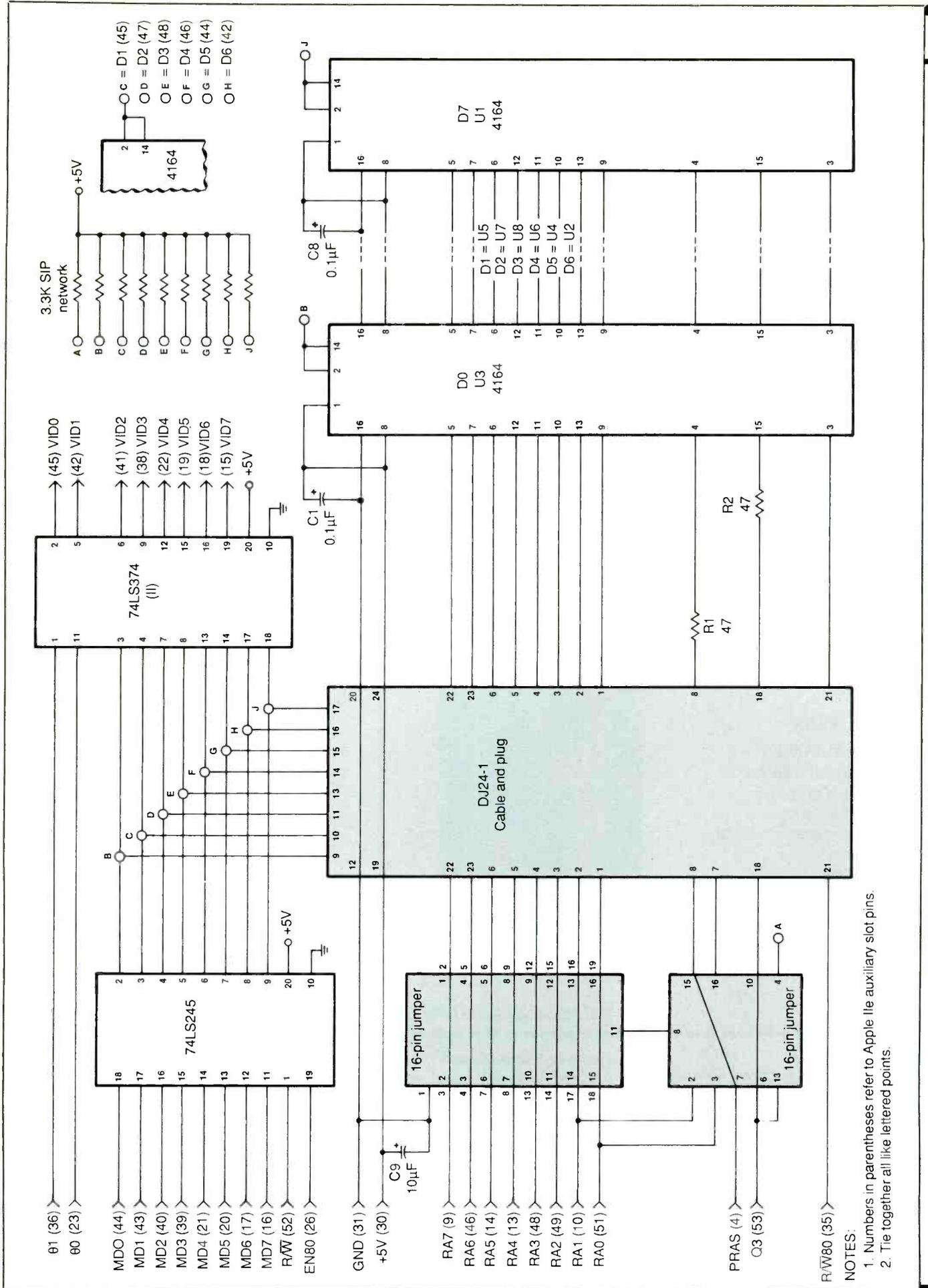
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NOTES:  
 1. Numbers in parentheses refer to Apple IIe auxiliary slot pins.  
 2. Tie together all like lettered points.

Fig. 2. Schematic diagram of 64K Memory Upgrade add-on for standard Apple IIe 80 Column Text Card.

## PARTS LIST

C1 thru C8—0.1- $\mu$ F, 35-volt tantalum capacitor

C9—10- $\mu$ F, 35-volt tantalum capacitor

R1,R2—47-ohm, 1/2-watt, 10% tolerance resistor

U1 thru U8—4146N-200 (200-ns) 64K  $\times$  1 dynamic RAM

Misc.—Perforated board with holes on 0.1" centers (Vector No. 64P44WE or similar); 8 low-profile, 16-pin Wire Wrap IC sockets for U1 through U8; Wire Wrap pins (Vector No. T-44 or similar); 24-pin DIP socket and ribbon cable (AP No. DJ24-1); 16-pin headers (2); about 50 ft. Kynar wrapping wire (preferably color coded); epoxy cement or silicone adhesive (see text); 3 sets 4-40  $\times$  1" machine screws, nuts and lockwashers; insulating fiber washers (see text); 1/4" spacers; solder; etc.

**Note:** The specified perforated board, Wire Wrap pins and plug/cable assembly are available from Jameco. Low-profile Wire Wrap sockets are available from Digi-Key. Most items listed are available from other sources as well.

mounts to the front of and fits between the 80 Column Text Card and the power supply when the combined assembly is plugged into the Apple IIe's Auxiliary slot.

No permanent alterations to the 80 Column Text Card are made by this upgrade. You don't even have to run +5-volt and ground wires from the computer's bus to the 64K Memory Upgrade card; these are supplied via the ribbon cable that plugs into the socket for and replaces the 2158B 1K RAM chip on the 80 Column Text Card. So any time you wish to restore the 80 Column Text Card to its original configuration, you can do so simply by unplugging a ribbon cable, dismounting the 64K Memory Expansion Upgrade board and replacing

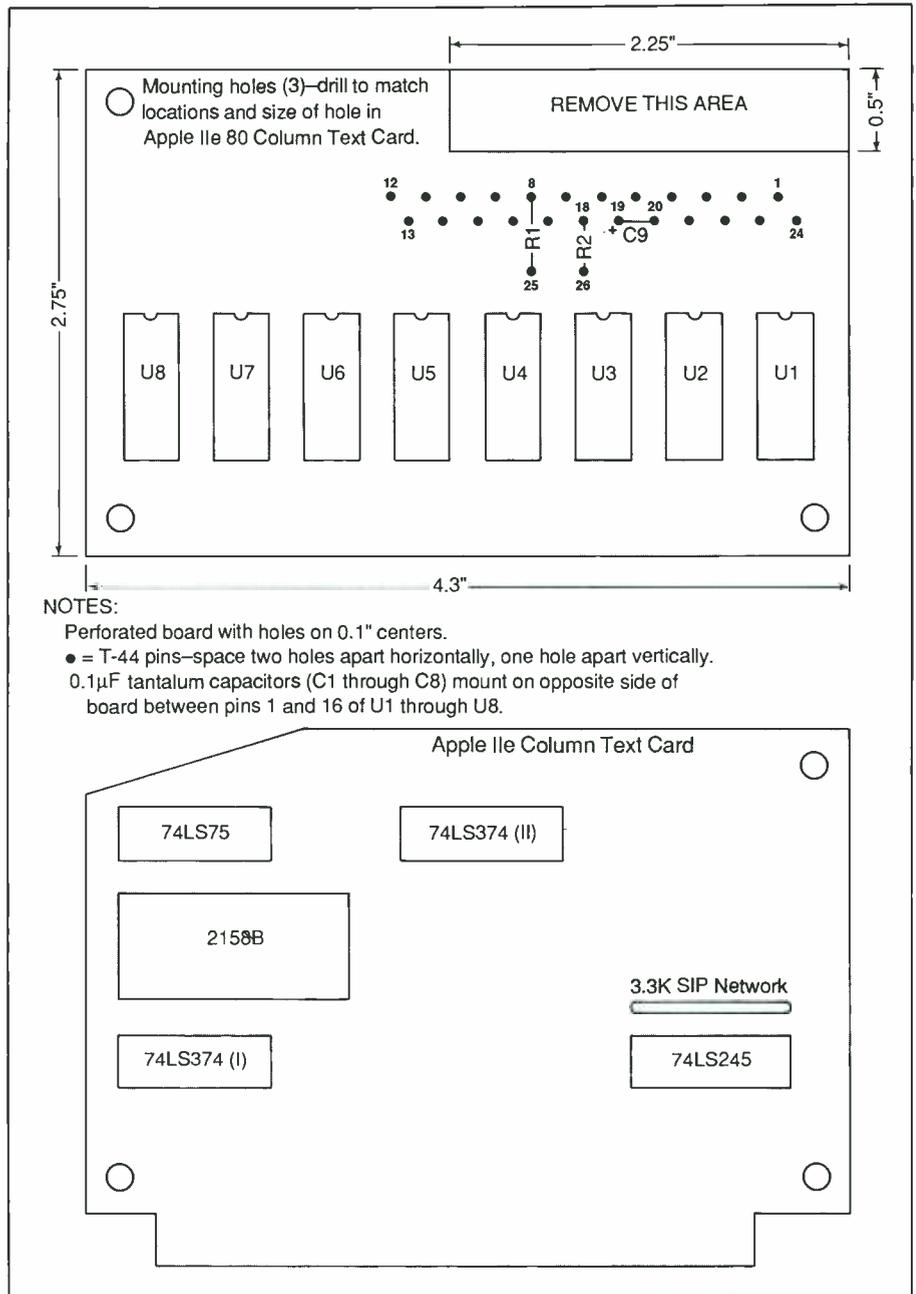


Fig. 3. Dimension details and hardware location/layout for 64K memory add-on board for 80 Column Text Card (upper) and locations and identifications of components on standard 80 Column Text Card (lower).

the ICs you removed from the 80 Column Text Card's sockets during modification.

When you're ready to get started, make sure your Apple IIe's power is turned off before you even open the computer's case. Also, always power down your computer whenever you

have to remove or plug in a board or an IC. If you make any insertions or removals with the power turned on, you can damage an IC, a plug-in board or/and the computer itself.

With the power turned off, remove the 80 Column Text Card from the computer's Auxiliary slot. Refer-

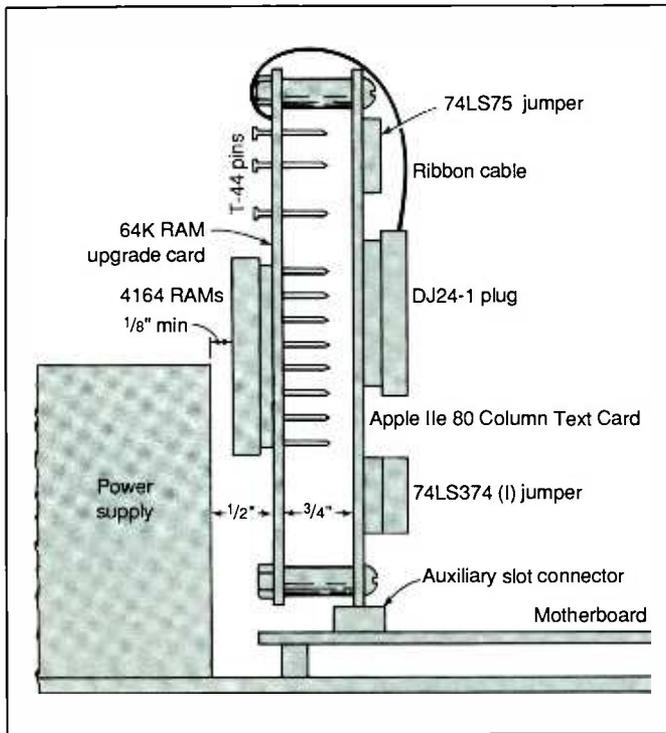
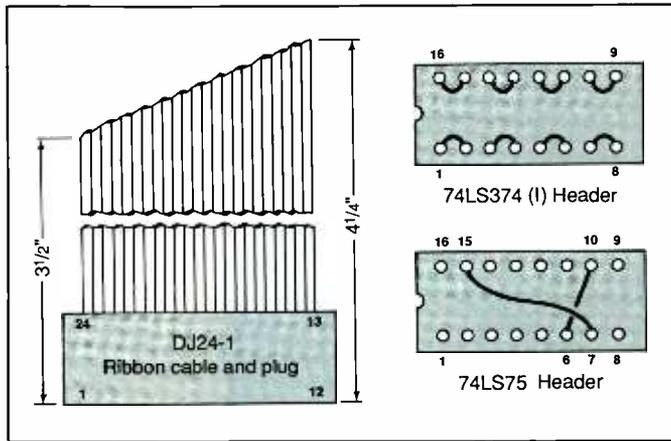


Fig. 4. End-view details of 80 Column Text Card with add-on memory board installed in Apple IIe Auxiliary bus slot shows clearances and mounting.

Fig. 5. Ribbon cable trimming details and wiring details for 16-pin DIP headers that replace ICs on 80 Column Text Card. Note how 16-pin 74LS374(I) header plugs into a 20-pin socket.



ring to Fig. 3, trim the perforated board to the dimensions shown in the upper drawing. Cut away and discard the indicated portion of the board. This done, place the perforated board against the rear of the 80 Column Text Card, shown in the lower drawing in Fig. 3, so that the cut-away area is at the top and faces in the same direction as the slope on the Text Card. With a sharply pointed pencil or a scribe, draw the outlines of the three corner holes in Text Card onto the perforated board. Set aside the Text Card. Then drill holes through the three marked circles; make these holes the same size as those in the 80 Column Text Card.

Make a trial fitting of the perforated board, using 4-40 x 1" machine screws, nuts and 3/4" spacers to check alignment with the 80 Column Text Card. When properly mounted, the perforated board should be spaced 3/4" from the surface of the solder side of the Text Card, as shown in Fig. 4. With this assembly plugged into the Auxiliary slot of your (powered-down) computer, there should be

about 1/2" of clearance between the surface of the perforated board and the power supply in the computer, as shown. Test fitting is important at this stage because if any adjustments must be made to assure proper alignment, they'll be far easier to make now than if you wait until later on when the new board is fully wired and populated.

While you have the two boards fastened to each other, check to make sure that the screw heads are electrically isolated from the 80 Column Text Card. If any isn't, plan on using insulating fiber washers between them and the board at each location where the problem exists.

Referring to the upper drawing in Fig. 3, cement low-profile 16-pin Wire Wrap IC sockets to the perforated board with epoxy cement or silicone adhesive. Do *not* install any RAMs in the IC sockets until after the 64K Memory Expansion Upgrade board is fully wired and interconnected with the 80 Column Text Card. Leave enough room at the top of the board so that the sockets don't

interfere with the machine hardware that will hold together the two boards, and space the sockets across the board so that there's a column of holes between each. Avoid getting cement or adhesive on any socket pins or into any socket receptacles.

While the cement or adhesive sets, wire the two jumper headers as detailed in Fig. 5. You can use bare wire for the header that goes into the 74LS374(I) socket on the 80 Column Text Card, but be sure to use insulated wire for the bridging conductors on the 74LS75 header. You might want to place a label with the IC identification written on it on each header for easy reference. (A jumper header is a simple way to route needed signals to the dynamic RAM on the 64K Memory Expansion Upgrade board without having to alter the 80 Column Text Card.)

Trim the ribbon cable connected to the DJ24-1 socket/cable assembly on a diagonal, as shown in Fig. 5. Make certain that the plug end is oriented as shown before you mark and cut the cable. After cutting the cable,

separate the conductors about  $\frac{3}{4}$ " from the cut end and carefully strip about  $\frac{3}{16}$ " of insulation from each. Twist together the fine wires in each conductor and tin with solder.

When the cement or adhesive between the sockets and perforated board has completely set, use narrow-nose pliers to insert T-44 pins into the holes in the board as shown in Fig. 3. Stagger these pins as shown and start the lower row near the lower edge of the board to make it easier to connect and solder the DJ24-1 cable them. Space the two rows of pins (numbered from 1 through 12 and 13 through 24) two board holes apart horizontally and the two rows one hole apart vertically. Then install pins 25 and 26 vertically in line with and as far as possible from pins 8 and 18, respectively, as the IC sockets will allow.

Trim the leads of the two 47-ohm resistors to as short as needed. Connect one resistor between pins 8 and 25 and the other resistor between pins 18 and 26. Similarly, trim the leads of the 10-microfarad tantalum capacitor as needed and connect it between pins 19 (+ side) and 20 (- side). Solder all six connections.

Flip over the board. Trim all leads of the eight 0.1-microfarad tantalum capacitors to about  $\frac{1}{2}$ ". Connect and solder one of these capacitors between pins 1 (+ side) and 16 (- side) of *U1*'s socket. Repeat this connect-and-solder procedure for the remaining capacitors and the sockets for *U2* through *U8*.

Place the 64K Memory Expansion Upgrade board component side up on your work surface and orient it so that the notched area is facing toward you. Then place the DJ24-1 plug/cable assembly between you and the board, with the connector nearest you and its pins facing down toward the work surface (see Fig. 5). The diagonal cut in the ribbon cable should now slope up and to the right. Also, in this orientation the numbered conductors of the cable will

now align directly with the numbered T-44 pins on the perforated board.

Connect and solder the left-most conductor of the ribbon cable (connected to plug pin 24) to T-44 pin number 24. Connect and solder the next conductor to the right (connected to plug pin 1) to T-44 pin 1. Repeat this procedure for all succeeding conductors and T-44 pins, finishing with the right-most cable conductor (connected to plug pin 12) going to T-44 pin 12. When you're through, use an ohmmeter or continuity tester to make sure that all wiring is correct.

Now Wire Wrap the 4164 RAM sockets into the circuit. This is the most difficult part of assembly, basically because of the repetitive nature of the wiring, which can lead to errors if you're not careful. When wiring the circuit, keep the conductors as short and the routing as direct as possible to preserve the timing requirements of the extended memory you're installing. That is, when you wire a pin of an IC socket to the same pin of each of the other sockets, start the wrapping run at *U1*'s socket,

proceed to the same pin on *U2*'s socket, then *U3*'s socket, and so on, ending with *U8*'s socket. Alternatively, you can start with the *U8* socket and work backward to the *U1* socket. Do *not* start with a socket somewhere in the middle of the bank and work randomly until all common pins are tied together.

Shown in Fig. 6 is a detail of the wiring for the RAM sockets. To make matters as foolproof as possible, however, wire the sockets according to the steps given in Checklist 1. As you make each wrap connection and wire run, check the box to the left of that step on the Checklist line. Begin your wiring with the first step in Checklist 1 and from there work down the list. When you've completed all wraps in Checklist 1, use an ohmmeter or continuity tester to check all wiring for continuity and shorts to the wrong pins before continuing to the next part of assembly.

Next, wire the T-44 pins to the RAM sockets as detailed in Checklist 2 and Fig. 7. The "T" designator in the Checklist is for the T-44 terminal

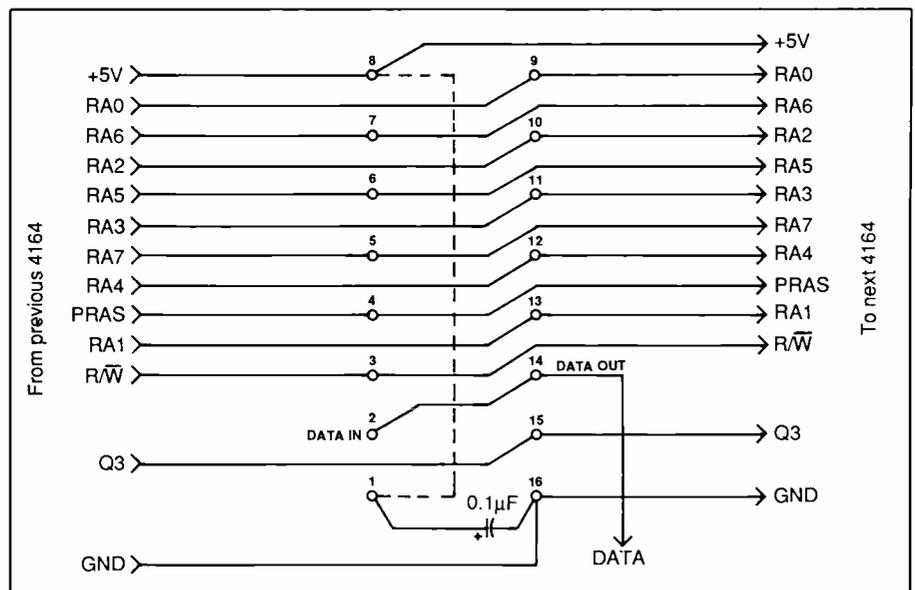


Fig. 6. Wiring details for just one RAM socket. Wire runs must be continuous for same-numbered pins in ascending or descending order from first RAM socket to last in bank, as explained in text.

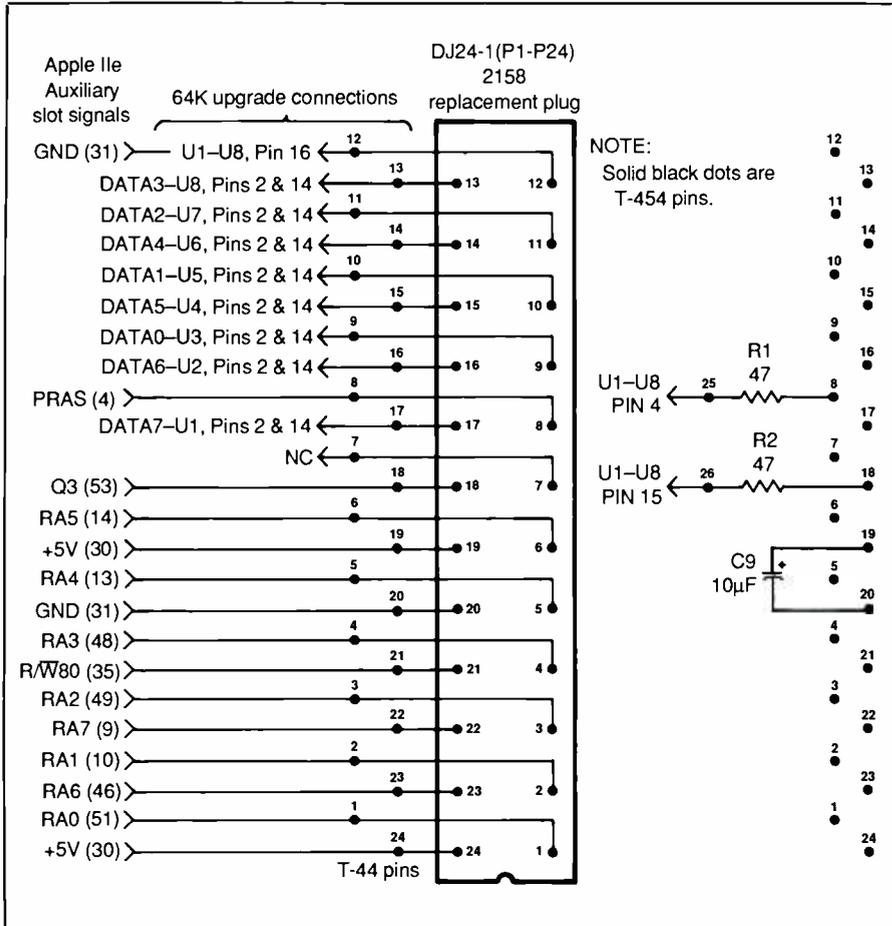


Fig. 7. Ribbon cable conductors on DJ24-1 plug assembly wire to T-44 pins on memory upgrade board as shown. Note that each plug pin conductor goes to the same-numbered T-44 pin.

that corresponds to the particular conductor number of the DJ24-1 ribbon cable. Note that T25 and T26 are the "other" ends of the two 47-ohm series resistors for the PRAS and Q3 signals, respectively. After you perform the wiring steps in Checklist 2, check all wiring for continuity and shorts to the wrong pins.

### Final Steps

Carefully remove the 74LS374(I), 74LS75 and 2158B integrated circuits from the 80 Column Text Card (see lower drawing in Fig. 3 for locations of these ICs). Make sure you don't bend or otherwise distort any IC pins, and handle the 2158B static

RAM chip with the care required for any MOS device to prevent it from being damaged by static electricity. Plug the pins of all three ICs into a piece of conductive foam carrier of the type used for shipping and storing MOS ICs. Then put this in a safe place where it will be readily available should you ever decide to restore the 80 Column Text Card to its original condition.

Plug the jumper header labeled "74LS75" into the same numbered socket on the 80 Column Text Card, orienting it in the same manner as the IC it replaces. Then plug the "74LS374(I)" jumper header into the same numbered socket on the 80 Column Text Card. Note, however, that

### Checklist 1. RAM Interconnections

Wrap From	To	Signal
<input type="checkbox"/> U1 pin 16	U2 thru U8 pin 16*	GND
<input type="checkbox"/> U1 pin 1	U1 pin 8	+5V
<input type="checkbox"/> U2 pin 1	U2 pin 8	+5V
<input type="checkbox"/> U3 pin 1	U3 pin 8	+5V
<input type="checkbox"/> U4 pin 1	U4 pin 8	+5V
<input type="checkbox"/> U5 pin 1	U5 pin 8	+5V
<input type="checkbox"/> U6 pin 1	U6 pin 8	+5V
<input type="checkbox"/> U7 pin 1	U7 pin 8	+5V
<input type="checkbox"/> U8 pin 1	U8 pin 8	+5V
<input type="checkbox"/> U1 pin 2	U1 pin 14	D7
<input type="checkbox"/> U2 pin 2	U2 pin 14	D6
<input type="checkbox"/> U3 pin 2	U3 pin 14	D0
<input type="checkbox"/> U4 pin 2	U4 pin 14	D5
<input type="checkbox"/> U5 pin 2	U5 pin 14	D1
<input type="checkbox"/> U6 pin 2	U6 pin 14	D4
<input type="checkbox"/> U7 pin 2	U7 pin 14	D2
<input type="checkbox"/> U8 pin 2	U8 pin 14	D3
<input type="checkbox"/> U1 pin 8	U2 thru U8 pin 8*	+5V
<input type="checkbox"/> U1 pin 11	U2 thru U8 pin 11*	RA3
<input type="checkbox"/> U1 pin 12	U2 thru U8 pin 12*	RA4
<input type="checkbox"/> U1 pin 6	U2 thru U8 pin 6*	RA5
<input type="checkbox"/> U1 pin 10	U2 thru U8 pin 10*	RA2
<input type="checkbox"/> U1 pin 13	U2 thru U8 pin 13*	RA1
<input type="checkbox"/> U1 pin 7	U2 thru U8 pin 7*	RA6
<input type="checkbox"/> U1 pin 9	U2 thru U8 pin 9*	RA0
<input type="checkbox"/> U1 pin 5	U2 thru U8 pin 5*	RA7
<input type="checkbox"/> U1 pin 15	U2 thru U8 pin 15*	Q3
<input type="checkbox"/> U1 pin 3	U2 thru U8 pin 3*	R/W80
<input type="checkbox"/> U1 pin 4	U2 thru U8 pin 4*	PRAS

\*Make wire runs starting at U1 and working up in ascending order to U8, or starting at U8 and down in descending order to U1 (see text).

16-pin header is actually replacing a 20-pin IC and must be installed in the socket with a one-pin offset at both ends of the socket as shown. That is, no header pins plug into socket re-

**Checklist 2.  
From T-44 Pins to RAM IC Sockets**

From Terminal Pin	To	Signal
<input type="checkbox"/> T1	U1 pin 9	RA0
<input type="checkbox"/> T2	U2 pin 13	RA1
<input type="checkbox"/> T3	U3 pin 10	RA2
<input type="checkbox"/> T4	U4 pin 11	RA3
<input type="checkbox"/> T5	U5 pin 12	RA4
<input type="checkbox"/> T6	U6 pin 6	RA5
<input type="checkbox"/> T7	no connection	
<input type="checkbox"/> T23	U1 pin 7	RA6
<input type="checkbox"/> T22	U2 pin 5	RA7
<input type="checkbox"/> T9	U3 pin 14	D0
<input type="checkbox"/> T10	U5 pin 14	D1
<input type="checkbox"/> T11	U7 pin 14	D2
<input type="checkbox"/> T12	U8 pin 16	GND
<input type="checkbox"/> T12	U6 pin 16	GND
<input type="checkbox"/> T13	U8 pin 14	D3
<input type="checkbox"/> T14	U6 pin 14	D4
<input type="checkbox"/> T15	U4 pin 14	D5
<input type="checkbox"/> T16	U2 pin 14	D6
<input type="checkbox"/> T17	U1 pin 14	D7
<input type="checkbox"/> T26	U4 pin 15	Q3
<input type="checkbox"/> T19	U5 pin 1	+5V
<input type="checkbox"/> T19	U8 pin 1	+5V
<input type="checkbox"/> T8		PRAS
<input type="checkbox"/> T18		Q3
<input type="checkbox"/> T20	U4 pin 16	GND
<input type="checkbox"/> T20	U2 pin 16	GND
<input type="checkbox"/> T21	U3 pin 3	R/W80
<input type="checkbox"/> T25	U2 pin 4	PRAS
<input type="checkbox"/> T24	U1 pin 8	+5V
<input type="checkbox"/> T24	U3 pin 8	+5V

**Checkout Table**

80 Column Card Finger	Signal	64K Memory Card Pin
30	+5V	T2
4	PRAS	T8,R1,T25
35	R/W80	T21
31	GND	T12
33	Q3	T18,R2,T2

ceptacles 1, 10, 11 and 20. Also, header pins 1 through 8 plug into socket receptacles 2 through 9, and header pins 9 through 16 plug into socket receptacles 11 through 19.

Trim all Wire Wrap pins, including those on the IC sockets, to about 1/2" from the surface of the board. The pins on some brands of IC sockets are short enough to require no trimming and can be left as they are. In any case, when you trim any pin, make sure you don't cut into the wrapped wire.

Referring to Fig. 4, mount the 64K Memory Expansion Upgrade board on the 80 Column Text Card. Use 3/4" spacers between the two boards and 4-40 x 1" machine screws, nuts and lockwashers to solidly secure the two together. (Don't forget to use insulated fiber washers between the hardware and 80 Column Text Card where you've determined they're needed.)

Route the ribbon cable up and over the two boards and gently but firmly plug it into the socket vacated by the 2158B RAM IC. Make sure the pin numbering of the DJ24-1 plug is oriented the same way as the RAM chip was before removal.

Make continuity checks between the 80 Column Text Card's edge-connector "fingers" and the pins on the 64K Memory Expansion Upgrade card as detailed in the Checkout Table. When everything checks out okay, install the 4164 RAM chips in the sockets on the Upgrade card. Handle these ICs as you would any MOS device. Make sure they're properly oriented before pushing them home in their sockets. Also, make sure that all IC pins go into the socket receptacles and that none fold under the ICs or overhang their sockets.

**Checkout and Use**

Plug your upgraded 80 Column Text Card with extended memory into the Auxiliary bus slot in your Apple IIe and power up the computer. Perform a self-test by pressing Solid Apple, Control and Reset simultaneously. Now boot DOS. Make sure that the 40-column mode works before proceeding further.

At the DOS prompt, key in PR #3 to activate the 80-column feature. If a reboot occurs unexpectedly after you type in PR #3, the extended RAM board isn't connected. Power down the computer and check the seating of the 24-pin plug in the 2158B socket on the 80 Column Text Card.

If the 40-column mode works properly but the 80-column mode displays only flickering "garbage," power down the computer and recheck all wiring and connections, especially the 74LS75 replacement header. If the 80-column mode appears to be working but you get occasional incorrect characters, suspect a bad 4164 chip. If the problem is a constant, the symptoms will change as you swap 4164 ICs on the board (don't forget to power down the computer and handle the MOS ICs with care as you swap chips). Once you determine which 6164 is defective, it's a simple matter of replacing it with a known-good chip to get the system up and running.

When everything checks out okay, boot Appleworks. As the program loads and is ready to use, the screen will display a "55K AVAILABLE" message. Now you can take full advantage of the extra memory afforded by your memory upgrade—at only a fraction of what it would have cost to replace your 80 Column Text Card with the Apple IIe Extended 80 Column Text Card.

If you wish, you can also use the extra 64K of RAM as a "RAM disk" by using the inexpensive "Ramdrive IIe" program. This program configures the extra memory as a roughly half-capacity disk drive. Its speed is truly astounding when compared to a physical floppy-disk drive.

As more software utilizing the extended memory becomes available, the effort you put into upgrading your 80 Column Text Card will continue to grow. This project offers an excellent return in the form of utility and personal satisfaction for only a modest cost.

**ME**

# A Subwoofer For Stereo

*This deep-bass subwoofer reaches down to 15 Hz to upgrade your present stereo system*

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By William R. Hoffman  
and Oliver H. Lieder

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**N**ow that digital sound is entrenched, with compact-disc (CD) players leading the way, demands on home stereo systems to reproduce the new sources with wider frequency range and greater loudness levels has increased. For instance, the response of the compact disc covers the full 5-Hz-to-20-kHz range—something that records and tapes never did—with no discernible noise or signal distortion at any listening level. Upgrading a conventional stereo system to meet these new demands can be an expensive proposition, unless you find some way to use as much of your current equipment as possible.

One of the most expensive components in upgrading is the loudspeakers. Speaker systems that can reproduce the full digital frequency range tend to be rather expensive as well as large in size. Yet many such speakers are only a little better than most better-quality systems except for their ability to handle the deepest bass range. Therefore, if you already have otherwise fine speaker systems, all you really need to upgrade your present stereo systems is a so-called “subwoofer” like the one to be described here.

You can build this subwoofer at relatively low cost from readily available lumber, without the need for a shop full of specialized woodworking tools. The subwoofer is designed



around a special dual-voice-coil driver that handles both stereo channels, which avoids loss in signal information when using a single driver. It's capable of reaching down to 15 Hz to faithfully reproduce the deepest of bass notes, and because it tops out at about 200 Hz, it doesn't interfere with your present “full-range” speakers over most of the audio range for which they were designed. You don't even need an extra dedicated power amplifier to drive the

subwoofer. Simply connect it across the same amplifier terminals to which you have your present speaker systems connected to enjoy truly deep bass reproduction. The subwoofer can handle up to 100 watts of continuous drive power.

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## *Some Basics*

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Since many good-quality full-range speaker systems can reproduce the bass register down to 60 to 70 Hz,

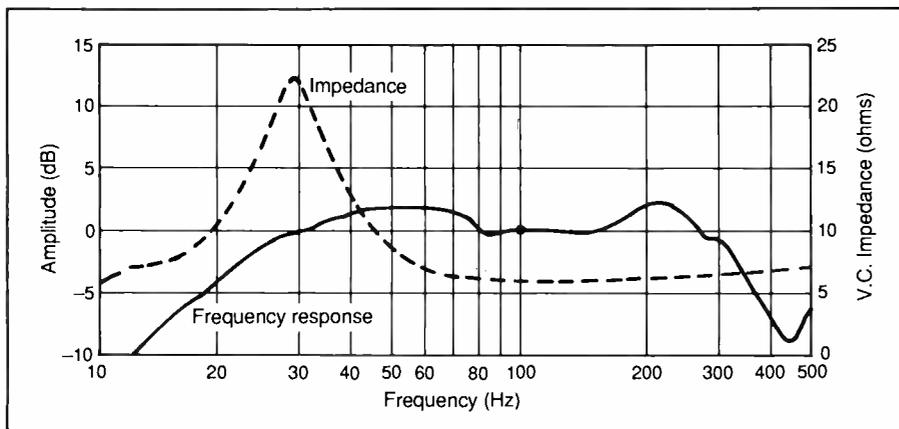


Fig. 1. Measured frequency response and voice-coil impedance (one measured) of subwoofer. The frequency response was taken from about 8" away and on-axis in a semireverberant environment, and known room effects have been subtracted from the response curve.

and most preamplifier/power-amplifier arrangements can go down to between 5 and 10 Hz, all one really needs to "feel" the really low bass notes is a good subwoofer.

Because characteristics of the special driver around which this subwoofer is built call for a relatively small 4.2-cu.-ft. internal volume, the enclosure you build will be less obtrusive in your listening room.

You may be wondering why you can get by with only one subwoofer in a two-channel stereo system. The reason has to do with psychoacoustics, which is how the human ear/brain perceives low-frequency sounds. Since the low frequencies the subwoofer reproduces have very long wavelengths of between 5 and 80 feet, the human ear has great difficulty in locating the source of the sound in this range. The deeper the bass, the more omnidirectional the sound appears to be. So if two subwoofers were reproducing the deep-bass sounds recorded in the separate stereo channels, you would perceive the result as coming from a single, omnidirectional "source." This being the case, there's no need for separate subwoofers.

More technically minded readers will find the following of interest.

The woofer measures 12" nominal in diameter. Its technical specifications include a Q (a measure of how much the bass driver peaks at resonance) of 0.44; a free-air resonance of 14 to 15 Hz; a loading volume of about 16.5 cu. ft.; a nominal efficiency of 88 dB/watt/meter, and a dc resistance per voice coil of 4.1 to 4.2 ohms.

When the woofer is installed in the enclosure described below, system resonance rises to 29 Hz and Q becomes 0.85. Its -3-dB SPL is 21 Hz, referenced to 0 dB at 100 Hz. Though interior volume of the enclosure is physically 4.2 cu. ft., stuffing the cavity of the enclosure with acoustical fiberglass wool raises this to an equivalent volume of 5.1 cu. ft.

With the subwoofer fully assembled, its frequency response and single voice-coil impedance were measured without the crossover network installed. The results are shown in Fig. 1. Note here the unusually smooth and extended overall bass response of the system.

Since the subwoofer is to operate over a range of only a few octaves, from about 15 Hz to 200 Hz, design of the enclosure is very simple. Our emphasis is on extended bass response with substantial power capability. These objectives dictate the use

of an acoustic-suspension sealed enclosure design.

Tests and measurements performed on the subwoofer were conducted with the aid of a variety of test instruments. These included: Sound Technology's Model 1700B oscillator and THD meter; Neumark's Model STD-272 calibrated electret condenser probe microphone; Leader's Model LMV-182A ac voltmeter; and B&K Precision's Model 1570A 4-trace, 80-MHz oscilloscope. During the tests and measurements, the subwoofer was driven by a Marantz Model 250 power amplifier.

All baffle designs except that of the sealed enclosure system will severely load the driver below the resonant cutoff point, making the woofer easy to overload with strong subsonic signals. Also, the acoustic-suspension system has a gentle rolloff below the cabinet's cutoff point, yielding the deepest possible bass response from a small enclosure.

With the above in mind, the only other design factor that must be decided upon is the Q of the completed system. For Q values of less than about 0.6, the sound usually ends up "fuzzy" and deficient in bass, while for Qs of 1.0 or greater, the sound is generally very "muddy" or "boomy." For a large bass speaker mechanism, then, the best Q values are usually between about 0.7 and 0.9 to ensure the cleanest and deepest bass possible. For our subwoofer, a Q of 0.85 was chosen on the basis of listening quality.

### Construction

Since the subwoofer's enclosure is basically a very simple box, as shown in Fig. 2, it's quite simple to build with ordinary home shop tools from materials that are readily available from just about any lumber yard. The dimensions of the six panels that make up the enclosure's walls shown in Fig. 2 need not be rigidly adhered to. If you prefer an enclosure with different proportions, you

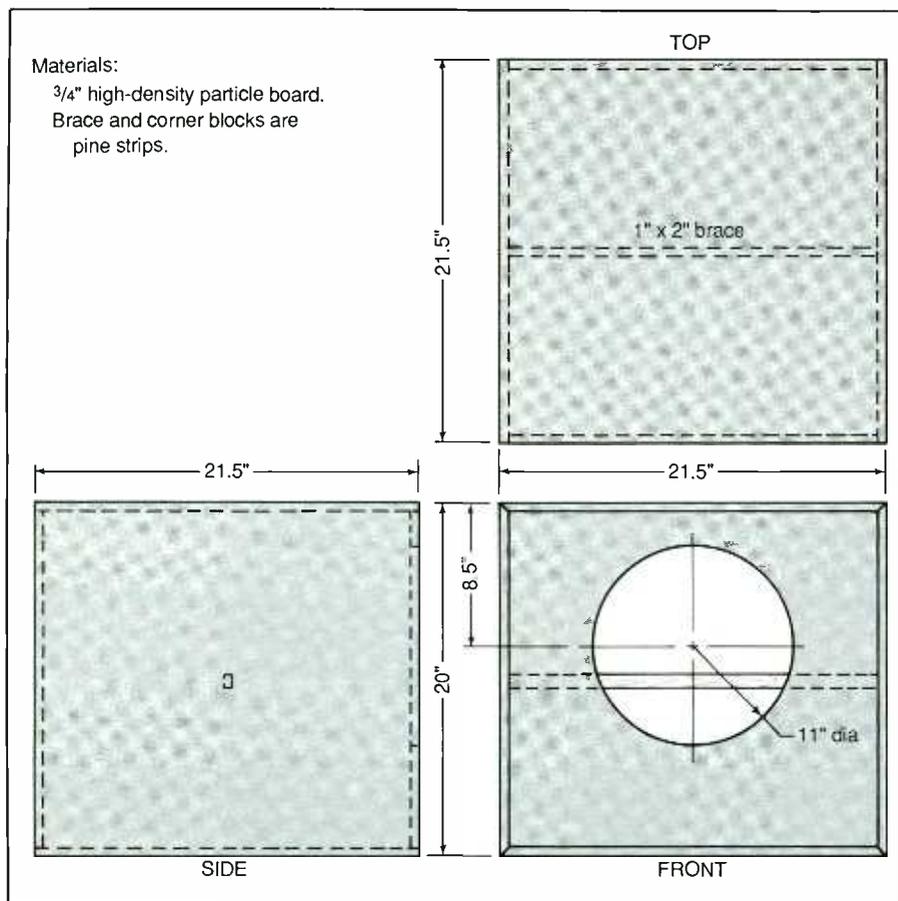


Fig. 2. Construction details of basic speaker enclosure. All corners are glued and screwed together with pine cleats.

can make adjustments in the dimensions of the various panels, just as long as you maintain approximately the same interior volume. The only other crucial factor to keep in mind is that the enclosure must be completely air-tight.

All six panels that make up the enclosure can be cut from a single 4 × 8-ft. sheet of  $\frac{3}{4}$ "-thick plywood or particle board with plenty of material left over for other uses. Before you strike any lines and begin cutting, however, there are several alterations in the basic plan to consider. First off, you can add 1" to the front-to-back dimension of the top, bottom and two side wall panels so that the speaker panel can be recessed 1" to make room for a framed grille that can be snapped in and out.

Other embellishments will make the subwoofer a more attractive

piece of furniture in your listening room, too. For example, increasing the height of the side walls and recessing the bottom panel by 2" will give you enough room around the bottom of the enclosure to attach a decorative molding "skirt." You can also give the enclosure more of a table appearance by adding a second panel to the original top panel so that it overhangs the sides and front of the basic box by about  $\frac{1}{2}$ ".

Once you know how you want to configure your enclosure and the dimensions required to make any modifications to the basic box, if any, strike the cut lines on the plywood or particle board. Don't forget to make adjustments in the dimensions to allow for the thickness of the saw blade. After cutting all panels to size, make the cutout for the speaker in the speaker panel.

## BILL OF MATERIALS

12" woofer with dual voice coil (McGee Radio Cat. No. SW40128)  
 200-Hz low-pass crossover network (McGee Radio Cat. No. SWCRO)  
 200-Hz high-pass crossover network (McGee Radio Cat. No. SWSAT; optional—see text)  
 4 × 8-ft. sheet of  $\frac{3}{4}$ "-thick plywood or high-density particle board for enclosure walls  
 1" × 2" pine for cross bracing  
 1" × 1" pine for corner cleats  
 2"-wide decorative molding (optional—see text)  
 No. 6 ×  $1\frac{1}{2}$ " wood screws  
 No. 6 ×  $1\frac{1}{4}$ " wood screws  
 No. 8 or No. 10 ×  $\frac{3}{4}$ " minimum pan-head sheet-metal screws  
 2 cu. ft. acoustical fiberglass batting or rock wool (see text)  
 4-contact screw-type terminal strip or barrier block  
 Silicone sealer or vinyl caulking  
 14-gauge speaker zip cord or individual 12- or 10-gauge stranded wire  
 Finishing materials for enclosure; solder, etc.

Note: Speaker and crossover network(s) are available from McGee Radio Co., 1901 McGee St., Kansas City, MO 64108.

Smoothly sand all cut edges and clean away all sawdust. Fasten one side panel to the bottom panel and the other side to the top panel to form two L-shaped assemblies. If you've decided to recess the bottom panel, don't forget to make allowances for it when fastening together the panels. Use full-length 1" × 1" pine cleats (minus any amount for recessed panels), glue and No. 6 ×  $1\frac{1}{2}$ " wood screws to join together the panels. Wherever two panels are joined with pine cleats, drive at least five evenly spaced screws in both directions through each cleat and into the panels to assure a rigid joint. Drill a pilot hole through each cleat and about halfway into the panel at each screw location.

Place the two L-shaped assemblies together and accurately align them and strike lines along the inside edges

of the rear panel onto the top, bottom and two side panels to serve as guides for cleat locations for the rear panel. Similarly, strike lines to show where the front-to-back cleats are to be secured to hold together the two assemblies at the abutting joints. Use glue and screws to mount full-length cleats along all struck lines.

Glue and screw together the two assemblies. Then glue and screw the recessed rear panel to its cleats.

Next, cut to length the four cleats needed to mount the speaker panel to the front of the enclosure. Set one cleat (two if the speaker panel is to be recessed) on the floor of the enclosure aligned with the front edge and strike a line on the panel along the inside edge of the cleat. Repeat for the three remaining panels to which the speaker panel joins. Mount the cleats to the panels with glue and screws.

Now run a thick bead of silicone sealer or vinyl caulking along all cleats, including those for the speaker panel, to fully air-seal the enclosure. Each cleat must have two sealer beads, one for each panel it abuts.

Cut to length the 1" x 2" pine cross-brace so that it makes a snug—but not force—fit when it's set in place with its ends roughly centered in the side panels as shown in Fig. 2. Secure the brace to the walls using short 1" x 1" cleats, glue and screws.

Mount the screw-type input terminal strip or 4-contact barrier block on the lower part of the rear panel of the basic box or on the bottom toward the rear if you raised the bottom panel.

Use the terminal strip as a template to mark the slot location and size for it. Drill a series of interconnected holes and use a rasp or file to make the slot required for lug clearance. For the barrier block, all you need are two 1/4" holes, the first midway between where the first and second contacts of the block will be and the second midway between where the third and fourth contacts will be.

If you raised the height of the bot-

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tom panel of the enclosure to make room for a decorative skirt, cut to length two more 1" x 2" pine braces. Secure one brace across and flush with the front opening of the channel created by the raised bottom panel, the other midway between the front and rear of the side walls. (Don't enclose the rear of the channel.) Secure the braces to both side panels and the bottom panel with full-length 1" x 1" pine cleats, glue and screws.

Secure the extra top panel that overhangs the sides and front of the enclosure as follows. First coat both mating surfaces with glue and allow it to set until tacky to the touch. Then invert and lower the enclosure onto the panel. After aligning the two, drill a pilot hole through the center of the enclosure's top panel and about halfway into the add-on panel and use a No. 6 x 1 1/4" wood screw to secure the two together, tightening only enough to prevent the assembly from shifting.

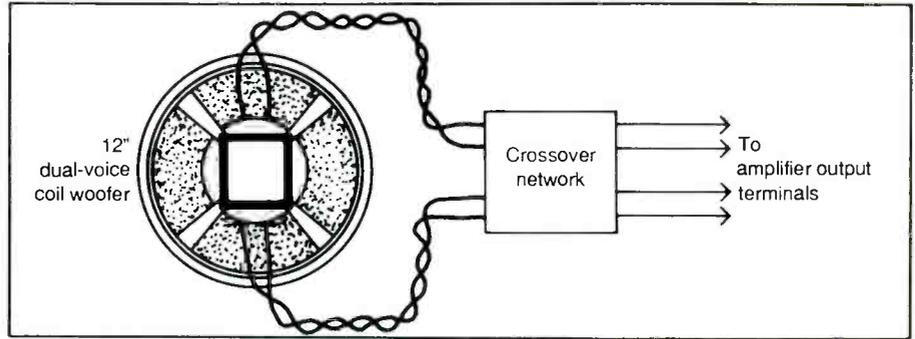


Fig. 3. Basic wiring diagram for integrating crossover network into system.

After making sure the add-on top panel is properly aligned with the enclosure, drill another pilot hole in the same manner about 1/2" from both cleats at one corner and follow with another screw. Fully tighten both screws. Do the same at the three remaining corners. Then drill four more equally spaced pilot holes between each of the corner screws and fasten with screws.

Use a damp cloth to wipe away any glue that bleeds out from between

the enclosure and top panel. Then glue and nail the pieces of molding that make up the skirt (use miter cuts at the mating corners and square cuts at the rear edges) to the bottom of the enclosure.

Rub down all exterior surfaces, except the bottom panel's, with first medium and then fine sandpaper. You want a smooth, velvet-like finish when you're done. Then thoroughly clean away all sawdust.

If you didn't recess the speaker

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panel, cut a piece of  $\frac{1}{4}$ "-thick Masonite to the same dimensions as the speaker panel, and remove a 13" diameter circle, centered in the same location as the speaker cutout. Cut the grille cloth 1" larger than the Masonite all around.

Place several dozen spots of glue randomly over the entire front surface of the Masonite. Then center the grille cloth over the glue side and wrap it around the edges of the Masonite. Secure it in place on the rear panel with thin beads of glue.

When the glue has dried, drill  $\frac{1}{16}$ " or so holes through the grille assembly, spacing them about 1" in from each of the four corners. Measure 1" away from the speaker cutout and drill four more of the same-size holes 90 degrees apart around the perimeter of the hole.

If you recessed the speaker panel, make a simple frame out of 1"  $\times$  1" pine. Make this frame about  $\frac{1}{16}$ " smaller top-to-bottom and left-to-right than the speaker panel. Use lap joints at the corners and glue and small nails to hold the frame together. Make sure the frame is squared before nailing it together. Then paint the frame flat black.

When the glue and paint have completely dried, lay the frame on the grill cloth and cut the cloth 2" larger all around the frame. Wrap the edges of the cloth around and secure it against the rear of the frame with staples or small tacks.

How you finish the enclosure depends on a number of factors, not the least of which are your preferences, how much time and money you want to spend on the task, and your finishing skills. Regardless of the material used, you can give the enclosure a smooth, professional-quality paint finish or cover it with wood veneer, plastic laminate or self-stick vinyl like Contact®.

If you built your enclosure from plywood, you can take advantage of its natural wood grain. Simply glue a narrow strip of wood veneer to the

front edges of the side walls and top panel and the side and front edges of the add-on top panel (if used). When the glue dries, lightly sand the veneer to blend into the plywood. Then stain the enclosure and finish it with polyurethane "varnish."

Paint the exterior surface of the speaker's front panel flat black.

### Putting it All Together

Separate by about 4" the conductors at both ends of four 24" lengths of speaker zip cord (or use individual stranded wire). Strip about  $\frac{3}{8}$ " of insulation from all conductors at both ends, tightly twist together the fine wires and lightly tin with solder. Connect and solder one end of each cord to the left and right input and output terminals on the crossover network, as illustrated in Fig. 3, keeping "phasing" of the wiring the same as you interconnect the speaker, crossover network and output connectors. Then mount the network in the center of the floor of the enclosure with silicone adhesive to ensure against rattling when the subwoofer is operating.

Pass the output end of the zip cord through the terminal strip's slot. Connect and solder the conductors to the lugs of the terminal strip with the two "+" conductors going to the two outer lugs and the "-" conductors going to the two inner lugs. Mount the terminal strip in its slot with wood screws, tighten the screw terminals and seal the strip against air leaks with silicone sealer.

If you're using a barrier block instead of a terminal strip, pass the two zip cords separately through the two holes you drilled for them. Wrap the conductor around one set of screw contacts on the barrier block. Observe the same wiring arrangement as described above for the terminal strip. Use wood screws to mount the barrier block to the selected mounting panel. Then pull any slack in the zip cords back into the enclosure and completely fill the holes through

which the zip cords exit with silicone sealer.

Identify the + and - screws of the terminal strip or barrier block in some manner. Red paint on the screw heads for the + inputs are all you need, or you can put stickers with "+" and "-" identifiers on the enclosure in line with the appropriate terminals.

Run a thick, continuous bead of silicone sealer or vinyl caulking down the center of the front surfaces of all four cleats to which the speaker panel is to be anchored. Set the speaker panel in place (speaker cutout nearer the top than the bottom panel) and press firmly into the sealer or caulking. Drill and countersink six equally spaced pilot holes  $\frac{1}{2}$ " in from each edge and secure the panel solidly in place with No. 6  $\times$   $\frac{1}{2}$ " flat-head wood screws.

Fill the enclosure's cavity with 2 cu. ft. of acoustical fiberglass wool or rock wool. Do *not* substitute carpeting, felt or foam rubber. These materials are far too dense and will restrict the flow of acoustical energy inside the enclosure. If you can't find acoustical fiberglass, you can use the same material used for home insulation, after stripping away the solid backing material.

It isn't necessary to staple or glue the fiberglass to the walls of the enclosure. Simply distribute it evenly in the cavity.

Pull the free ends of the zip cord connected to the output end of the crossover network through the speaker cutout. (Redistribute the fiberglass wool if necessary). Connect and solder the conductors to the speaker's voice coils, observing proper polarity. Then run a thick bead of silicone sealer around the lip of the cutout to create an air seal and gently lower the speaker into place. Make sure the wiring doesn't lay against the metal frame; otherwise you'll hear buzzes and rattles as you listen to your music. Use at least  $\frac{3}{4}$ "-long

*(Continued on page 91)*

## Infrared Radiation

By Forrest M. Mims, III

Detection and generation of infrared radiation has long played an important role in solid-state electronics. In this column, I will discuss infrared radiation and some of the ways it can be detected. In a subsequent column, I will also describe some exceptionally sensitive but reasonably priced infrared detectors that can detect a human being from a distance of more than 50 feet.

### Infrared Radiation

Sir William Herschel is best known among astronomers as the discoverer of the planet Uranus. Herschel was also the discoverer of infrared radiation, so named because it is the range of wavelengths above the red portion of the visible spectrum. Herschel made this momentous discovery in 1800 by repeating Sir Isaac Newton's famous 1666 experiment in which sunlight was divided into its constituent colors by a prism. Herschel placed thermometers in the various colors to determine which produced the

greatest heating effects and found that red light produced the highest temperature. When he placed a thermometer in the dark region beyond the red light, he found that the temperature was even higher, therefore proving the existence of invisible heat rays.

Herschel performed many experiments that proved infrared radiation behaves much like visible light. He was able to focus infrared rays with lenses and reflect them with mirrors. He also discovered that the same kind of infrared rays emitted by sunlight are generated by hot coals. It was eventually discovered that infrared radiation is a form of *electromagnetic radiation*.

Figure 1 shows that the infrared portion of the electromagnetic spectrum falls between visible light and radio waves. Ultraviolet radiation, visible light and infrared radiation are often collectively termed the "optical spectrum." As Fig. 1 shows, the infrared wavelengths occupy the largest portion of the optical spectrum.

Often infrared radiation is described as heat waves. This is a misleading defini-

tion since heat can be produced by other electromagnetic wavelengths. Consider, for example, a cup of boiling water inside a microwave oven and the ability of a beam of pure blue light from a 5-watt argon laser to ignite fabric and wood. If its intensity is sufficiently high, *any* portion of electromagnetic radiation can be considered "heat waves."

### Blackbody Radiation

An understanding of the term "blackbody radiation" is especially important to any discussion of infrared radiation. Electromagnetic radiation is emitted by *all* matter having a temperature greater than absolute zero (0 degree Kelvin or -273.16 degrees Celsius). This radiation is known as "blackbody radiation." Since no known naturally occurring matter has a temperature of absolute zero, *all* matter is a source of blackbody radiation.

Since "blackbody" is such a peculiar term, it's important to understand its derivation. Imagine a substance that absorbs 100 percent of the radiation striking its surface. That is, no radiation is

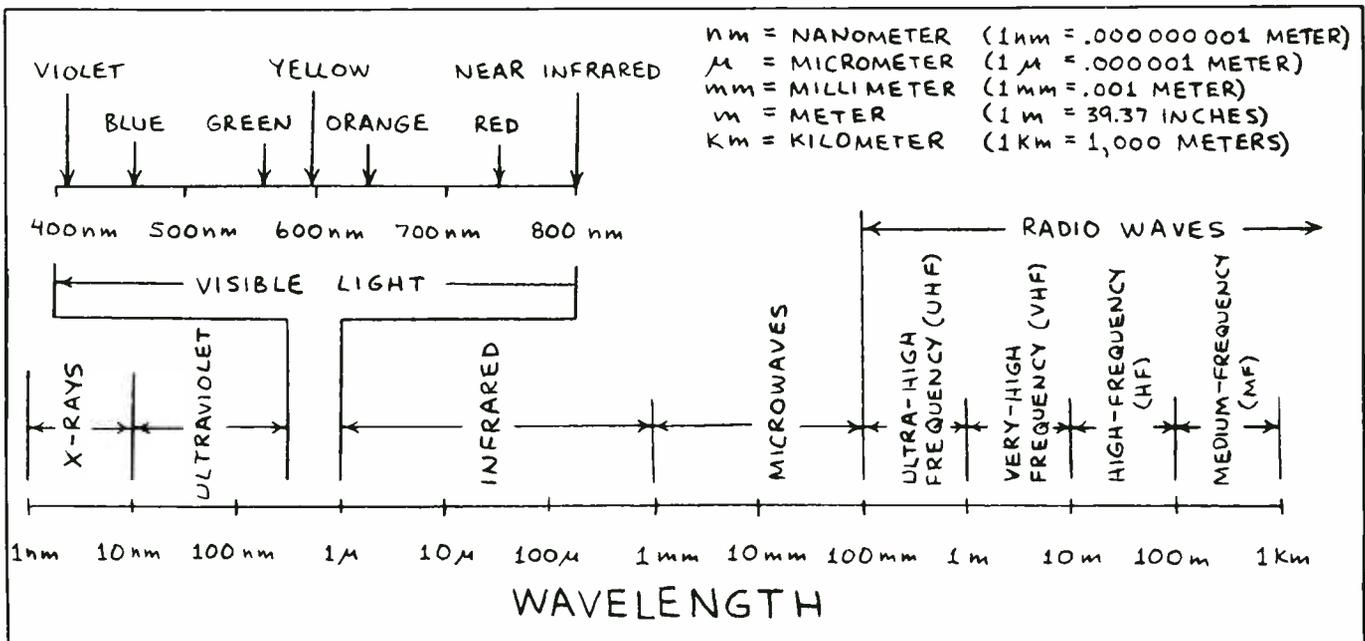
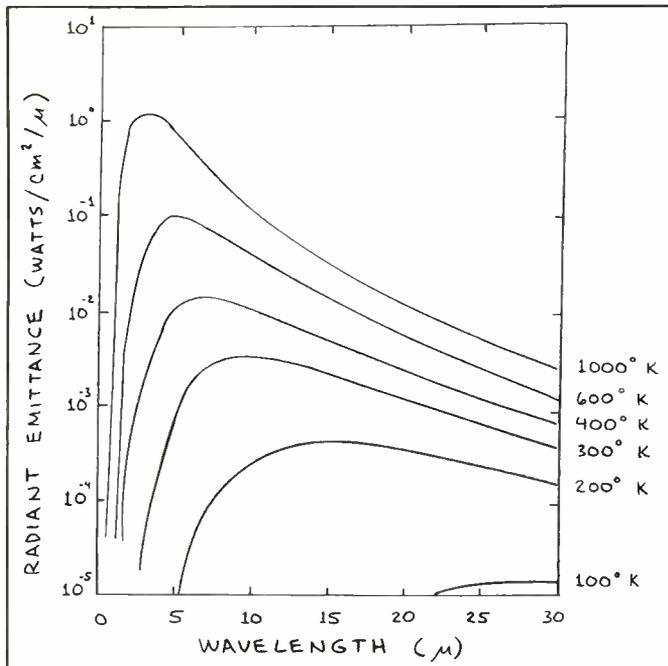
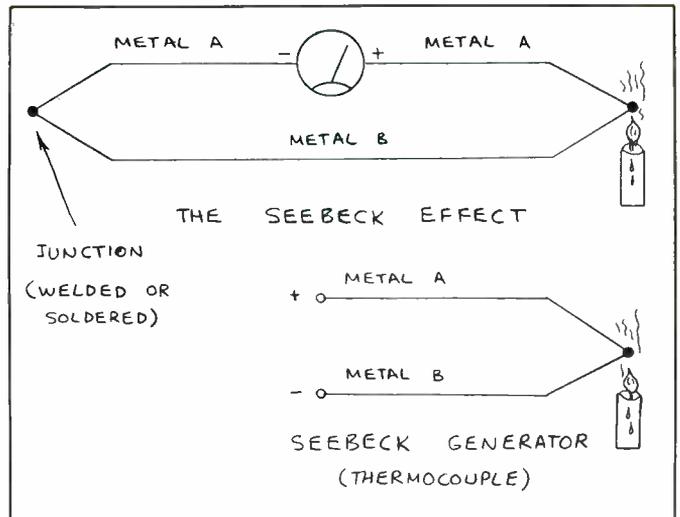


Fig. 1. The electromagnetic spectrum.



◀ Fig. 2. Blackbody curves from 100° to 1,000° K.

Fig. 3. The Seebeck effect.



reflected and none is transmitted. Likewise, all the radiation generated within the substance when it is heated is emitted. If this hypothetical substance were illuminated with visible light, it would appear perfectly black, since all the light would be absorbed and none would be reflected. Hence the term "blackbody."

Though there is no perfect blackbody, substances like lampblack and asphalt have characteristics that approach those of a blackbody. Asphalt, for example, has a very low reflectance of less than 5 percent in the visible wavelengths. It absorbs nearly all the optical radiation that strikes it. This warms the asphalt which, in turn, efficiently emits as infrared radiation the heat generated by radiation it has absorbed.

Probably the most confusing aspect of the term "blackbody" is that a very hot blackbody will emit radiation at visible wavelengths. That's why some people prefer the term "universal radiator."

It so happens that the blackbody radiation emitted by matter whose temperature is less than about 1725 degrees Celsius falls mainly in the infrared portion of the spectrum. The peak wavelength of

the radiation emitted by a substance is inversely proportional to the temperature of the substance. Thus, the blackbody radiation from a hot soldering iron may have a peak wavelength of a few microns while the body of a human being emits energy having a peak wavelength of about 10 microns. Some of the blackbody radiation from a hot coal is visible as a red or orange glow if the coal is hot enough.

Figure 2 illustrates the spectrum emitted by blackbodies at various temperatures. The most obvious conclusion to be drawn from Fig. 2 is that the peak wavelength of the emitted radiation is, as noted above, inversely proportional to the blackbody temperature.

Blackbody curves such as those in Fig. 2 have many practical applications. Assume you wish to design an infrared sensor capable of detecting a human being. Since various sensors respond to different ranges of wavelengths, the selection of a detector depends on the peak wavelength of blackbody radiation emitted by a human being. The normal body temperature of a human being is 37 degrees Celsius or 310 degrees Kelvin. From Fig.

2, this corresponds to a peak blackbody emission of around 9 microns. Since the temperature of the skin is somewhat less than the internal body temperature, the peak wavelength is actually closer to 10 microns. Knowing this, an appropriate detector can be selected.

Heat produced by a soldering iron, your own bodies and a hot coal is obvious to anyone, but it is important to remember that *everything* is a source of blackbody radiation. In other words, if the human eye were sensitive to the entire electromagnetic spectrum, *everything* we looked at would glow, especially at night. That includes ice, grass, the sky, a switched-off lamp, people and this page of text. While some people have expressed a wish to see beyond the visible spectrum, nature must have realized our puny visual cortex could never cope with the clutter of confusing signals, to say nothing of the consequent lack of privacy.

### Infrared Detectors

Many kinds of detectors are capable of sensing infrared radiation, most of which can be classified as thermal, photoelec-

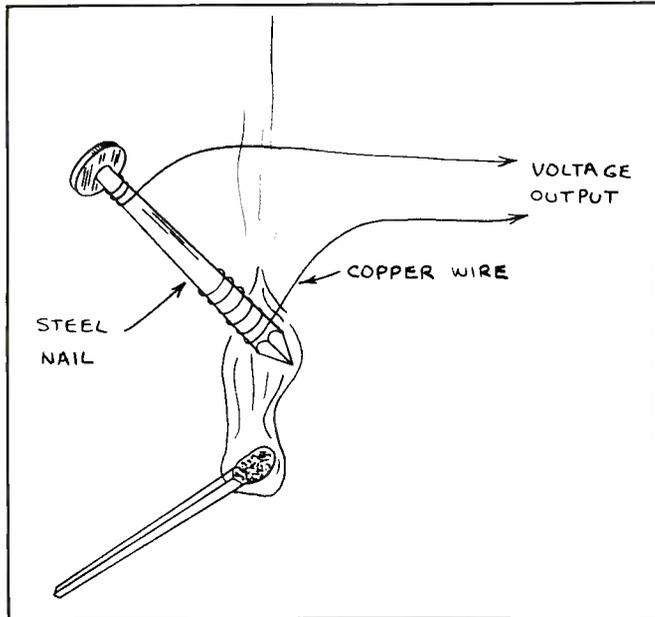


Fig. 4. Demonstration thermocouple.

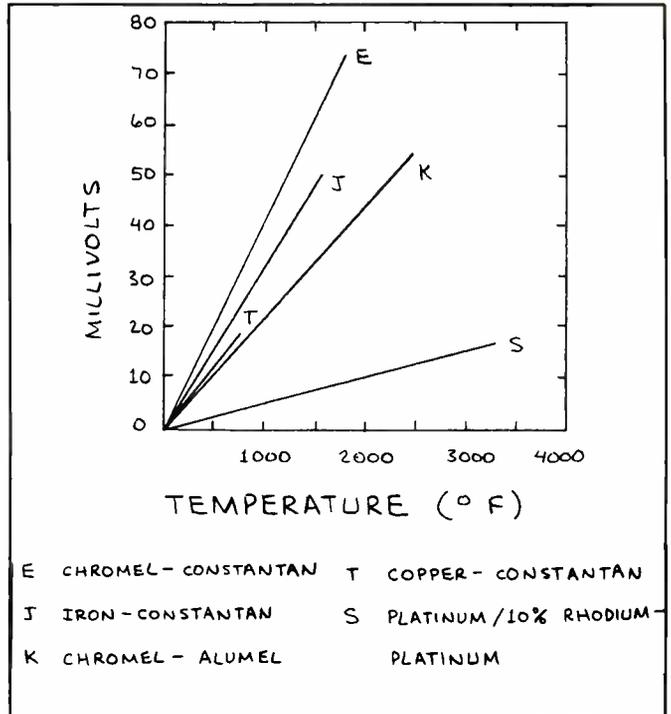


Fig. 5. Some important thermocouple output voltages.

E CHROMEL-CONSTANTAN	T COPPER-CONSTANTAN
J IRON-CONSTANTAN	S PLATINUM/10% RHODIUM
K CHROMEL-ALUMEL	PLATINUM

tric or photoemissive. Some of these detectors are exceptionally sensitive, and many are reasonably priced.

Infrared detectors are often trickier to operate than sensors designed to detect visible light. For example, temperature fluctuations produced by currents of air can easily exceed those of an object a detector is intended to detect.

## Thermal Detectors

The characteristics of many materials are changed by heat. Thermal detectors capitalize on this to detect the presence of infrared radiation. Unlike other kinds of detectors, thermal detectors usually have a relatively flat spectral response. This is important when it is necessary to measure the total infrared radiation emitted by an object. Generally, the spectral response of a specific detector is determined by the spectral transmission of the device's protective window and not the detector material.

There are many kinds of thermal de-

ectors. Among the most common are the following:

● **Thermocouples.** If the ends of two wires made of dissimilar metals are soldered or welded together, a current will flow in the wires when one of the junctions is heated. This is known as the "Seebeck effect." Figure 3 illustrates this effect and a simple Seebeck generator composed of only one junction of two dissimilar metals.

The Seebeck effect is the basis for the thermocouple, which is a generic name for a broad family of sensors that generate a voltage when heated. Sometimes two or more thermocouples are connected in series ("stacked") to give a higher output voltage. This arrangement is called a "thermopile."

Figure 4 shows how a simple demonstration thermocouple can be made by wrapping some copper wire around the end of a steel nail. This arrangement will generate a few millivolts when the end of the nail is heated by a candle flame.

Commercial thermocouples are made

from metals that generate up to 70 millivolts or more when heated. Figure 5 shows the voltage output for five different thermocouple junctions. Note that both base metals and alloys are used to make thermocouples. Constantin, for instance, is a generic name for a family of copper-nickel alloys.

A broad range of thermocouples designed primarily for temperature sensing is made by Omega Engineering, Inc. Omega's *Complete Temperature Measurement Handbook and Encyclopedia* is an invaluable reference on the subject.

Thermocouples designed specifically for detecting the infrared radiated by a distant source are also available. Many of these sensors are miniature thermopiles made from a series array of thin films of dissimilar metals. Figure 6 is a photograph of a miniature thermopile made by Sensors, Inc. This sensor generates a millivolt or so when placed 6 inches from a lighted match. It generated 0.1 millivolt when I placed it 1 inch from the palm of my hand.

Miniature thermopiles like the one in Fig. 6 are simple to use since they generate a voltage that can be easily amplified by a low-noise dc amplifier. They also produce less noise than other types of infrared detectors. On the downside, thermopile detectors have a slower response time than most other IR detectors. Therefore, they are not suited for monitoring rapidly fluctuating infrared signals.

● **Thermistors.** The resistance of a thin film or flake of semiconducting material will change in response to temperature. This thermally sensitive resistor is called a "thermistor." Common thermistor materials include oxides of copper, cobalt, manganese, iron, titanium and nickel. The resistance of a typical thermistor changes around 4 percent per degree Celsius.

Simple single-element thermistors are used to measure temperature in countless applications. In the June 1985 installment of this column, which has been reprinted in *Forrest Mims' Circuit Scrap-*

*book II* (Sams, 1987, pp. 121-126), I described how to assemble a thermistor-based, calibrated temperature monitoring sonde that can be flown from a small helium-filled balloon. The sonde transforms temperature data into a pulse-frequency modulated signal that drives a near-infrared LED. The signal from the LED is sent to a simple ground-based receiver via an optical fiber.

Thermistors designed specifically to detect the IR radiation emitted by a distant source, rather than ambient temperature, often incorporate two adjacent flakes of semiconductor material. One flake is coated with an IR-absorbing black material, while the other is covered by an IR shield. The covered detector functions as a compensation element that subtracts the effect of ambient temperature on the active detector.

The ratio of the resistance of a thermistor at a particular temperature to its resistance at 125 degrees C is called the thermistor's "resistance ratio." Figure 7

compares the resistance ratio of two typical thermistors with that of a platinum resistance temperature detector (RTD). The RTD, which is not a thermistor, consists of a metal wire or film whose resistance changes with temperature.

Thermistors are very inexpensive, many being available for a few dollars or less. Their response time of as little as a few milliseconds is faster than that of thermocouples. However, the circuitry required to monitor their resistance is somewhat more complex than circuits used with thermocouples. Often, thermistors are connected in a Wheatstone bridge circuit, as shown in Fig. 8. To provide ambient temperature compensation, *R1* in Fig. 8(B) can be a thermistor that is identical to the adjacent IR-sensitive device. Both thermistors should be mounted close together. The active device should be exposed to the infrared being monitored, and the compensating device should be shielded.

Since thermistors must be biased by a

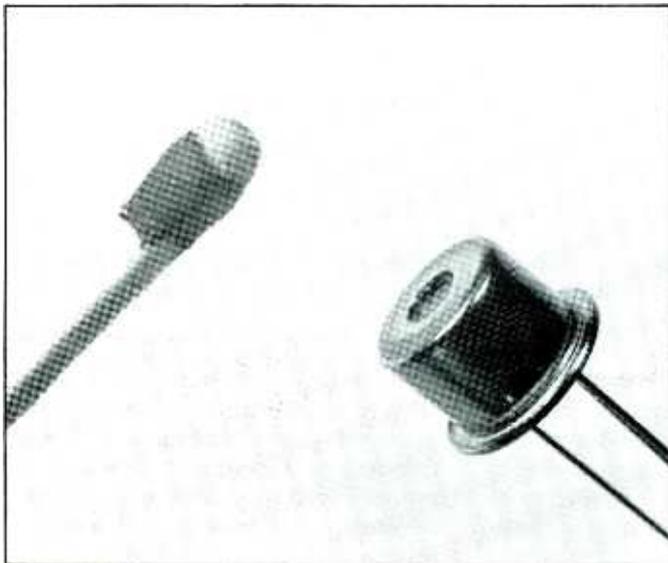


Fig. 6. Miniature infrared-sensitive thermopile detector.

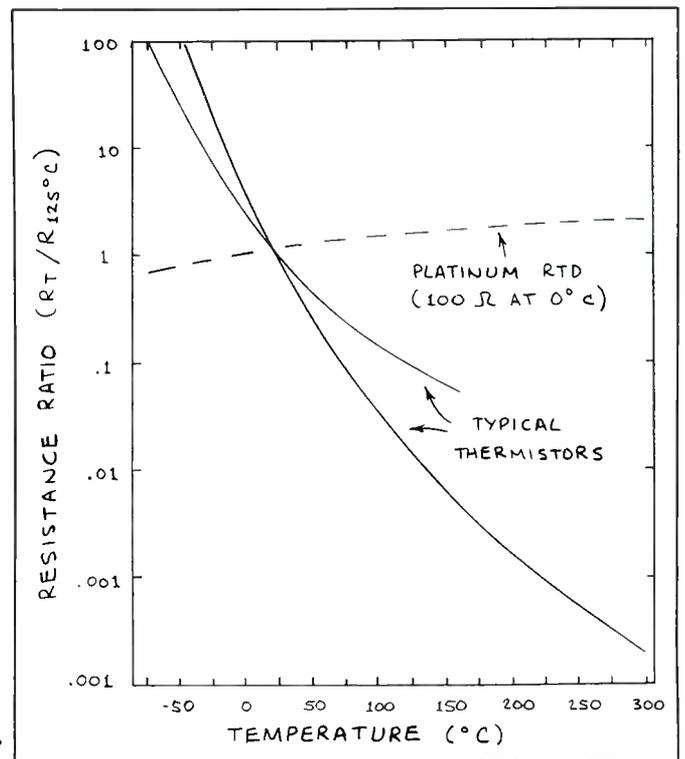


Fig. 7. Resistance ratio of typical thermistors and a platinum resistance temperature detector (RTD).

dc current to make it possible to monitor their resistance, they're more susceptible to noise than are thermocouples and thermopiles. Furthermore, the tolerance and stability of thermistors, while acceptable for most applications, is not as good as that of other IR detectors.

Several manufacturers of thermistors publish catalogs and handbooks that contain abundant information about design, construction and use of thermistors. See publications available from Fenwal Electronics, Thermometrics, Inc., and Omega Engineering, to name just a few.

## Pyroelectric Detectors

Some 23 centuries ago, the Greeks discovered that a tourmaline crystal when placed in hot ashes, first attracted and then repelled adjacent particles of ash. This phenomenon is called the "pyroelectric effect" (*pyro* is Greek for fire).

Lithium tantalate is a member of a family of so-called unsymmetrical crystals that exhibit the pyroelectric effect. A thin chip of lithium tantalate having electrodes deposited on both sides is an excellent detector of infrared radiation. Since lithium tantalate is an excellent insulator, this assembly forms a capacitor. Lithium tantalate exhibits an internal electric field which is collected by the electrodes. When illuminated by infrared radiation, the charge on the electrodes is almost instantly altered.

Typical lithium tantalate detectors have a capacitance of about 30 picofarads. Monitoring the charge on such a small capacitor requires an amplifier with a high input impedance. For this reason, most lithium tantalate detectors are packaged together with a FET and a high-value load resistor that together provide necessary impedance conversion.

Pyroelectric detectors are exceptionally sensitive and provide much faster response times than thermocouples and thermistors. When the load resistor is reduced to 50 ohms, nanosecond response times can be achieved. Though pyroelec-

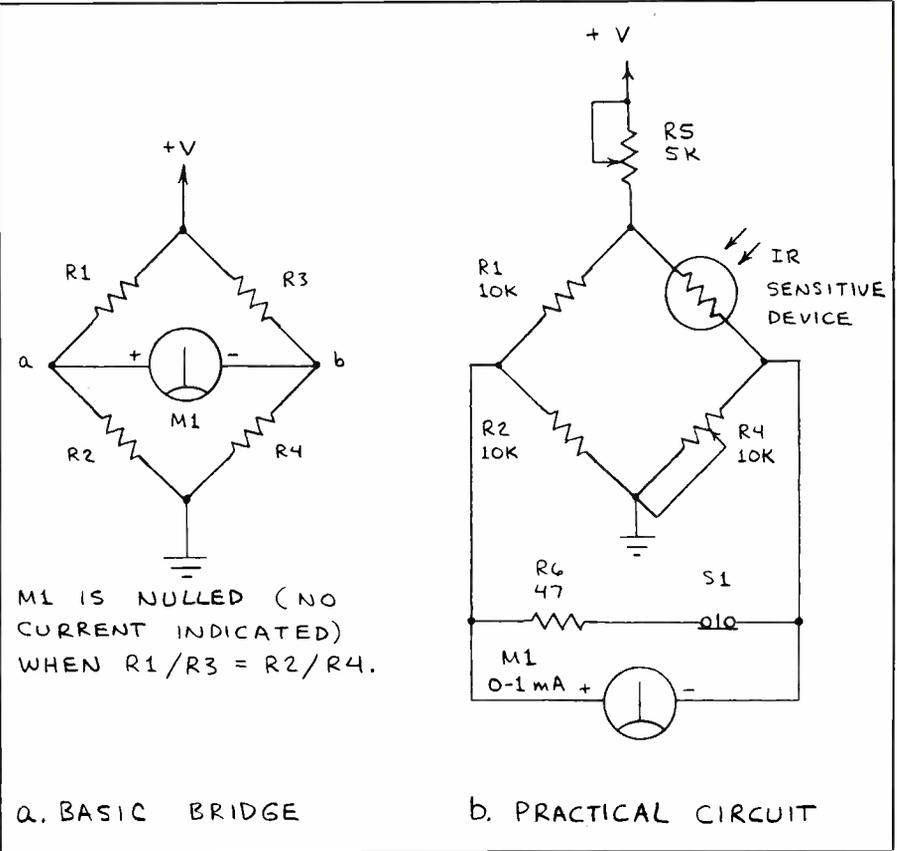


Fig. 8. Wheatstone bridge for infrared-sensitive resistors.

tric detectors have in the past been very expensive, they can now be purchased for around \$25.

It's important to understand that, unlike thermocouples and thermistors, pyroelectric detectors respond only to *changes* in infrared radiation. This is a serious drawback for applications in which a steady source of infrared is to be detected. For these applications a mechanical chopper must be used to transform the steady infrared striking the detector into a series of pulses. On the other hand, this operating mode is advantageous when the source of infrared is modulated. For example, lithium tantalate is ideal for detecting a human being who moves across its field of view. This appli-

cation will be discussed in considerable detail in a subsequent column.

## Nonthermal Detectors

Infrared detectors that respond directly to incoming photons of infrared, rather than the heat they produce, are classified as nonthermal detectors. Unlike thermal detectors, nonthermal detectors are sensitive to particular regions of the infrared spectrum. Like thermal detectors, their overall sensitivity can be influenced by the infrared transmission of their window material.

There are many kinds of nonthermal detectors, including infrared-sensitive imaging tubes that contain mosaics of

### Addresses

The following manufacturers mentioned in this column are only a few of the more than 100 who make many kinds of infrared detectors and systems. Additional sources will be given in a subsequent column.

**Fenwal Electronics**  
63 Fountain Street  
Framingham, MA 01701

**Omega Engineering, Inc.**  
P.O. Box 4047  
Stamford, CT 06907

**Photonics Spectra Magazine**  
P.O. Box 1146  
Pittsfield, MA 01202

**Sensors, Inc.**  
6812 South State Road  
Saline, MI 48176

**Thermometrics, Inc.**  
808 U.S. Highway 1  
Edison, NJ 08817

thousands of detector elements. Among the most common single-element infrared nonthermal detectors are the following:

● **Solid-State Photodetectors.** Many different kinds of solid-state photodetectors are capable of detecting infrared radiation, particularly those wavelengths near the visible spectrum. While many such detectors are very sensitive, they are all subject to internally generated random noise. Therefore, for the highest degree of sensitivity, it is often necessary to cool these detectors to reduce their internal noise level. Cooling can be accomplished by means of miniature cryogenic refrigeration units, various liquified gases or solid-state thermoelectric heat pumps. There are three broad classes of such detectors:

● **Photovoltaic.** These detectors generate a current in response to infrared radiation. Examples include pn-junction silicon photodiodes and solar cells. Silicon detectors, which have a peak response near 850 to 900 nanometers in the near-

infrared, can sense radiation having a wavelength beyond 1 micron. Indium arsenide detectors have a peak spectral response near 3.5 microns.

● **Photoconductive.** These detectors require an external bias current. The current flowing through the detector is altered by the presence of infrared. Examples include reverse-biased pn- and pin-junction detectors. Many kinds of photovoltaic detectors can be operated in the photoconductive mode.

The spectral response of silicon detectors was noted above. Devices made from more exotic compounds can detect longer wavelengths. Gold-doped germanium, for example, has a peak response near 12 microns. And mercury cadmium telluride has a peak response near 15 microns.

● **Photoresistive.** These detectors are bulk semiconductors whose resistance changes in response to detected infrared radiation. Visible-light photoresistors are made from cadmium sulfide and cadmium selenide. Lead sulfide, which is often used to make infrared-sensing photoresistors, has a peak spectral response of between 2.5 and 3 microns.

### Going Further

Though this column has been primarily tutorial in nature, I hope it has helped you to better understand the diverse world of infrared radiation and how it is detected. In a subsequent column, I will present some hands-on infrared detection circuits. Meanwhile, for more information about infrared be sure to visit a good library and read up on the subject. You might also want to request literature from various manufacturers of infrared detectors. Consult trade directories for addresses and phone numbers. One such directory is the multi-volume "The Optical Industry and Systems Purchasing Directory" published by *Photonics Spectra* magazine. If you cannot find trade directories at your local public library, try the library at an engineering university or technical school. **ME**

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## “WordStar” Under \$60, Windows Over Anything

By Eric Grevstad

This month, Garrison Keillor retires from his popular National Public Radio show, *A Prairie Home Companion*, giving the last of his small-town monologues beginning, “it’s been a quiet week in Lake Wobegon.” I could salute him by saying “It’s been a quiet month in the MS-DOS world.” Apple’s Macintosh II and Commodore’s Amiga 2000 have made their debuts, showing the triumph of IBM PC-style slotted architecture. Compaq has cranked up its 80286 clock speed and chosen a gas-plasma screen for its Portable III, showing its tradition of first-class engineering at lethally high prices.

As for me, I’m still shying away from the cutting edge—hanging around my apartment, playing with low-priced, interesting software. My Apple friends say the Mac II has a palette of 16.8-million colors, but I’m partly color-blind and could probably see only three or four million anyway.

### Why Buy WordStar 4?

By now you’ve seen the headlines—“Cows Come Home, Hell Freezes Over, MicroPro Upgrades WordStar”—and read about WordStar Professional Release 4 (\$495), the new edition of 1978’s word-processing legend. I just opened my copy and like it so far, but I’m not going to write about it here because I already have. With a few alterations, WordStar 4 is NewWord 3, the independently produced WordStar 3.31 clone which I praised in the December 1986 issue before MicroPro shrewdly bought the rights to it.

However, if you balk at MicroPro’s price and can live without some of Release 4’s improvements—no pop-up thesaurus, automatic indexing, or programmable function keys—you can get most of the rest for \$436 less. The man responsible is Bruce Tonkin, fanatic Microsoft QuickBASIC programmer and head of TNT Software, and his \$59 surprise is called My Word 2.0. It looks a little stark

```

HELP FOR MY WORD! version 2.00  FILE=PEARL  TIME: 20:47:18
CLEAR MEMORY = 46288 CHARACTERS ( 1734 USED). INSERT MODE = ON
Key definitions:
F1=Help          F2=Resume edit      F3=Save file       F4=Save and exit
F5=Rename file   F6=Rename disk file  F7=Clear memory    F8=Erase disk file
F9=Directory     F10=Any directory   ALT-F1=DOS command CTRL-F1=Dot commands
MOVE Forward:    ^D char ^F word ^Z para | BLOCK: ^KB start ^KH end ^KH hide
MOVE Back:       ^S char ^A word ^W para | BLOCK SORT: ALT-A up ALT-D down
MOVE Up:         ^E line ^R scrn ^QR doc | BLOCK COPY: ^NC
MOVE Down:       ^X line ^C scrn ^QC doc | BLOCK CASE: ALT-U change to upper
MOVE To line:    ^QS start ^QD end     | BLOCK CASE: ALT-L/ALT-I lower/invert
MOVE To block:  ^QB start ^QK end     | FORMAT: ^B reform ^OC center
MOVE To screen: ^PGUP top ^PGDN end | FORMAT ALL: ALT-B start, ^U stop
DELETE: ^G char ^T word ^Y line ^KY block | RIGHT MARGIN: ^OR set ESC read
UNDELETE: ^U          | TAB: ^OI insert ^ON delete
FILE Save: ^KD done ^KS continue | CALCULATOR: ALT-C use ALT-R recall
FINISHED: ^KX save ^KQ quit      | FIND/REPLACE: ^QF find ^QA replace
FILE: ^KR read ^KW write block   | LINE: ^N insert ^RETURN split
FORMULA: ^OM evaluate (..formula line) | INSERT CODE: ^P ctrl ALT-P graphics
READ RULER LINE: ^OF STATUS LINE: ESC | CONTINUOUS STATUS LINE: ^OH
DEFINE MACRO: ALT-= R/W MACROS: ALT- | EXECUTE MACRO: ALT-1 through ALT-0
HOME=start line END=end line      | ^HOME=start file ^END=end file
INS=change to insert/overtyp     | DEL=delete character to left
ARROW KEYS: up, down, left, and right cursor movement
Now press the appropriate FUNCTION key:
    
```

Now, that’s a help screen: My Word cuts WordStar down to size.

and homely, but has features galore. It also makes pure ASCII instead of scrambled high-bit-format files, and runs faster than both old and new WordStars.

My Word is a WordStar clone, using familiar, formidable commands such as Ctrl-Y to delete a line and Ctrl-B to reformat a paragraph. It keeps documents entirely in RAM, restricted to 48,000 characters (you can link files for long printouts), but the extra speed is worth it: My Word performs 3,000 search and replaces in 10.4 seconds, five times as fast as WordStar 4 (ten times as fast as WordStar 3.31). Scrolling is instantaneous; blocks are copied as fast as you can pound Ctrl-KC.

Like WordStar 4, My Word has features from a 3.31 user’s wish list: an undelete function, access to DOS commands while editing, a built-in calculator, and command or text macros. They’re not as glamorous as their MicroPro counterparts—the calculator, for instance, uses reverse Polish notation—but they work.

There’s no column block mode as in Word Star 4, but the Alt-A and Alt-D commands sort a block in ascending or descending ASCII order (capital Z before lowercase a); I typed 200 names at

random, and My Word ordered them in 11.4 seconds. The program can save files without extra line feeds or carriage returns for programming or communications use.

The printing program (reached, like the editor, from a main menu) is remarkably fast and versatile, offering everything from parallel, serial, or disk file output to options for creating mailing labels or a simple table of contents. For more fancy formatting, there’s a swarm of WordStar-style dot commands. If you’re deft with imbedded printing instructions, My Word’s ready for anything from headers and page numbers to proportional spacing, microjustification, and merge printing.

Novices will be daunted by the sample files in the well-organized and -indexed manual, but I haven’t seen another word processor with half the mail merge at twice the price, whether it’s layers of nested files, formatting or calculating numeric variables, reading variables from disk files or the keyboard, or merging files with conditional logic.

Obviously, you sacrifice some things for a \$59 price. My Word won’t offer help if you’re stuck halfway through a command, as WordStar will. It won’t

show line spacing or justification on screen, though you can watch for page breaks in a status line toggled with Ctrl-OH. The spelling checker is fast but underpowered: it creates a corrected second copy of your document on disk, which will probably need to be loaded into My Word and reformatted, and makes you type corrections and check capitalization yourself by manual means.

As a WordStar clone, My Word is harder to use (and, despite its great speed, slower) than my favorite inexpensive word processor, Ann Arbor Software's Textra (April 1987, p. 86), but has much more sophisticated printing and formatting abilities. If you're not put off by WordStar commands, My Word has all the horsepower of a Daytona 500 racing car, though with a corresponding lack of frills and upholstery in the cockpit. For another \$59, QuickBASIC programmers can get under the hood themselves, with ready-to-tinker source code. The rest of us can take a flier on Tonkin's 30-day money-back guarantee, or at least think twice before sending \$495 to MicroPro. [See an alternate view in this issue's "Software Focus"—Ed.]

### Making Menus

I got more than I bargained for from Flash-Up Windows (\$90). From the Software Bottling Company of New York's ads, I thought the product was something like Alpha Software's Keyworks, which lets you create pop-up menus of key-stroke macros, or Personics' Smart-Notes, which lets you annotate an application with notes or help screens. Actually, Flash-Up Windows is like both of those products, plus a DOS shell or menu package and an interface development system for programmers. It's a little complex for casual users, but could be the ultimate add-on or front end for micro managers.

The flashy part of Flash-Up is a memory-resident module (25K, plus 1K to 39K for data) that loads library files, groups of windows you create for each application, from disk into memory and then displays individual windows on top



Customize any software—even your own.

of dBase III, WordPerfect, or whatever. As with other pop-ups, Flash-Ups turn underlying graphics screens into garbage, but it had no trouble redrawing mine perfectly after execution.

A window can be either plain text (a help screen) or a moving-bar menu whose items send input or command macros to the underlying program—or send control codes to a printer, pause for keyboard input, display a saved screen image, or call a submenu with more choices.

If menu items aren't clear enough, you can give each one its own help screen or definition that pops up alongside as you move the cursor. The window editor gives you copious control over windows' size, color, border style, screen location, even use of the extended character set and a "repeat last key" command for artistic lines or boxes.

You can summon these windows practically any way except verbally—from a main menu called with Alt-Home or another hot key, through individually assigned hot keys (as with other macro programs), or with commands from the DOS prompt or within batch files when there's no program running. Or your ap-

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# PC PAPERS...

Without further adventure, they reached the dwelling of Governor Bellingham. This was a large wooden house, built in a fashion of which there are still specimens extant in the streets of our older towns; not moss-sorrorred and melancholy at heart with the many remembered or forgotten, that have

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- Delete Text
- Block Move, Copy, Delete
- Character Fonts
- Save to Disk
- Printing & Options
- Formatting Commands
- Move cursor
- make selection

Erase next or previous word, line, sentence, paragraph.

year on its sunny windows, It had, walls being overlaid with a kind of ken glass were plentifully intermixed; slant-wise over the front of the d as if diamonds had been flung against illiancy might have befitted Aladdin's f a grave old Puritan ruler. It was d seemingly cabalistic figures and taste of the age, which had been drawn and had now grown hard and durable,

for the admiration of after times.

Pearl, looking at this bright wonder of a house, began to caper and dance, and imperatively required that the whole breadth of sunshine

PEARL PAGE 1 PG LN= 1; LINE 1/ 28 COL. 1 MARGIN= 72 (INS)

Notice fancy characters and help window of this Flash-Up menu (on top of My Word).

plication can call Flash-Up automatically, by simply displaying an alert character (usually the tilde) followed by a command on screen. For programs that don't go through normal video channels, such as Lotus 1-2-3, Flash-Up also monitors the printer port; use one of 1-2-3's own macros to print a range of cells containing tilde commands, and your windows will be awake and flashing.

That last method is a little tricky for everyday macro users, but the key to using Flash-Up Windows with your own programs in BASIC, Pascal, C, Fortran, Cobol, or applications languages like dBase: a simple PRINT statement (to give a BASIC example) can summon a classy-looking display of menus and context-sensitive help screens. Even if you're not a programmer, Flash-Up can swap library files between memory and disk to help you build a complete, consistent interface for novice users—everything from a program selector replacing the DOS prompt to "Print" or "Save" menus that look the same, though they give different commands, in your spreadsheet and word processor.

It'll take some work to set up because the window editor is a separate, nonresident program—you must know exactly

what keystrokes a menu item should transmit, or constantly shuffle between the editor and your application debugging macros. You shouldn't need more than one library file of windows for each application, though you'll have to keep track of filenames and memory allocations. (Also, my Tandy, like some other clones, ignores Alt-keypad commands; the installation program let me reassign Flash-Up's hot keys.)

But if you write your own programs, tend a computer used by coworkers, or are pushing the limits of other macro utilities, Flash-Up lets you go wild with windows for your windows, help screens for your help screens. I'll be playing with this one for some time. **ME**

### Names and Addresses

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718-458-3700

## Connecting a Laserwriter to just about any computer; custom keyboards; a hot Postscript BBS . . .

By Don Lancaster

Every now and then, I'll find the answer to a hacker help-line question long after I have misplaced who asked it. So, let's pick up a few loose ends.

One reader wanted a good way to measure the speed of a pitched baseball. After consulting with the coach who lives across the street, I find that an ordinary hand-held police speed radar works like a champ. So good, in fact, that there doesn't seem to be anybody making anything else to do the job.

No, you don't have to cover the ball with foil or anything like that. In fact, a pitched ball a few feet from the unit has a much larger radar cross section than does a vehicle way down the street.

Since it is good public relations for your local police, the chances are you can pick up the use of both a radar and an operator for free if you just ask.

Incidentally, the actual speed of a ball thrown by a high-school pitcher typically varies from 60 to 95 mph. College and professional baseballs, of course, travel even faster.

Another reader wanted to build a custom calculator-style keyboard. The obvious thing to do here is check out the usual surplus sources, including the fine advertisers here in *Modern Electronics*. You can often pick up surplus calculator keyboards for a dollar or less, and then easily rework them into your own application.

If you want a fully professional first-rate custom keyboard, the *KB Denver* people do have all sorts of options available, ranging from snap-dome through full travel. They also have custom do-it-yourself kits.

Yet another reader needed great heaping bunches of LED lamps, cheaply and in a hurry. Two obvious hacker sources for this would be *Jameco* and *Mouser Electronics*.

The people at *Fairchild Semiconductor* just came out with a new free *Power Products Data Book*. This beauty includes several ap notes on switching pow-

er supplies and on the use of power MOSFET devices.

As per our usual reminder, this is your column and you can pick up technical help per the end box. On to this month's feature attraction.

### How do I Hook Up the Laserwriter?

There's a lot of misinformation being circulated on this, so let's set the record straight.

You most definitely do *not* need either a Macintosh or the Appletalk network to use a Laserwriter. Just about any personal computer and virtually any word processor or telecomm program will work just fine. In fact, the Mac/Appletalk route can be slow and expensive.

The Laserwriter does speak Postscript, a very powerful and newly standard typesetting language. The Postscript code can be gotten from an internal Diablo 630 daisywheel emulator, from any of hundreds of canned application programs, or from your own custom Postscript routines, created on any old word processor or editor utility.

Postscript is easy to learn and use, has outstanding documentation, is fun, and is extremely addictive. You will nearly always get the best-looking final results with your own custom Postscript code, written your way for your use. On the other hand, with "pure" Postscript, all you see on the screen is your own Postscript code. Many canned application programs will instead give you a crude screen approximation of your page images. But note that there is no video monitor available anywhere at any price that can give you an accurate picture of all those nine-million dots on the final Laserwriter page. Thus, and contrary to many of those ad claims, "what you see is what you get" simply does not exist for the Laserwriter. For true "what you see is what you get," you print the image on paper and then look at it. This is the only way to do it.

At any rate, there are four ways to operate the Laserwriter, depending on the setting of a 4-position switch labeled 1200, 9600, Special and Appletalk.

The 1200 mode is the least used. This is permanently configured to allow serial data communications from either an RS-232 25-pin connector or else an RS-422 or RS-423 9-pin connector. The baud rate is 1200, with 7 data bits and no parity. XON/XOFF handshaking is used, but this becomes important only with extremely long or extremely slow routines.

The 1200 position is useful for direct modem communication. It also gives you a way to "undo" erroneous programming of the more powerful 9600 and Special modes, even if these modes have been bombed beyond belief.

Note that 1,200 baud is ridiculously slow for most other uses.

The 9600 mode is initially set up for 9,600 baud, 7 data bits, 1 stop bit, no parity and XON/XOFF handshaking activated. Handshaking becomes extremely important on any input file longer than 5,000 or so characters.

The 9600 mode is programmable. You can set the baud rate up to 57,600 or less; you can change the parity, data bits, and stop bits. You can also switch to a "DTR," or a "hard-wire" handshake should XON/XOFF be positively not available on your host computer.

The Special mode is initially set up to do a Diablo 630 daisywheel emulation for quick and dirty dumping of routine 12-point text with no graphics. Once again, the initial values are set up for 9,600 baud, 7 data bits, 1 stop bit, no parity, and XON/XOFF activated.

While convenient and fast, the 630 emulator is like buying a Porsche motor car only to listen to its radio. Most users outgrow this mode after approximately 12 minutes of use—well, perhaps 15 minutes on the outside.

Finally, the Appletalk position allows use of the Appletalk network, providing one way to let several users access the same Laserwriter. But note that a Laserwriter is vastly more useful, and infinite-

# HARDWARE HACKER...

ly more convenient if you can reach out and touch it from your work station.

In addition, Appletalk requires expensive cables, is often much slower than is 9,600 baud and can very severely and unnecessarily limit your choice of host computer and applications packages.

Presently, the four most popular computers for laserwriter use are the Apple IIc/IIe/IIgs and Macintosh, the PC and clones, and the Atari ST. As details vary, let's see how to use each of these.

- *To A Macintosh.* With the Mac, you first have to decide whether or not to make use of Appletalk. While Appletalk is often a poor, expensive, and slow choice, politics or your chosen application program may force this decision upon you. If you do go the Appletalk route, you buy a special \$150 cable from Apple and plug it between the Mac and Laserwriter. The printer is switched to the "Appletalk" position, and then the Printer Chooser desk accessory is used on the Mac to set up the proper connection protocols.

If you intend using a canned application program, just follow the instructions given.

Contrary to popular belief, you can easily run your own Postscript routines over the Appletalk network. This first requires a piece of special but low-cost software, such as the Adobe Font Downloader or Send PS, the latter available for \$10 from Adobe Systems.

To use either of these code downloaders, you must have your Postscript code on-disk in a standard ASCII text file format. Note that a MacWrite document can *not* be used here. Instead, you can use MacWrite to create and edit your file. You then select "Save as," give the code a new file name, and then save to disk as an unformatted and standard ASCII text file. The downloader then will automatically select your file and report error messages.

For direct Laserwriter operation on a Mac, just connect a plain old Imagewriter printer cable between the Mac and the Laserwriter, and select a telecomm pro-

```
% DTR.ON.XON.OFF (Laserwriter 38 Handshake changer)
%.....
```

```
% This routine will PERMANENTLY change a Version 38.0
% or higher Laserwriter from XON/XOFF handshaking to
% DTR (hard wire "pin 20") handshaking.
```

```
% DO NOT USE ROUTINE UNLESS IT IS ABSOLUTELY NECESSARY!
```

```
% The process can be reversed by running XON.ON.DTR.OFF.
% Note that the default Laserwriter handshaking is XON/XOFF.
```

```
% Always wait 45 seconds or repower after running this code.
```

```
% This routine must NOT be used more than 5000 times over
% the life of the Laserwriter.
```

```
% .....
```

```
serverdict begin 0 exitserver
```

```
statusdict begin
```

```
25 9600 4 setsccbatach
```

```
25 9600 4 setsccinteractive
```

```
end
```

Fig. 1. Postscript code to select Laserwriter DTR handshaking.

gram capable of both 9,600 baud and XON/XOFF handshaking. Switch to 9600 and communicate away.

To check out serial data communications, always start with a file consisting of the single word *showpage* all in lower case. If you cannot eject a Laserwriter page, then something is wrong with your comm setup. But note that some telecomm programs are extremely slow when purportedly communicating at 9,600 baud. MacTerminal is especially atrocious. Try Red Ryder or something else better written.

But isn't 9,600 baud 9,600 baud? Not really, since there is overhead and disk access involved, before, between, and after the actual sending of each character. To measure the virtual baud rate of any program, just send out 10,000 characters

and see how long it takes. A true 9,600-baud link will finish the job in a tad under 10 seconds.

The usual way to send Postscript on the Mac is to create and edit your file with a word processor, save it to disk as a standard ASCII text file, and then send it out with a separate disk-based telecommunications program.

- *To An Apple IIc, IIe and IIgs.* One of the real surprises is that it is far faster, far cheaper, and far more convenient to use an Apple IIe as a Laserwriter driver than it is to use the Mac to send your own Postscript code to the Laserwriter. The two main reasons for this are that IIe telecommunication does 9,600 baud or higher communication must faster than the Mac does (with or without Appletalk, and that you can easily have a single pro-

gram that edits and sends RAM-resident Postscript code, while at the same time reporting and recording the return error messages, without any need for repeated trips to the disk or clipboard.

A Super Serial Card is best used with the IIe, set to S1: 4, 6, 7 on; S2 1, 4 on, terminal mode, arrow down. Connect an ordinary RS-232 printer cable between the Super Serial Card and the Laserwriter. Switch the Laserwriter to 9,600.

Once again, if you are using a canned applications program, just follow the instructions that came with it.

To activate the handshaking on your own Postscript routines, place an [I] X E [I] Z at the beginning of your files. As with the Mac, you can use any word processor or editor, save to disk as a standard unformatted ASCII text file, and then send that file with your favorite telecomm program.

As before, to check the serial communications, always start with a file consisting of the single word *showpage* all in lower case. If you cannot eject a Laserwriter page, then something is wrong with your comm setup. But there is a much better way than all this. ProDOS Applewriter 2.0 or 2.1 will simultaneously let you create, edit, and send Postscript code, while at the same time receiving and optionally *recording* error messages—all without program switching or mandatory disk access.

Other benefits of Applewriter include its powerful self-prompting macro glossaries and its superb WPL supervisory programming language. The latter can actually write Postscript code for you, in addition to handling user prompts, doing help screens, handling fancy mailing list manipulations, and much more.

You have to get sneaky to get single program write/transmit/report/record operation from a stock Applewriter. First you create a glossary entry that, on a single keystroke, prints and then will immediately switch to the [Q]-I modem receive operation just as soon as printing is through. To record the error messages at the end of your current document, just

follow this with a manual [esc]-R. This is really only half-duplex operation, but you can easily get it to behave as if it were true full-duplex, catching all error messages all the time. The simplest way to do this to write or call me for a free and short Postscript error handler that you append to the beginning of your routines or download on your first power up. Otherwise, a simple delay loop of 3500-{37 sin pop} repeat at the beginning of your file will catch all errors on short files and most errors on longer ones. Those few that remain can be trapped out with creative use of .epo and .epl.

Yes, you can use Appleworks, especially when doing Diablo emulation. But the many hassles involved with those short line lengths, the lack of glossaries, no WPL supervisor, or error messages

and the inability to embed control characters, etc. makes Applewriter a vastly better choice for serious Postscript work.

Appleworks also does not lend itself very well to proportional and fill justified fonts, especially with tabbed fields.

The IIc is nearly as useful as the IIe as a Laserwriter driver, but you have to pay close attention to one particular detail. If you have a new IIc with the 3.5 monitor ROM, XON/XOFF handshaking will work the same way it does when using a IIe. Namely, placing a [I] X E [I] Z at the beginning of the document will turn on the handshaking for you. On the other hand, if you have an old IIc and a newer (version 38.0 or higher) Laserwriter, use Fig. 1 to make a simple patch that lets you switch your Laserwriter to DTR or hard-wire handshaking. This patch may

```
% XON.ON.DTR.OFF (Laserwriter 38 Handshake changer)
%.....

% This routine will PERMANANTLY change a Version 38
% or higher Laserwriter from DTR handshaking back to
% its default XON/XOFF handshaking.

% This code undoes a previously run DTR.ON.XON.OFF, returning
% the Laserwriter back to its normal mode of operation.
% Always wait 45 seconds or repower after running this code.

% This routine must NOT be used more than 5000 times over
% the life of the Laserwriter.

% .....

serverdict begin 0 exitserver

statusdict begin

25 9600 0 setsccbatch

25 9600 0 setsccinteractive

end
```

Fig. 2. Postscript code to restore Laserwriter XON/XOFF handshaking.

prevent other users from accessing the Laserwriter in their intended way.

A patch to return you to XON/XOFF handshaking is shown in Fig. 2. Either of these patches can also be used to change the baud rate, simply by replacing the 9,600 with the selected rate. Maximum standard rate allowed is 57,600. Do *not* use any commas in the baud rate!

Another gotcha: Do not use either of these patches more than 5,000 times over the life of the printer. Plan your work.

I know of no way to use an old IIC on an old Laserwriter, short of doing the free IIC monitor upgrade. Note that this is a new upgrade done for 3.5-inch disks; the old "modem fix" upgrade is no help at all here.

Oh yes, there's one other IIC detail. Instead of flipping switches on a Super Serial Card, you change the baud rate and such by using the IIC utilities diskette.

The IIGS is presently marginal as a Laserwriter driver, but it very shortly should get considerably better. Eventually, the IIGS has the potential to become far and away the best Laserwriter driver.

There is now a built in Appletalk driver. Unfortunately, this driver presently lets you run only in a new Imagewriter emulation mode. While fine for internal Appleworks documents, this is otherwise nearly useless.

Presumably a Postscript/Appletalk print driver will shortly become available. You can also run most IIE software on a IIGS by adding your own Super Serial Card and running in the 9600 mode.

I have available some patches that let Applewriter print on a IIGS without the Super Serial Card. At the present time, though, the key patches for error communication and maximum possible throughput are not quite ready.

• *To An IBM PC or Compatible.* As with the other machines, if you have a canned applications program, follow the instruction when hooking the Laserwriter to an IBM PC or compatible computer.

For your own Postscript code, you have to get around two fundamental incompatibilities: Some PCs may not offer

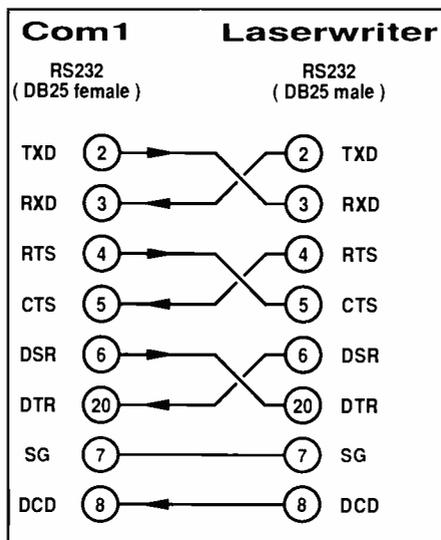


Fig. 3. Cable wiring scheme to connect a Laserwriter to an IBM PC or compatible computer.

serial ports, and the stock PC does not offer any XON/XOFF handshaking, while the stock Laserwriter does not allow DTR handshaking.

Kits are available that provide the serial COM1 port for a PC or clone. You absolutely *must* have one of these to use a Laserwriter. Beyond that, you have to use comm software that allows properly activated XON/XOFF handshaking, or a software patch must be made to semi-permanently change the Laserwriter to DTR handshaking, as in Fig. 1.

A special cable is needed to get from

the COM1: port over to the Laserwriter and is shown in Fig. 3. You can easily build this out of a modem eliminator and an RS-232 extension cable.

Once you have the serial port, the comm cable, and the handshaking resolved, you can use any word processor to create your Postscript code and then transmit it with your favorite telecomm program. You can also use DOS to directly send a Postscript file. This is fast, cheap, and convenient, but it does not provide return error messages or let you work interactively with the Laserwriter. Instead, to send a stock ASCII textfile on disk, just do a . . .

```
mode com1:9600,n7,1,p
mode lpt1:=com1:
copy filename lpt1:
```

As with all other machines, always start with a simple *showpage* file. If you cannot eject a page, there is no point in trying anything else.

One expert at PC to Laserwriter connections is Woody Baker, who can be reached by dialing (512) 837-2679. He welcomes user calls.

• *To An Atari ST.* The Atari 512ST or 1040ST are quite easy to use as Laserwriter drivers, since XON/XOFF handshaking is readily available under the GEM operating system. As with the other machines, select 9,600 baud, 7 data bits, 1 stop bit, and XON/XOFF handshaking activated. Since handshaking is done by the operating system, no special handshake commands have to be inserted into each Postscript file.

## NAMES AND NUMBERS

**Adobe Systems**  
1870 Embarcadero Rd. S120  
Palo Alto, CA 94303  
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**Fairchild**  
4300 Redwood Hwy.  
San Rafael, CA 94903  
(415) 479-8000

**Jameco Electronics**  
1355 Shoreway Rd.  
Belmont, CA 94002  
(415) 592-8097

**KB Denver**  
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Frederick, CO 80530  
(303) 833-3500

**Mouser Electronics**  
2401 Hwy. 287 North  
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(817) 483-4422

**PostScript BBS**  
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**Synergetics**  
 Box 809  
 Thatcher, AZ 85552  
 (602) 428-4073

The usual way to handle your Postscript code here is to create and edit it with a word processor, saving to disk as a standard ASCII text file. The text file is then sent to the Laserwriter using either the GEM operating system or your favorite telecomm program. Always start with a simple *showpage* file and get that to work first.

• *To Other Computers.* The Laserwriter can be used with *any* word processor or editor on virtually *any* computer that has a standard serial data communications ability. For any computer not mentioned above, set up your machine so that you are doing serial communications at 9,600 baud, 7 data bits, 1 stop bit, and no parity, using a typical printer cable. If XON/XOFF handshaking is available, use it, either by activating it in your operating system or telecomm program or adding the needed prefix to each Postscript file or routine. If XON/XOFF is not available, switch to DTR handshaking per Fig. 1. Do not do this unless absolutely necessary.

Create standard ASCII text files with a word processor or editor, save them to disk, and send them with the operating system or comm program. Should XON/XOFF not be available, use the patch to provide the DTR communications. As before, always start with a simple *showpage* test.

By the way, there is a new and independent *Postscript* bulletin board at (409) 244-4704. Although there are no user charges, advertisers and sponsors

are urgently needed. 24 hours, 300/1200/2400 baud.

I have bunches of stuff that can help you with all your Laserwriter communications. Besides my free helpline (602) 428-4073 and my free listings, I have an *Introduction to Postscript* VHS videotape, along with my open and unlocked *Postscript Show and Tell* that runs on all major personal computers. We also stock both the *Adobe* Postscript books. Just write or call for a free list of all the other goodies. **ME**

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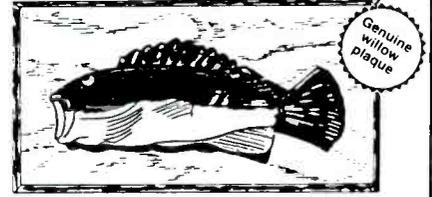
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## WordStar Professional Release 4 Discovers The Fountain of Youth

By Art Salsberg

That venerable word-processing war horse, WordStar, got a new lease on life beyond its million-plus loyal users. It had reached Version 3.31 about four years ago and just stopped growing. But now, in a giant leap, it's at Version 4.0. Are its control codes the same? Is it "buggy"? How fast is it? Does it work with old WordStar files? The questions seemed endless as the examination began.

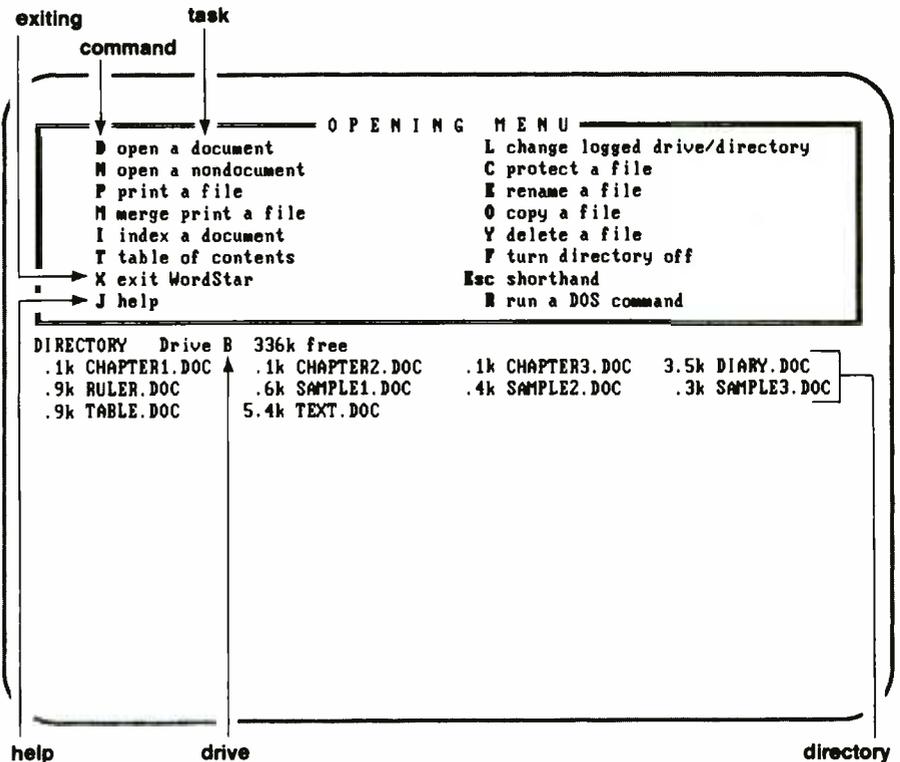
As a WordStar lover (through version 3.30), with all its faults, I had given up hope on an update and was finally planning to switch. Therefore, I put the \$495 retail-priced package to work as quickly as I could. (Registered WordStar owners can upgrade for only \$89 plus shipping, while registered users who bought WordStar Professional 3.31 between December 1986 and March 31, 1987 can get free copies of Version 4.0. Just provide the serial number on your old WordStar program, which, I understand, will be sort of winked at if it's not that of an original user, though only one Version 4.0 to a matched number might be sent. Additionally, Micropro has a special introductory discount of \$100 for newcomers.)

It comes with an assortment of disks—none copy protected, of course. They are Program, Install, Dictionary, Tutor, Word Finder Disk 1, Word Finder Disk 2. These are accompanied by a handsome, three-ring binder and matching slipcase, with beautifully printed manuals.

The "look" was right and, after a cursory examination of the manual ("documentation"), it, too, passed muster. So all things were in place, with the inclusion of an expanded spelling checker and a thesaurus. Now I decided to work with the new WordStar *before* reading all about its additions and enhancements.

### First Look

After loading the programs onto my hard disk drive, I "installed" the word processor, picking my way through the choices quickly while I marveled at the long list



WordStar 4.0's Opening Menu.

of printer drivers I could choose from, including Hewlett-Packard laser printer models.

A Config.Sys file must be set up for Files = 20, which the install process does for you automatically if you don't have it (I did). A separate file, WSCHANGE, is available to make a host of changes that are not considered basic, which greatly simplifies a first installation by a tyro. Then I transferred the separate synonym finder to the same directory.

That was easy. Now to start the new program. Up came an orderly menu on the screen, a bit different than the old version's, with a few additions such as Table of Contents, Run a DOS Command, etc., but familiar anyway. Keying in the well-known "D" for document, typing a file name, I pressed Return. The display immediately requested a Y or N for choosing a new file in the event I mistakenly spelled an existing file's name wrong. Hitting Y, the "blank" docu-

ment page instantly appeared. The status line across the top was modestly changed, indicating page number, line number, and character count, as well as the file name and Insert and Align words across the top.

At the bottom were ten highlighted boxes to identify function keys (I was using a monochrome monitor; for color, all I had to do was make the selection during installation). Each box had two lines of copy, so I assumed that the number of functions I could choose were increased. Probably have to press Shift to get the top-most ones, I thought, which proved correct later.

The Help Menu consumed a large part of the screen, so I pressed the Ctrl-J keys to change its level for more writing room. (Later, I used the WSCHANGE file to set Help at a level that did not always display the Menu.) Then I typed. It was smoothly the same. One difference I quickly observed was that the Back Space

and Delete keys now worked in the intuitive manner in which they should, unlike the earlier version. That is, the Back Space deleted letters to the left, while the Delete key removed letters the cursor was under. Another was a difference in the use of some Function Key numbers. (There's a file patch to change numbering to that of the older version, but I stayed with the new ones.)

Using the boldface function key introduced a **B** in front of a word. But here a big difference occurred: *all the following copy was brightly highlighted!* Inserting the same control code at the end of the word shut off highlighting of all text except for the word I wanted boldfaced. The same happened when I pressed F3 for underlining a word, except that all following text became underlined until I added another ^S at the end of my selected word(s). Great! Now the user is warned if he forgets to add the turn-off code, which, if not caught, will surprise the user with printed matter that contains unwanted boldfaced words. Inserting control codes to get italics, superscript or subscript also initiates highlighting.

Among the function-key labels aligned at the bottom of the screen was "ChkWord" for F4. Since the label below it, Bold, was used successfully to in-

sert a boldface command, and a numeral 1 was at the extreme left in line with Bold, I assumed that all the labels above this line-up required using a shift key at the same time the function key was pressed. Doing this, with the cursor under a word, immediately caused a window to appear that indicated spelling of the word (in this case, the word was noted as being spelled correctly, while a bevy of suggested words with alternate spelling appeared underneath the comment.) It all happened at a blink of the eye, that's how fast the spelling checker works.

Looking at the function labels, it was obvious that a host of convenient commands were added to save some keystrokes and to make it easier for newcomers to work with WordStar. For example, Shift-F2 centers text on a line, as well as old WordStar's Ctrl-OC command.

An apparently new command, Undo, was listed as F2. This is an unerase feature that allows a user to restore data that was mistakenly erased. Works like a charm, immediately popping back the copy I purposely erased for the test.

Overall operating speed is swift, placing the new WordStar in the fast lane. What a relief from the older version's snail-like pace. (Very-large files can slow up a few operations, though, I subse-

quently discovered.) Now I turned to the manual to try out new twists and turns that were bared there, satisfied that an experienced WordStar user will feel right at home with Release 4.0.

What follows now are advances incorporated into the latest version of WordStar and hands-on experiences working with Version 4.0 for many days.

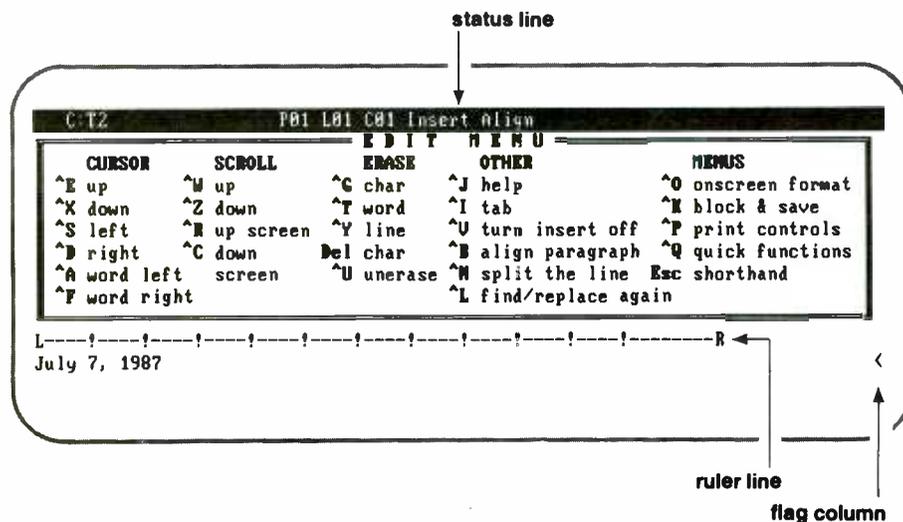
### WordStar Equipment Needs

With more than 125 enhancements, WordStar Professional 4.0 obviously represents a truly major upgrade. I'll cover the most important changes here, aside from ones cited.

WordStar 4.0 gains its increased speed by using more computer memory. The program ate up 261K plus 33K for the thesaurus. Add about 11K more for buffer memory set aside for working files and another 53K for DOS, adding up to a total of 358K of memory space used. Therefore, bare RAM minimum is 320K without the thesaurus. If you want to enjoy the full speed that the program is capable of achieving, you'll need more memory working space for documents (for which you might increase the number of buffers) and other memory-resident programs you might wish to use, of course.

With 640K, you'll get the whole spell-er's main dictionary in memory. Otherwise part of it will be automatically retained on disk, which doesn't matter much if it's a hard disk. In any event, 512K of computer RAM should be a minimum, I think, which nowadays is no big deal. The computer I'm using to examine WordStar is an old IBM PC with the slow 4.77-MHz clock and 576K of RAM. Once the 20 buffers (10.56K) are filled up with your work, understand, disk and memory transferring will take up the slack, which could cut into its fast speed for a few operations, such as Save.

With a large 28K file (16 double-spaced pages or about 4,200 words), which is about 63% more bytes than the buffers can hold, for example, my initial test showed that it took 12 seconds to save while continuing to remain working in the file. In an 8.3K file, in contrast, this operation required only 7 seconds,



The Edit Menu appears at the top of screen when a document is opened. Help Level can be set to eliminate automatic appearance, providing more document work space.

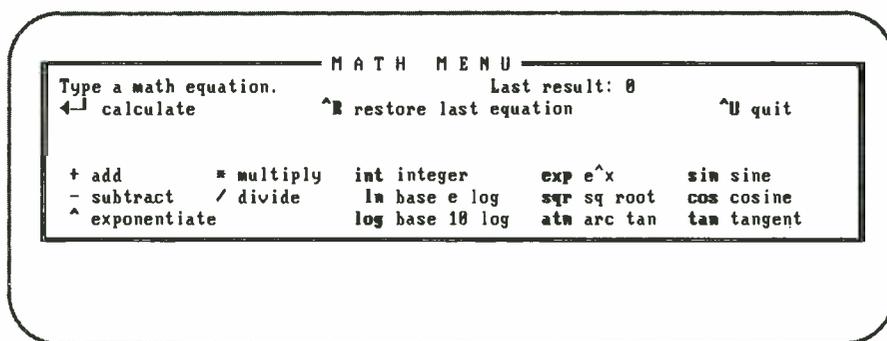
while a 5.5K file needed 4 seconds and a 0.1K file less than 1 second. In subsequent timings, however, I learned that this time varied according to where my cursor was positioned. At some points I was able to Save the 28K document and stay in the file and commence working within about 3 seconds! Seems that the closer to the file end that the cursor is, the faster the Save time. Saving data and exiting to the main menu, however, is always fast, with a 28K file regularly consuming less than 4 seconds. (Whereas saving and *remaining* in a file creates up to three temporary files, saving and exiting only adds a backup file, .bak.) With other commands, such as Find, it only took a few seconds to go through six pages in search of a word and about six or seven seconds to search through ten pages with my relatively lethargic 4.77-MHz PC. Any reference to pages here, incidentally, refers to printed pages, not merely screen pages, which would increase the "page" number by far.

In general, the new WordStar proved to be far speedier than earlier versions.

If you use a 360K floppy, you'll have to erase some unused program material to store both WordStar and the *full* thesaurus on one disk. Should this be the case, you can still have a thesaurus on your program disk by using an abbreviated file that has 120,000 synonyms instead of the full 220,000, and by erasing many printer drivers in the program that you won't be using. (You can always restore printer drivers with your program disk.)

WordStar warns the user when only 3K bytes of memory is left by displaying a LARGE-FILE message in the status line. I wondered if it emitted a beep-sound alert, but I never reached this point. There are lots of alternatives that can follow in order to free up memory space. It's best to maintain shorter files anyway, rather than one giant one. This way, you won't go way past the buffer memory capacity and, therefore, maintain speediest operation.

Files with WordStar shouldn't exceed 1/3rd of the free disk space. So if your file is 20K, you should have at least 40K available on disk to work with. This doesn't present a problem with hard disk



WordStar 4.0's new Math Menu.

drives, but it well could with a 360K floppy data disk since it's more likely to come close to its capacity at some time.

## Enhancements

For me, the most important enhancements to the new WordStar—aside from the aforementioned increase in operating speed, boldface and underlining attention-getting devices, and an unerase or undo feature—are path support, compatibility with WordStar 3.3 files and being able to work with DOS without leaving the document I'm writing.

As an example of path support, I chose O from the opening menu to copy a file. Typing /word/filename (another subdirectory and name of the file I wanted to copy) in response to the display's query, and the new file's name, the old file was added to WS 4.0 in a flash. I was able to change to the other directory, too, to check file names there without leaving WordStar. Working with the old WordStar file within the new version proved that it was fully compatible.

With these major improvements in WordStar 4.0, I felt that everything else added was gravy. For prospective users who are not long-time WordStar users, and perhaps not as forgiving, the perspective is different. They *must* have additional features if WordStar is to be a serious candidate for their new word processing program due to strong competition from a handful of first-class products. And they're right.

Happily, the WordStar pot is nearly full!

Commencing with my favorites, the large choice of printer drivers (about 110 listed plus customizing prospects), which includes laser-printer support galore, is most welcome. The ability to easily set up columns and move *column* blocks is gratifying. So is making it simple to strip the 8th bit in order to quickly put data into ASCII format; *multi-line* header and footer capability; greatly increased dot-command power that doesn't require a merge-printing activity (except for variables, naturally) in order to use them; and the ability to set new margins and indentations easily in the middle of the copy to enhance page design.

There are so many other important features, though, that did not head my list simply because I had already worked around some with add-on programs (some of which I can now eliminate since the new WordStar has 'em).

WordStar 4.0 has *math* functions, for example, brought up by keying ^QM while you're editing. A Math Menu window is instantly displayed, featuring 14 math functions you can use, including trigonometry, exponentials and logarithms. You simply type in the equation for solving (2 + 2 or whatever) and press Return for the answer. To paste the answer into the copy you're editing, at the cursor position, you press Esc and then =. Or press Esc and \$ to get it in dollar format. WordStar 4.0 also totals numbers (or dollars) in a marked block, even if with words mixed in with the numbers.

CorrectStar, WordStar Professional's spelling checker, has been expanded to 87,000 words, up from 67,000. You can

check spelling while you're editing, check a single word, every word or even type out a word for a fast check. There's a 1,500-word personal dictionary for adding new words, as well as optional specialized dictionaries for financial, legal and medical work (\$25 each). The speller is fast and good. Its only shortcoming was not catching repeated words and an absence of proper names in its dictionary, like John. It automatically aligns the right margin, too, if necessary, which is a good feature that many spelling checkers don't have.

The 220,000-word thesaurus, Word Finder, is a top-notch choice to complement WordStar 4.0. (See *Modern Electronics* January 1987 for a detailed review of the separate module produced by Microlytics, Inc.)

A variety of operating shortcuts have been introduced. For example, now there are *macros*, up to 36 of them, that allow you to create your own simple key code to produce long strings of copy or commands at a single stroke. Just press Esc and type the key you chose to execute it. A few macros have already been built into WordStar 4.0, such as the date and the time (assuming your computer is set up to produce the correct information), which can be quickly inserted into your copy.

In addition to the foregoing, which is labeled Shorthand, there are provisions for 40 function-key choices (using Shift, Ctrl and Alt keys) set up; they're also programmable.

Using Alt with the function keys produces a variety of *graphic line drawings*

that can be used to enhance text by, say, surrounding it in a box. There's also a box file that's 23 columns wide by 7 lines deep that can be called up quickly. Marking and moving commands transfer text into the box; function keys make doing it a snap.

Authors and scholars will be delighted by the addition of Subject Indexing with pages and Table of Contents capabilities that are chosen from the opening menu. The manual notes that indexing is different from the earlier WordStar's Star-Index program, which can still run with Version 4.0.

These are the highlights of new features in WordStar 4.0. But a hundred other small and not-so-small modifications add up to an immense increase in operating flexibility, as follows.

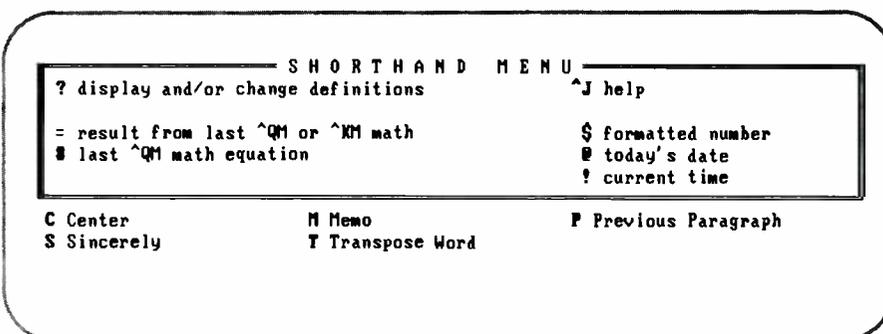
### More Improvements

Find and Find/Replace has been improved, including the option of automatically aligning paragraphs if needed when a replacement is made, which I like very much.

- You can prevent files from being written to so that accidental changes can't be made to, say, final documents. This can be toggled from the main menu.
- There are a host of cursor-movement conveniences, such as pressing Ctrl-Cursor Arrow to jump words quickly, Ctrl-Home to jump to the very beginning of your document, etc. You can also go directly to a specified page or line.
- Continuous underlining can be initiated or turned off with a dot command. In

default mode, spaces aren't underlined. And you can obtain proportional spacing, turning it on or off with a dot command while you're editing. Print command characters and dot commands can be turned off with the new WordStar so that you can obtain a better preview of what the document looks like when it's printed. Using a dot command, character widths can now be changed for dot-matrix printing, also. A dot command can be used to initiate draft printing (near-letter-quality is the default).

- WordStar 4.0 has a local area network (LAN) version, which supports file-locking. There are single-user and node versions. Site licensing is available.
- Extended characters can be printed using the Alt key and the numeric keypad. So you can create foreign alphabets, such as Greek symbols, an *umlaut* (the two dots over a vowel in German), etc.
- A character count is at your fingertips by pressing ^Q?, which quickly gives you the count from the beginning of your material to your cursor. You can also get a count of words, lines and characters by running a command, WC, from within WordStar or directly from DOS, for any number of files in the directory.
- Sheet feeders are fully supported.
- Now you can type three lines of headers and footers, whereas the old WordStar limited you to only one line for each.
- You can select different printer drivers when you're preparing to print, enabling you to conveniently pick the printer of choice or permit another computer with a different printer to be used without any hassle. Also, you can choose the number of copies you wish to print, as well as page numbers. Saving and exiting to the print screen can be done in one set of key strokes by pressing Ctrl-PrtSc keys simultaneously.
- Directory files display their memory size in K. Also, the amount of free disk space is always shown.
- There are more flag characters at the right column than before, providing ready information about use of dot commands, block markers and form feed.
- The Help Menu and fingertip explanations have been enormously improved. So has the operating manual and practice



The Shorthand Menu illustrates preset shorthand characters and a few defined ones. To "type" the word, Sincerely, one would press the Esc key and then the letter S.

# SOFTWARE FOCUS...

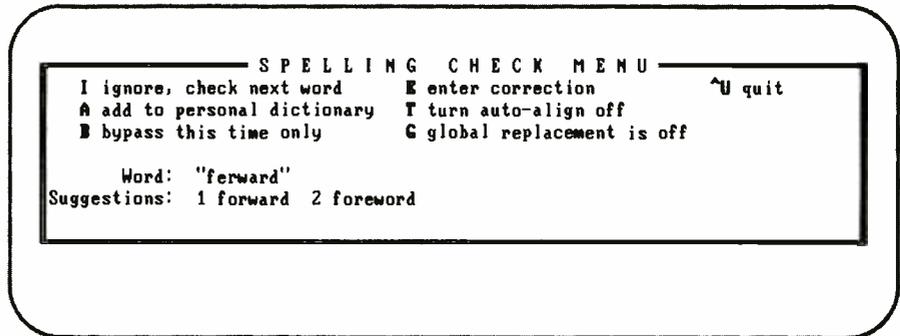
lessons, supplemented by a fast, elementary tour of WordStar 4.0 on the Tutor disk, as well as additional on-disk documentation.

- Should you maintain WordStar working files in the same directory as the program (you can now use subdirectories if you wish), and the files exceed screen display space at the opening menu, you can still scroll, of course, to view more files. But now you can also use a wild card (?????.Txt, or whatever) to selectively display the files you want to choose from or to delete a batch of files. Directory file listings are sorted alphabetically from left to right and can be chosen by moving the cursor to the one you want and pressing Return, as well as by typing the file name. You can still go directly to a specific file from the DOS prompt (ws word.txt, for example), avoiding the opening menu.

- Among the bevy of new commands that are time-savers is Ctrl-6, which deletes a hard carriage return and its margin flag. Also, dot command .LS lets you choose and save a line-space selection (the old Ctrl-OS that can't be saved is retained, too).

As you can see by the brief coverage of enhancements above, WordStar Professional Version 4.0 is loaded! One has to work with the new version, of course, to fully appreciate its increased power. For example, now you can use merge printing to produce a batch of letters that include variables of updated financial information through use of math formulas that automatically change amounts applied to the party it's addressed to while retaining the bulk of the letter that everyone should get. This will speed up automated printing of updated invoices, financial status reports, real-estate reports, etc.

One happily discovers that a full right-margin alignment from single-spaced copy to double-spaced matter no longer leaves only single spaces between paragraphs, eliminating the need to manually insert paragraph spaces. Or learn from experience that reforming a paragraph with function-key F7 leaves the cursor where it was at the first sentence of the paragraph, whereas Ctrl-B, which is assumed to replicate the command, positions the cursor at the beginning of the



*The Spelling Check Menu shows the available choices you have when you check out a word while you are editing a file.*

next paragraph. And delight in uncovering that you don't have to end-mark italic or boldface words if the words to be highlighted continue to a new sentence. This used to require starting beginning and ending control commands anew in the next sentence; at least in 3.30's version.

WordStar's ace-in-the-hole—the greatest customization capability extant—has been intensified. Using WSCHANGE, for example, 4.0 can be used with an EGA board to get 43 lines. And the super word processing program can be modified to show 66-line-long full pages on a screen or 132-character-wide pages for wide-carriage spreadsheet users.

## Comments & Conclusions

WordStar Professional Version 4 arrived just in the nick of time. More and more users were switching to other modern programs, while first-time buyers of powerful word-processing software were turning away from the older version. Without the acquisition of NewWord, which operated similarly to WordStar (which is not surprising since it was developed by two former Micropro employees), with a great number of enhancements, the new release would probably still be a year away, if ever.

It stands now as a truly competitive full-blown word-processing program while retaining virtually all the compatibility and familiar control commands of older versions.

The new program makes needed concessions to potential users who want word-processor control to be as easy as possible by its addition of macros, more function keys, an excellent help menu,

and a very good manual. It added a host of modern functions, such as Math, Path Support, Macros, Increased Speed, and so on. It still has a few omissions that have to be addressed to place both its legs firmly into the front rank of word-processor software, though. I'd liken it now to dBase II's great upgrade to dBase III. This was followed by III Plus, which added its "Assistant" with pull-down menus. This, with some other enhancements, boosted the database management program to the top again. I expect the same progression with WordStar.

I agree with Micropro International's founder, Seymour Rubinstein, that using the control key and another key in combination is faster in the long run, but many newcomers don't want to work that hard to learn all those codes; at least not right away. Well, Version 4.0 has met them half way.

In the next upgrade, I'd like to see a software switching facility to alternately display 20 of the 40 function-key meanings. With Version 4.0, the only way to view all the F-key meanings is to make a change to display two blocks at the screen's bottom, giving up a few lines of document work space. Keyboard templates, which WordStar includes, can lie across the top empty space on a keyboard to give some guidance, however.

I did not find any bugs or glitches in all the time I worked with Version 4.0. This doesn't mean that there aren't any lurking somewhere, but nothing cropped up at all after heavy use, which is a wonderful sign.

Now let's take a look at my wish list for future versions.

A split-screen option is the leading major omission in 4.0 . . . for me! A professional package should have it! Although the Micropro people won't call their next shot, based on conversations I've had with them it's very likely that this feature will be one of others in the next upgrade (which is expected by the end of '87).

Other features I'd like to see are an outliner, sort ability, and footnoting. Beyond this, there are some minor improvements that could be made, as follows.

Cursor movement could be snappier. Also, when I choose continuous-underlined, I'd like to see it displayed as such instead of showing the default, skipping spaces between letters, remaining on screen. (But it's a major improvement over earlier versions, which displayed no underlines at all!)

Certainly, other people may wish for some additional features, such as automatic paragraph numbering as an option, which many lawyers want, and automatic paragraph reformat while you're working. Lastly, displaying actual fonts chosen, such as italics (if your printer supports it; mine doesn't) on the screen would be nice, but one can't have everything, we know.

These quibbles aside, I feel that Micropro International did a truly splendid job in upgrading WordStar. Enough to leverage anyone now using WordStar to upgrade to the latest version, especially with the added inducement of reduced upgrade prices. Enough to attract many newcomers to powerful word processing.

With Version 4.0, WordStar Professional has decidedly joined the small group of top-notch, power-packed programs available today for IBM-type personal computers. There'll be a CP/M version shortly, too, I'm told, so WordStar isn't forsaking its roots.

It's evident that Version 4.0, with more power than ever, can still be customized to the nth degree, adding to its strength (a large, general patch and automatic patching file helps this along). Another important buying consideration is that software developers always write their programs with WordStar interfacing in mind due to its gigantic user base. Therefore, you don't have to worry about annoying interface problems that

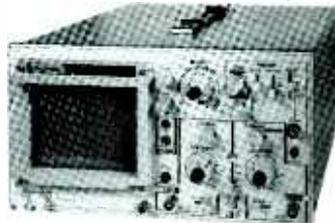
you often bump up against with utility software, which is common enough with XYWrite and Microsoft Word.

Considering all its extensive improvements and future upgrade expectancy on top of its underlying potency as a word processor, I would unhesitatingly recommend WordStar Professional Version 4.0 for consideration to any serious user

of word processing. It's a safe bet that some of my carping will likely be severely cut into in the next revision. Coupling this with Micropro's new stance on all-out customer support—which includes taking care of registered owners with good deals for upgrades—fortifies this view.

Welcome back, the true WordStar. **ME**

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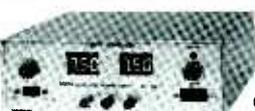
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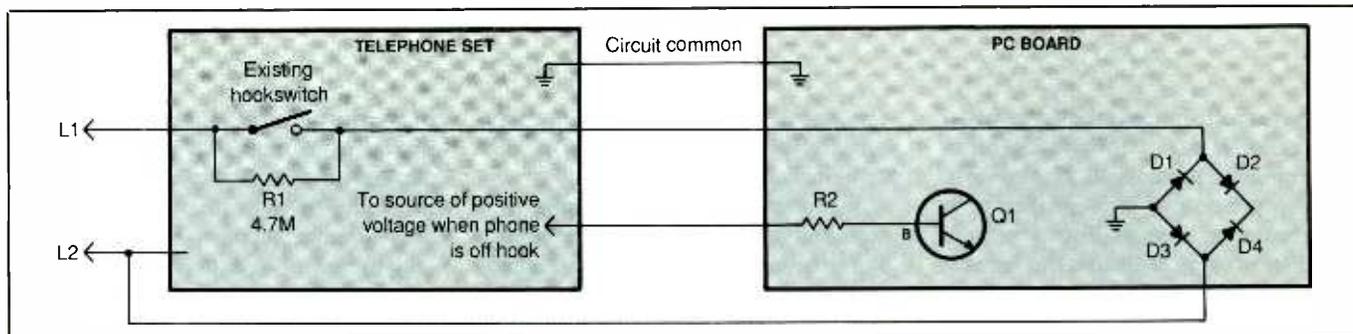


Fig. 4. Details for converting existing telephone into a Memory Dialer.

instrument's circuit common reference. In some instruments, circuit common is the wire labeled L2.

When you've located the part of the telephone circuit that's at +5 to +12 volts under the off-hook condition, connect a wire from that point to R2 on the circuit board. Then connect a wire between the circuit's common reference point and ground in the Telephone Memory Dialer's circuit, at the junction of D1 and D2.

Since the LED isn't used in this version of the Dialer, install a jumper wire between the two pads on the circuit board provided for LED1. This will complete the circuit to the zener diode that provides voltage protection for IC1.

Stand-alone versions of the project can be housed inside any plastic or metal box that's large enough to accommodate the circuit board and dual AA-cell holder and has sufficient panel room for mounting the keypad and the LED.

### Checkout and Use

Checkout of the Telephone Memory Dialer is a simple procedure. First, make sure the project's switch is set to the off position. Then plug its cord into the telephone line via the modular jack. At this time, the LED on any stand-alone unit should be off. Set the switch to on (or pick up the handset of the telephone instrument in which the project is installed). The LED should come on

only when the Telephone Memory Dialer is turned on while the accompanying telephone instrument is on-hook. Dial any number; you should hear the tones in the telephone receiver. To hang up, place the telephone on-hook and set the switch to off.

If the LED doesn't come on when it should or you don't obtain proper operation, carefully check the connections to the D1 through D4 diode bridge and the orientations of all diodes and the LED. If you've modified an existing telephone instrument, use a voltmeter to check to see that C1 charges up to at least 5 volts when the receiver is off-hook and check to see if there is +5 to +12 volts at R2.

When dialing out numbers not stored in memory (including any number in the redial memory buffer), use the Telephone Memory Dialer's keypad as you would use the keypad on any telephone instrument. Remember, numbers of any length can be dialed but the first key pressed can not be \* or #.

To take advantage of the recall capability of the project, press the # key twice. The last number you dialed via the keypad, automatically stored in the redial buffer, will be transmitted out over the telephone line. Keep in mind, however, that redial is valid only for telephone numbers that don't exceed 16 digits in length.

To store a number in memory,

first set the switch to on for a stand-alone Dialer or lift the telephone off the hook for a built-in Dialer. Press \* once and then key in via the dialing keypad the number (any number key from 0 through 9) for the memory location into which you want to store the number. Now dial the number you wish to store exactly as you would to dial out. Though you'll hear in the telephone's headset the tones for the number being dialed, the tones won't go out over the telephone line. Replace the telephone handset or set the switch to off. The number you want stored will now be in the desired location in memory.

To store numbers in any other locations in memory, repeat the above procedure for each number and separate memory location, up to a maximum of 10 numbers and locations.

To recall and dial out a number from memory, lift the telephone instrument's handset for the built-in unit or set the switch in the stand-alone unit to on. Press # two times and then the keypad button for the location in which the number you want is stored. The stored number will be immediately dialed out in rapid sequence.

There is one minor inconvenience with regard to redialing of a number stored in memory. You can't simply activate redial by pressing the # key twice as you do to redial a number dialed via the keypad. To redial a number stored in memory, you must perform the recall procedure. **ME**

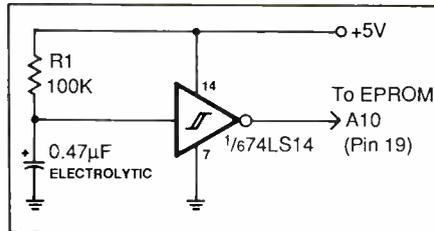
the feedback word has changed again—to 010. When feedback capacitor *C1* discharges, making the address input 0000000010, the output data word remains 01010010 and the output will be stable until the STEP input goes high again.

The above sequence of events continues with the stepper motor winding signal changing at every low-to-high transition of the STEP input. At the same time, the feedback word changes at every STEP transition. If DIRECTION input A4 is high, the process is the same, except that the feedback word changes in reverse order at the low-to-high STEP transition. The Fig. 3 stepper-motor controller circuit has room for expansion at the address inputs to the EPROM. These uncommitted inputs could be used to connect mechanical limit switches to the EPROM. Then a program could be worked up to inhibit the stepper motor in one direction if the corresponding limit switch is activated by the rotation of the motor shaft past a certain point.

Another use of the uncommitted address inputs is shown in Fig. 4. Here an R/C network and Schmitt-trigger inverter (the latter to clean up the slowly rising voltage across the capacitor) generate a power-on reset signal that forces the EPROM to output a specific data word whenever power is applied. When programming the EPROM for the reset function, simply "burn in" the reset data word at all locations above address 1000000000.

### **Construction Tips**

When you build the circuits presented here—and any others of your own design—be sure to connect a 0.01-microfarad disc capacitor between pins 12 and 24 of the EPROM to reduce switching noise on the power-supply lines. These and most other circuits can be wired in any manner that suits you, including on printed-circuit boards of your own design and fabrication, on solderless bread-



*Fig. 4. A power-on reset for the stepper-motor controller.*

boarding sockets and on perforated board with appropriate Wire Wrap or solder hardware. Though component layout is rarely critical, you should keep all component leads and interconnecting wire runs as short

and direct as possible, especially when you point-to-point wire or Wire Wrap the circuits.

After any circuit in which an EPROM is used is wired and ready to put into operation, always cover the window on the EPROM with a self-stick opaque label or black electrical tape. If you don't cover the window (or at least house the circuit in a light-tight enclosure), you run the risk of accidentally erasing the data programmed into the EPROM. Bright direct sunlight can erase the programmed-in data in short order, and even fluorescent light can erase the data in less than a week. **ME**

## **A Subwoofer For Stereo *(from page 65)***

panhead sheet-metal screws to anchor the speaker solidly in place.

Make a check of the system's airtightness by placing the tips of the fingers of one hand around the dust dome in the center of the cone, pushing gently inward and quickly releasing your hand. The speaker's cone should take a few seconds to come back to its rest position, indicating a good seal.

Secure the flush-mount grille cloth on the Masonite frame to the front of the enclosure, with the speaker projecting into the cutout area, with decorative brass or bronze upholstery tacks driven through all eight holes you drilled. If your grille cloth is on a 1" × 1" pine frame, simply press it into place in the recess in front of the speaker panel; friction will hold it solidly in place.

### **Setting Up the System**

Connect the subwoofer to your amplifier's right and left outputs via the same terminals to which your main speakers are connected. With the crossover network built into the subwoofer, only frequencies below about 200 Hz will be heard from the subwoofer. This permits both sets of speakers to reproduce all the bass

notes in the music being played. If you're concerned about your amplifier being able to handle the heavier load, you can install a second crossover network between the amplifier's outputs and your main speakers so that they will reproduce only those frequencies beyond 200 Hz or so. This can be an important consideration when using speakers that have a very limited bass capacity, preventing them from distorting on wide-excursion bass notes. You can obtain a crossover network for your main speakers from the same source given in the Bill of Materials for the subwoofer's network.

What can you expect with the addition of the subwoofer to your present stereo system? Ideally, bass sounds should never be overbearing or too prominent. Only a musical passage with real bass tones should make itself heard (and felt!). This subwoofer is more than capable of providing just this. Indeed, you might not at first notice its presence, which is a good sign. But when you play the opening strains of "Zarathustra," or the cannon shots from the Telarc "1812 Overture," you'll know exactly why you needed to add this subwoofer to your system. **ME**

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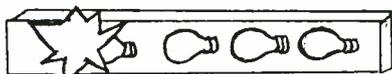
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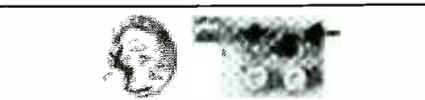


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er current source if you're checking out house, automotive or other high-power wiring. Don't use a source that's not current limited. If you do, heating will occur in the circuit you're troubleshooting, which can lead to false indications.

To make the procedure for locating a short circuit as simple as possible, always connect the current source into the circuit under test at the power-input terminals in the same polarity as the supply that normally powers the circuit. If you can't locate the exact points in the circuit to which the negative and positive

sides of the power supply go, you can simply connect the current source with its output conductors to any convenient positive and negative rail points in the circuit, in the proper polarity. This way, the current source will be delivering a metered amount of power to all circuits just as the power supply normally would.

Once the current source is connected as described to the circuit under test, current will flow through only the short circuit(s), which will make it easy for the Short-Circuit Detector to locate the shorts themselves. To trace a short circuit, first set both switches on the Detector to on and rotate the control until the piezoelectric buzzer silences and both LEDs are off.

Connect the Short-Circuit Detector's positive probe to the positive side of the current source. Then touch its negative probe to each negative-rail connection, starting at the connection closest to the current source's negative input to the circuit and working toward the farthest negative connection until the buzzer sounds and either the + or - LED lights. This is the point in the circuit where maximum current is flowing and, thus, where a possible short circuit exists.

If you note only one component in this leg of the circuit between the positive and negative rails at this point, you've located the defective component. To verify this, desolder or unplug the suspected component and use the Detector to see if the short-circuit condition still exists. If it doesn't, simply replace the defective component with a known good one of the same type to restore the circuit to proper operation.

If the short-circuit condition persists, there may be more than one component in this leg of the circuit. In this case, disconnect or unplug each component until the condition is cleared up to isolate the specific faulty one. Then replace it with a known good one. If more than three

components are in this leg of the circuit, it might be easier to temporarily isolate it from the rest of the circuit by slicing through the positive rail conductors on both sides of the suspected leg. Move the positive lead of the current source and positive probe of the Short-Circuit Detector to the isolated positive rail point. Then probe the negative rail with the negative lead of the Detector until the buzzer sounds and one of the LEDs lights to further isolate the faulty component.

Occasionally, there may be more than one short circuit in a device under test. Evidence of this will appear when, after replacing one faulty component with a good one, the circuit still fails to operate as it should. In a case like this, you must trace each short to the defective component until all is well with the circuit. Use the procedure detailed above in each case. If necessary, temporarily isolate each leg from the circuit under test to nail down each specific bad component.

As you use the Short-Circuit Detector to locate short circuits, you'll note that the size of the conductors will determine how close you can come to a faulty component before the buzzer sounds and either of the two LEDs light. With the ability to detect potentials of less than 100 microvolts, the Short-Circuit Detector can be used with sources as low as 50 milliamperes to detect a short circuit on printed-circuit board copper traces at a distance of 1/8" from the short. Similarly, 100 milliamperes can be detected on a 1/4"-wide trace at a distance of 1/2", while 200 milliamperes can be detected on a #24 plated copper wire at a distance of 1/4" from the short.

Because the Short-Circuit Detector has a very-low input impedance and very high internal gain, you are cautioned to avoid using the device as a "voltmeter." If you do use it in this manner, you run the risk of permanently damaging the accessory. **ME**



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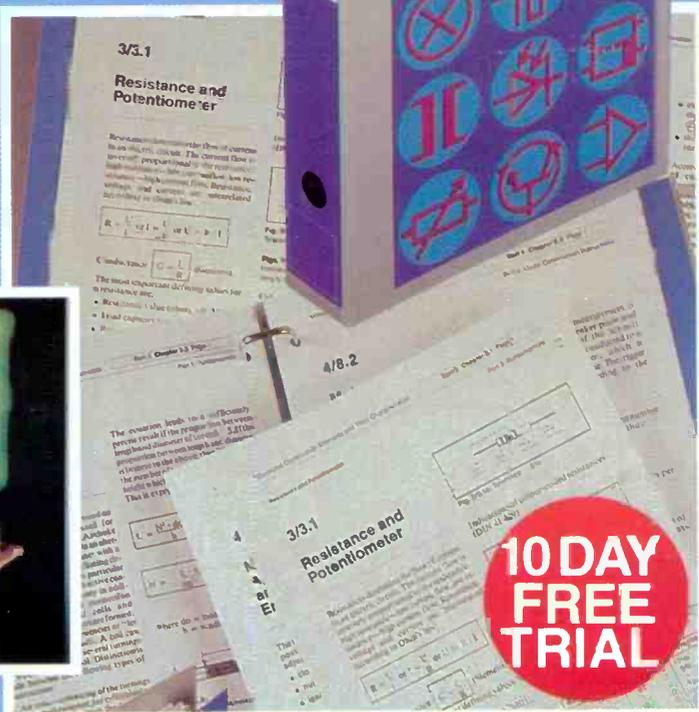
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