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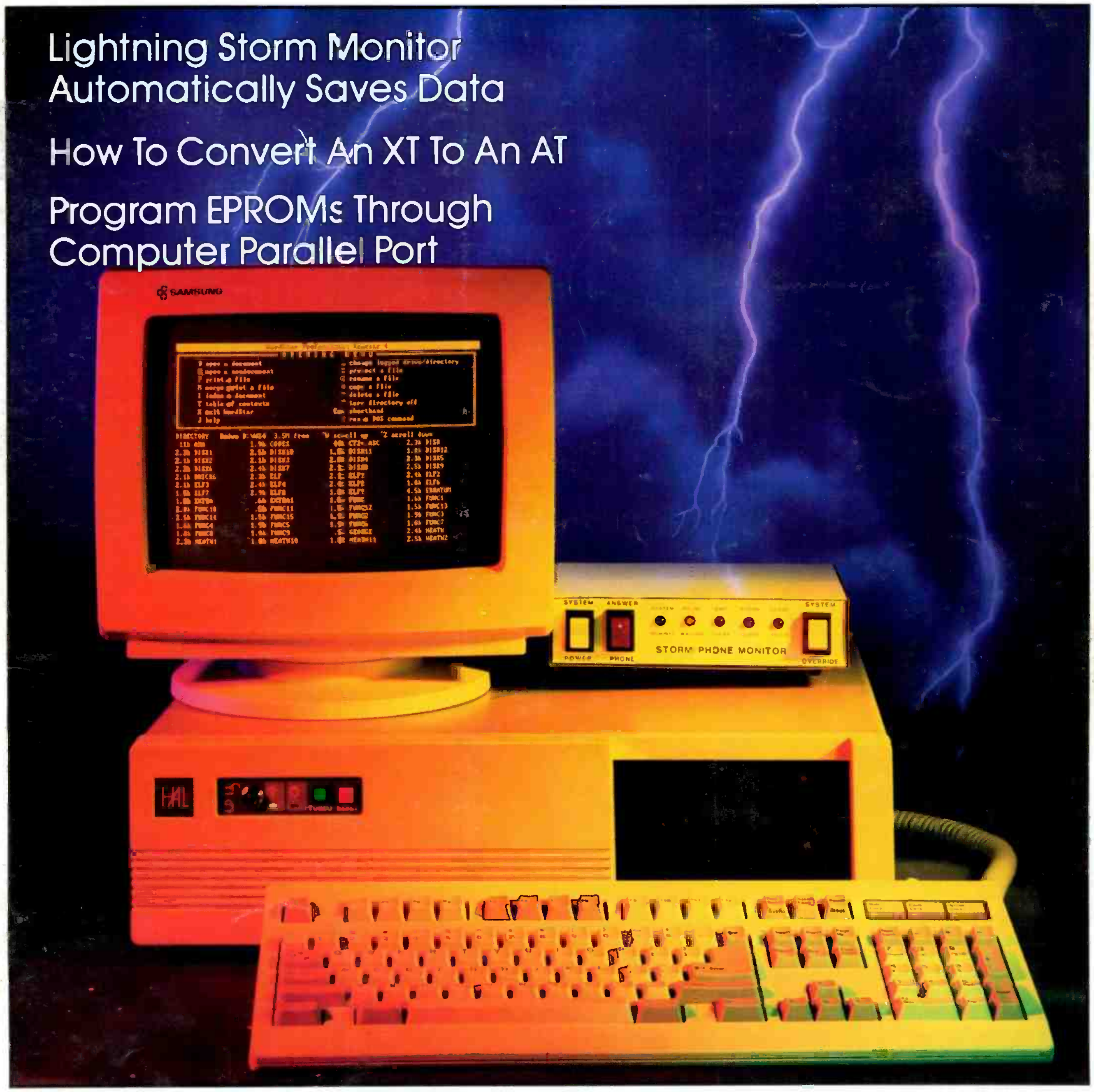

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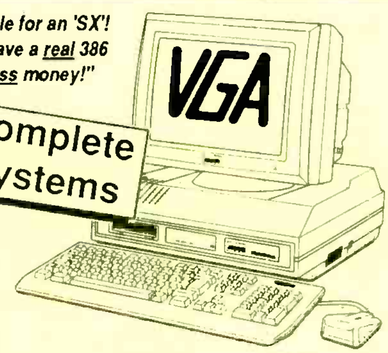

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Volume 1, No. 3 June 1991

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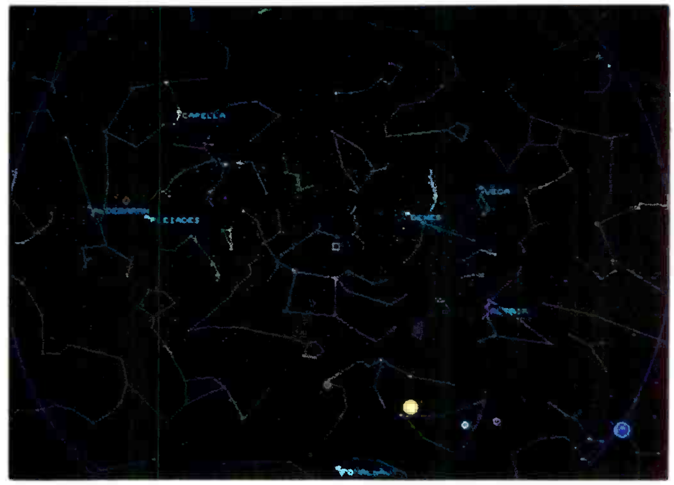

90

ON THE COVER The "Lightning Storm Monitor" protector featured this month is designed to guard your computer and peripherals from damage induced by electrical storms. It alerts you to imminent danger and automatically closes files, saves data in RAM to disk and powers down and disconnects your computer equipment from the ac line.

Photo by Lorinda Sullivan

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CIRCLE NO. 96 ON FREE INFORMATION CARD

The Pen is Mightier than the Key

If you're not a capable typist, using a computer keyboard can be an insufferable hurdle. A pointing device, such as a mouse and appropriate software, can make things easier in some instances, though speed-ups are mostly limited to making the operating system more friendly to work with and to applications software that isn't keyboard driven, such as drawing programs.

Alternatives are speech-recognition and handwriting-recognition systems. The latter was given a major boost recently by the announcement of a special operating system designed specifically for pen-based mobile computers. It was developed by GO Corp. (Foster City, CA). It's said that the new OS can be made data compatible with MS-DOS, which opens all sorts of possibilities.

Though the pen-based system isn't the panacea that non-typists yearn for, it does promise a host of benefits for note-taking, filling in forms, drawing, editing, marking up matter with hand-written suggestions and comments and a bevy of other computing applications that can use an electronic "pen" advantageously to write directly onto a flat LCD screen. Commands are issued with such gestures as tapping, circling and crossing out. All on a system that's lighter and smaller than any laptop or notebook computer; and without a keyboard, allowing the user to even write while walking.

PenPoint is written in the C programming language, allowing programmers to port huge parts of existing code to it. The 32-bit object-oriented OS takes up about 3MB.

IBM, GO Corp.'s first licensee, has set up a special division to develop a machine that uses this new OS, with expectations that it will debut in '92. Interestingly, GO has licensed Apple Computer's AppleTalk networking software for its new *PenPoint* OS. Application developers include such stalwarts as Lotus, Borland and WordPerfect, among 40 third-party companies that have publicly committed to providing technology for the *PenPoint* OS.

One GO developer, Photonics, is said to have developed a wireless infrared connectivity product for portable computers, including pen-based types. It reportedly can send data over IR light at speeds up to 1 megabit per second.

GO isn't the only way to go for pen-based systems. Twenty-one computer manufacturers announced they will build pen-based computers to support Microsoft's *Pen Windows* operating system, a graphical operating system built on the familiar Microsoft *Windows*. IBM is not among the supporters, which is heavily weighted by Japanese computer makers, including Sharp, Samsung, Fujitsu, Hitachi, Toshiba and Canon, among them. Projections range from 3-million to 6-million installed units within five years, up from a projected 45,000 pen-based systems of whatever kind estimated to be sold this year.

When the moment of truth arrives with real products based on the new operating systems cited above, you'll hear plenty about character accuracy, word accuracy, correction ease, implementation speed, flexibility, compatibility, operating simplicity, application programs, etc. Keep in mind, too, that many applications, such as placing an "X" in a box, don't even heavily depend on handwriting recognition.

This is undoubtedly an exciting product. GO's brash new system will apparently utilize computer technology in the form of a rather unobtrusive portable appliance and isn't designed for desktop use. It reportedly boots up automatically, ready to be used when powered to on and displays a freeze-frame of what was last recorded. Alternatively, Microsoft's pen-based OS, using its *Windows* technology, and said to be usable with existing *Windows* packages, might be the desktop computer user's pen-writing accessory of choice.

Both sound appealing to me at first blush, especially GO's mobile one if data can indeed be exchanged with DOS machines and can be transmitted by phone. People who aren't already pretty good typists and need such support at a desk will likely look more warmly at Microsoft's pen-based *Windows* system, of course. Then again, new gadgets have a way of getting into the blood. Why not both? We'll see.

I'm looking forward to this electronic ink. Aren't you?

Art Salsberg

Letters

A Real Winner!

• Congratulations on transforming a magazine that was "very good" into a "Real Winner!"

Dave Ross
Woodstock, CT

• I teach electronics at a Career Center in Springfield. Part of my second-semester course content is an introduction to microcontrollers. We use the 8501 family of controllers. I am encouraged to see you will be writing about this area of electronics.

I would like to relate a couple of things that I have found in my work with microcontrollers: First, I have just received an excellent book from West Publishing Co. written by Kenneth J. Ayala, *The 8501 Microcontroller*. The book comes with a student version of the *PseudoSam* assembler and simulator for this family of controllers. Second, I have a source of bare printed-circuit boards for 8031 and 8052AH-BASIC controllers: Cottage Resources Corp., Suite 3-762, 1405 Stevenson Dr., Springfield, IL 62703. The 8031 board is very simple—an 8031, MAX232, 74LA373 and 2764. The 8052AH-BASIC board has places for a MAX232, 6264, 2764 and 74LS373. The 8031 board costs $14, whereas the 8052 board costs $25. Both could provide a cheap means for getting started in microcontrollers.

Hope this information is of some use to you. Keep up the excellent articles.

Frank R. Thornton
Springfield, IL

• I have a 286-TL/2 Tandy computer and am getting ready to purchase a full-blown 386. I'm interested in your new format, but I hope you won't forget novices and continue to publish construction projects for us.

I read your article evaluating PCB software for PCs with great interest. I own *PCBoards* and have compared many of the other programs mentioned with friends and associates. Unless you're a professional electronics design engineer, the upper-priced systems aren't for you. *PCBoards* is easy to learn and run, yet it will easily build two-layer PC patterns. New features address several of the shortcomings mentioned in the article. Demo

(Continued on page 84)

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IBM Wanderings. Meanwhile, IBM and Microsoft had a falling out over OS/2's future. Big Blue is pressing forward aggressively with plans to distance itself from Microsoft's New Technology or OS/2 3.0 as the logical upgrade path for OS/2 users . . . .Microsoft states that NT will be a major product that is more important than IBM's OS/2, while IBM's Lee Reiswig says that he does not see any need for *Windows-32* and that IBM does not see NT as OS/2's logical successor.

OS/2 1.3, the latest version from IBM and probably the last from Microsoft, is considerably more compact than earlier versions. It requires 2 megabytes of RAM but still takes a hefty hardware investment to operate. OS/2's major current advantage over *Windows* is much faster performance for some specific applications, such as Aldus' *PageMaker* and Borland's *Paradox*, both of which use threads to allow very efficient multitasking. This is exactly what *Windows-32* promises, while offering the advantage of running on both NT (OS/2 3.0) and MS-DOS platforms, although not on current OS/2 versions.

XYQUEST, the *XyWrite* word-processor maker, says it is completing development on a full-featured DOS word processor that will be marketed exclusively by IBM, who plans to make it the flagship of a new line of WP software. It will be based on *XyWrite III Plus*, with improvements. *XyWrite* owners will be able to upgrade for $100.

Dataman Coming. The 19.5-ounce Sony Data Diskman should premiere in the U.S. by summertime. Data Diskman reads special 3-inch 200-MB CD-ROM-type disks and presents text information on a built-in 10-line × 15-character LCD display. There are already English-language titles to be available by year-end. Disk Dataman will also play CD-single audio discs through a built-in speaker and should retail for just under $500, with disk prices ranging from $25 to $200.

Cellular Laptops. Toshiba announced it will introduce a laptop computer with a built-in cellular modem this June. And AST Research, among others, says it is working on designs of small integrated cellular modems for notebook-size computers. Also, Sony contributed technology to General Magic, formed last year by a couple of Apple employees who are apparently developing a personal communicator device that will provide pocket computer access to information via cellular modem technology.

Yellow Pages on CD-ROM. The entire U.S. telephone "Yellow Pages" are now available on a CD-ROM disk published by Cambridge, MA-based SpeedDial. The 9.2-million business telephone numbers on the disk come from more than 4,800 local phone books published in all 50 states . . . . SpeedDial retails for just under $400, and the memory-resident software provides fast access to phone numbers from within other MS-DOS applications software. Searches can be narrowed with entries in five fields: company name; standard Yellow Pages headings, such as Auto Repair; city; state; and area code . . . . A similar database for residential phone numbers is not yet on CD-ROM, but it can be accessed on CompuServe by typing GO PHONEFILE.

Viruses Spreading. Computer viruses infect more than a quarter of major U.S. personal computer users each month, based on a survey by Certus International, a Cleveland-based software company. These computer code bits, often sneakily introduced to software shared over electronic bulletin boards, can destroy data files or cause computers to lock up.

Viruses are going international, too. A new MS-DOS system one, known as Hymn, has been detected in the U.S.S.R. It is activated when an infected computer's clock reaches a date where the number of the month equals the day of the month, such as January 1. Since software tends to spread rapidly around the world, the Russian virus would soon become a problem in Western Europe and in the U.S . . . . With Russian-grown virus programs unknown in this country, the usual anti-virus software sold here will probably not detect the infection.

Elsewhere. Back in the U.S., Colorado-based Romaton has produced the first nonvolatile DRAM chip. Present memory chips require a constant supply of power to retain data, but these new "ferroelectric" chips could herald a new way of designing general-purpose computers, especially for embedded devices.

Meanwhile, in Zurich, Switzerland, IBM researchers have developed a way to build 20,000 semiconductor lasers on a single 2-inch disc, which would open the way eventually for a major price reduction.

My Moscow source tells me that computer parts and negotiable currency are in such short supply that factories are actually trading chips for food.

More Operating Systems. A recent Microsoft Systems Strategy Seminar offered a look inside multi-billionaire Bill Gates' plans for changes in his company's operating systems. *Low-end* users will continue to have MS-DOS; *mid-range* users will be offered ever-improving versions of *Windows* with multimedia extensions added; and *high-end* users will be offered a Microsoft version of OS/2 3.0, also known as New Technology.

With MS-DOS 5.0 still on the horizon, and some unflattering comments from a few beta testers who compare it unfavorably with Digital Research's DR DOS 5.0, news is starting to leak out that Microsoft is readying both an upgrade and a new 32-bit *Windows* version. Look for *Windows* 3.1 to debut at Fall Comdex, providing more Help screens and more space for DOS applications in the virtual DOS sessions . . . . But the big move for *Windows* 3.1 is that it is expected to start showing up on laptop systems booting directly from a ROM chip.

Microsoft's newly developing OS, called NT or New Technology, is apparently another operating system that will either replace or compete with OS/2 and compete directly with Unix (which Microsoft also sells). Look for it to be ready for upcoming powerful 80586-based computers and to seamlessly support both *Windows* and present OS/2 applications, despite it being a totally rewritten OS . . . . *Win-32*, a new 386/486-specific version of *Windows*, will run on either DOS or OS/2 version 3.0 (NT), offering many features to attract desktop publishers.

Multimedia. Once again, Microsoft and other companies are pushing the idea of using computers as interactive entertainment, educational and promotional devices by adding high-quality sound and video programs. Barriers to this move include difficulty of producing really good multimedia software, the high cost of the systems needed to run multimedia (VGA graphics and stereo sound are essential minimums) and the big question of whether people really want to be distracted from data analysis by extraneous images and sounds.

Look for more innovative products and pricing from small U.S. companies that are taking the lead in research and development efforts, rather than following in the steps of established hardware builders.

Letters are welcome, either by e-mail or Post Office. Address comments to John McCormick, RD # 1 Box 99, Mahaffey, PA 15757; CompuServe: 76360,44; GEnie: NB.WAS; or MCI Mail: 321-7180. No phone calls, please.

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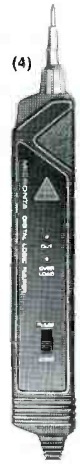

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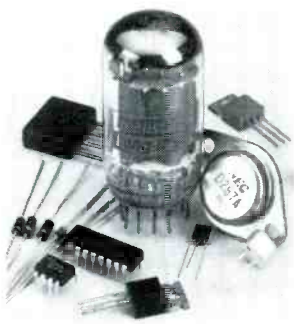

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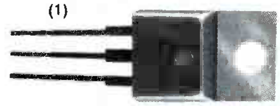

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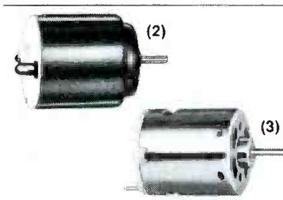

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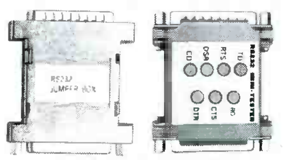
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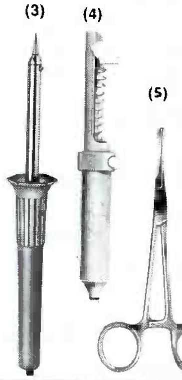

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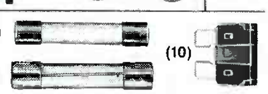

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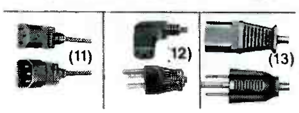

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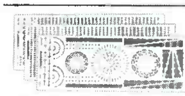

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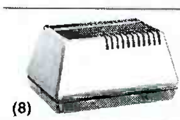

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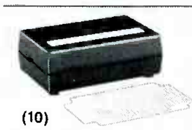

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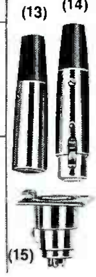

(1) Voltage Regulator ICs. Feature built-in overload protection and thermal shutdown. Maximum input: 35VDC.
7805. 5V. #276-1770 . . . . 1.19
7812. 12V. #278-1771 . . . . 1.19

(2) Low-Voltage Motor. Just the thing for science projects, robotics and solar power demos. Operates 1½ to 3VDC. About 1½″ long. #273-223 . . . . 99¢

(3) High-Speed 12VDC Motor. Up to 15,200 RPM, no load. About 2″ long. #273-255 . . . . 2.99

(4) "Ding-Dong" Chime. This IC and mini-speaker combo is ideal for a customer-entry alert or doorbell. Produces 80 dB sound pressure at 12 VDC. Operates 6 to 18 VDC. #273-071 . . . . 8.99

(5) Surface-Mount Resistors. 200-piece assortment of 15 popular values. Rated 1/8 watt, 5%. #271-313 . . . . **Set 4.99**

Radio Shack Has 20 different project enclosures in stock!

(6) Metal Project Cabinet. An attractive, easy-to-drill housing at a low price. 3 × 5¼ × 5⅞″. #270-253 . . . . 6.79

(7) Project Labels. Four sheets of rub-on letters, numerals and calibrations. #270-201 . . . . 2.99

(8) Power Supply Case. Vented 2½ × 4⅝ × 3¼″ molded case. #270-287 . . . . 3.99

(9) 0 to 15 DC Voltmeter. Panel-mount. #270-1754 . . . . 7.95

(10) Box/Board Combo. Molded enclosure plus predrilled 2 × 3⅛″ board, labels and more. #270-291 . . . . 4.99

(11) Eight-Position Phono Jack Board. #274-370 . . . . 1.39

(12) 1:1 Audio Transformer. Z: 600-900Ω. #273-1374 . . . . . . 3.59

(13) Three-Pin XLR Mike Plug. Metal body. #274-010 . . . . . . 2.99

(14) Three-Pin XLR Mike Inline Socket. #274-011 . . . . 2.99

(15) Three-Pin XLR Mike Panel Socket. #274-013 . . . . 3.69

Since 1921 Radio Shack has been the place to obtain up-to-date electronic parts as well as quality tools, test equipment and accessories at low prices. Over 7000 locations to serve you—NOBODY COMPARES

Prices apply at participating Radio Shack stores and dealers. Radio Shack is a division of Tandy Corporation

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AMERICA'S TECHNOLOGY STORE

CIRCLE NO. 108 ON FREE INFORMATION CARD

Office In A Box

Laser Computer is now shipping the Laser Pal 386SX model that includes most computer features needed for a business at home. The space-saving cabinet houses a 16-MHz 80386SX CPU with 1M RAM, 40M hard drive, 1.2M 5¼" and 1.44M 3½" floppy drives, enhanced SuperVGA card with 512K video RAM, 2,400-bps internal modem, and four peripheral ports. *GeoWorks Ensemble* and *The Complete Communicator* software round out the package. *GeoWorks Ensemble* is an easy-to-use integrated package, while *The Complete Communicator* provides fax/data modem transmission and voice mail. List price is $3,000.

CIRCLE NO. 1 ON FREE CARD

PC Port Expander

The NTI VOPEX-2AVMM-L port expander allows two keyboards, two mice and two VGA monitors to be connected to the same PC. Each can be up to 500 feet from the computer. It permits the same image to be shown on both monitors and provides instantaneous and automatic access from either keyboard and/or

mouse location. Thus, two users can share one computer or one user can access the same computer from two different locations.

The VOPEX-2AVMM-L, housed in a metal case that measures 6.5" × 5.5" × 2.5", comes with cables that connect the PC with keyboards and monitors and requires 117 or 220 volts ac. Similar units are available for other computer models. Price is $435.

CIRCLE NO. 2 ON FREE CARD

Continuous Workstation Monitor

The Charge-Guard Model 720 from 3M eliminates the need for ESD audits and record keeping by continuously pulsing a very low 5-μA dc reference signal through a special dual-conductor wrist strap and cord. The monitor shows a green light when connected wrist strap and conductive work surface are properly grounded and functioning correctly. The 720 uses flashing lights and buzzers to alert the user when an unsafe condition occurs.

CIRCLE NO. 3 ON FREE CARD

Anti-Virus Organization

The National Computer Security Association is dedicated to keeping its members and their computers virus-free. It publishes a bimonthly newsletter and numerous books, all dedicated to helping the computer user remove and prevent viruses. NCSA estimates that new viruses are being created at the rate of one per day. A non-profit organization, NCSA provides free telephone support for any virus problem, free analysis of any virus you may have and a free BBS that members can use to download anti-virus tools. Individual membership is $45 per year.

CIRCLE NO. 4 ON FREE CARD

Bit-Mapped Graphics

By Steve Rimmer
(Windcrest/Tab Books. Soft cover. 492 pages. $26.95)
This intermediate-level book covers bit-mapped graphics for both IBM/compatible and MAC computers. The text covers the major players in the field: GEM/IMG, PCX, GIF, TIFF, and EPS. Both monochrome and color systems are discussed, as is printing to various types of printers. Dithering and Format Translation each get a chapter devoted to them. The author provides numerous C programs that require Quick C or another computer.

Commodore Laptop With *Windows*

Commodore threw its hat into the laptop ring with the introduction of a 7-pound C286-LT VGA notebook-sized PC that comes bundled with *Windows*. The C286-LT is equipped with an 80C286 CPU operating at 12.5 MHz, 1M of RAM (expandable to 5M), 20M hard drive, serial and parallel ports and carrying case. Commodore's laptop is covered by CommodoreExpress, a 24-hour toll free helpline and door-to-

door customer service program in cooperation with Federal Express.

CIRCLE NO. 6 ON FREE CARD

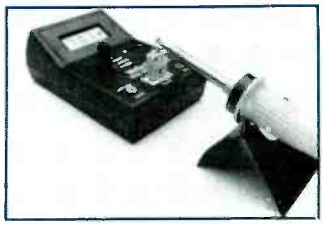
Expanded DOS Memory

ExtenDOS from Dakota Research is a general-purpose DOS memory extender that can increase usable DOS memory beyond 640K. System memory space between 640K and 1,024K that is not used by system resources can contain *ExtenDOS* memory. Software compatibility is achieved because additional memory is managed by DOS. Any program that requests additional memory from DOS has access to *ExtenDOS* memory. There are simply more DOS memory regions available. Optional *MovUP* software works with *ExtenDOS* to move device drivers and other resident software out of conventional memory. $129.

CIRCLE NO. 7 ON FREE CARD

Soldering-Iron Tester

The WA2000 soldering-iron analyzer from Weller Tools is capable of accurately testing tip temperature, tip-to-ground resistance and tip-to-ground noise. Results of the tests are displayed on a large LCD readout in °F or °C. Users can rapidly determine if their soldering stations are in compli-



ance with DOD-2000. Suggested retail price is $450.

CIRCLE NO. 8 ON FREE CARD

GRAPH Version 3 Ships

MicroMath is shipping Version 3 of its popular high-speed easy-to-use *Graph* program for plotting scientific/engineering data. New features include extended-memory support, multiple y-axis plotting, import/export of Lotus, dBASE and ASCII files, residual plotting options and digital data smoothing. Publication-quality output can be sent to PostScript devices, HPGL plotters and dot-matrix printers. Single-user copy of *Graph* is $150; site-license pricing available upon request.

CIRCLE NO. 9 ON FREE CARD

Free Engineering Software Catalog

Bsoft (Columbus, OH) has a free catalog that lists and describes modestly priced $30 to $190 engineering software. Programs listed include schematic drawing, CAD, computer-aided waveform viewing, logic circuit emulator and circuit analysis among others. All programs are for IBM and compatible computers.

CIRCLE NO. 10 ON FREE CARD

Free Clip-Art Catalog

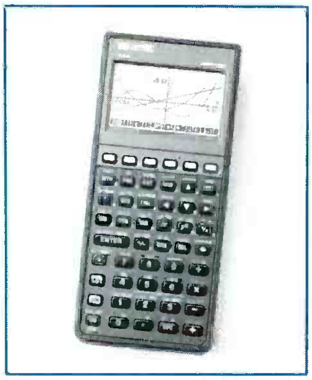
ArtMaker Software has a free catalog of 300-dpi Disk Art for Desktop Publisher using the Macintosh or IBM/compatible computers. All disks have between 50 and 60 images that can be manipulated (PCX format

for IBM/compatible, Paint for Macs) by most graphics and publishing programs. Individual disks are $15 each, with discounts for quantity purchases. Over 100 disk titles are available.

CIRCLE NO. 11 ON FREE CARD

HP Calculators

Hewlett Packard updates its calculator line with two new technical calculators and an IBM/compatible link to help users develop programs for the HP48 series. The HP32SII improves upon the HP32S reverse-Polish notation (RPN)



scientific calculator. New features include an algebraic equation solver, formula entry and evaluation, fraction arithmetic and manipulation and unit conversions. The HP32SII replaces the HP32S and remains priced at $70. The HP48S offers all features of the HP48SX, except the expansion capability. With a $250 list price, the HP48S is $100 below the HP48SX. The HP 82208B program-development link (software and cable), which lists for $120, lets HP 38-series users write, document and save programs on IBM/compatible computers. With the cable connecting computer and calculator, programs can be downloaded, debugged and run.

CIRCLE NO. 12 ON FREE CARD

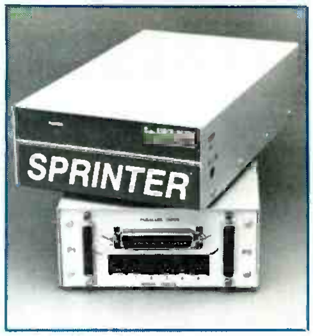
Toner-Cartridge Recharge Catalog

Chenesko Products' free new catalog covers toner-cartridge-recharge products and services. Cartridges supported are those for LaserJet II, IID, IIP and III; Apple LaserWriter, LaserWriter Plus, IINT and IINTX; QMS Kiss and Big Kiss; Cordata LP-300 and LP-300X; and many other laser printers, as well as the Canon PC series of personal copiers.

CIRCLE NO. 13 ON FREE CARD

Printer-Sharing Devices

Belkin Components, a manufacturer of LAN cabling products, offers automatic stand-alone printer-sharing devices called "Sprinters." Multiple computer users send data to be printed to Sprinter, which queues the data in its buffer. Sprinter then directs data to the user-specified printer in the order received. Three Sprinter models are available, and each allows multiple computers with serial ports to share up to two parallel printers. Each model includes 256K memory and is user-



upgradable to 512K, 768K, or 1M with standard 256K DRAM chips. The six-input Model 6X2 is priced at $695; seven-input model 7X2, $849; and ten-input 10X2, $995.

CIRCLE NO. 14 ON FREE CARD

Dvorak's Guide to DOS & PC Performance

By John C. Dvorak and Nick Anis
(Osborne McGraw-Hill.
(Soft cover. 954 pages; two 5¼" utilities disks. $49.95)

At best, DOS is often confusing, even to those who have used it for years. To the newcomer, DOS can be overwhelming. This book addresses needs of both long-time users and newcomers and succeeds in being useful to both groups amazingly well. In large part, this is due to the clear, straightforward writing style employed by the authors. A few evenings spent with the book and the 50-or-so utilities on two floppy disks included with the book could move a casual DOS user up to the "power user" category. DOS basics and commonly used commands are covered first. Authors then tackle utility programs that augment or replace DOS utilities.

Major utilities (commercial, shareware and freeware) are described and evaluated in each chapter, providing newcomers with a basis for judging the suitability of a particular program. Also covered are multitasking and memory management. Nearly 200 pages are devoted to *Windows* and other operating environments including OS/2, UNIX, *Desqview*, DR-DOS 5.0 and various network systems. Numerous means of "speeding up" PC performance are provided in detail. Other odds and ends include a tutorial on the use of Debug, documentation for utilities included on its disks and a discussion of hardware upgrades. An install program on Disk 1 smoothly installs the floppy-based utilities included in the package. Highly recommended.

Upgraded Test Card

KickStart 2 is a major upgrade of Landmark's (Clearwater, FL) add-in diagnostic card that features complete pre-boot system diagnostics, password protection in EPROM, software-configurable I/O, switches and LEDs for test control and comprehensive manual with troubleshooting procedures. Users can select and run any of KickStart 2's diagnostic tests, including special batch tests. LEDs display results without requiring a monitor to be attached. $600 (includes unlimited toll-free technical support). Landmark has merged with diagnostic software developer SuperSoft, Inc. to create the world's largest third-party diagnostics company.

CIRCLE NO. 16 ON FREE CARD

EMS Manager

Merrill & Bryan's *Turbo EMS* 5.0 is an expanded memory management program that offers full EMS support for both 386 and non-386 computers. The program is compatible with any clock speed and comes in both 3.5" and 5.25" formats. For users with LIM 3.2 memory boards, *Turbo EMS* simulates LIM 4.0, enabling users to benefit from advancements made in

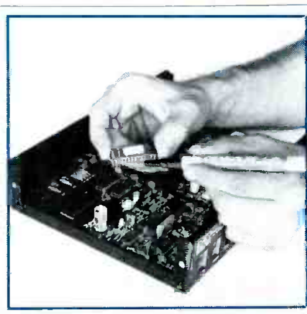
memory management. It features automatic spillover or demand paging, which allows the program to overflow data to any combination of expanded-memory hardware, extended memory and hard and floppy disk.

Turbo EMS 5.0's Shuttle utility, designed for non-386 machines, allows users to relocate device drivers, TSRs and network shells out of conventional memory. Additional features include network compatibility, VDISK detection, extended memory starting address, page-frame alignment, high-memory analysis, true page aliasing and fast disk and extended-memory access. System requirements are an IBM/compatible with 256K RAM, a 3.5" or 5.25" floppy drive and DOS 2.1 or later. Price is $100.

CIRCLE NO. 17 ON FREE CARD

Deoxidizer Pen

Caig's Cramolin DeOxidizer is now available in a convenient pen applicator. It is nonflammable, non-corrosive, non-toxic and ozone-safe. The pen includes two chisel-head tips and one round-head tip that are easily replaceable. The deoxidizer is said to remove oxidation from connectors and prevent its recurrence.



CIRCLE NO. 19 ON FREE CARD

Windows Help

Fanfare Software introduces two new *Windows* utilities, *Right On!* and *Magic Cursor!*. *Right On!* is a mouse utility that lets users make full use of the right and middle mouse buttons. Users can set these buttons to simulate a left-button double click, to send any keystroke, or to run any program. *Magic Cursor!* lets users enlarge, customize and blink the standard mouse arrow cursor. The program includes over 40 professionally designed cursors, including arrows of different sizes, cross-hairs, hands, pen or pencil, mouse and more. Each program retails for $50 or $70 for the combination.

CIRCLE NO. 20 ON FREE CARD

Quattro Pro Upgrade

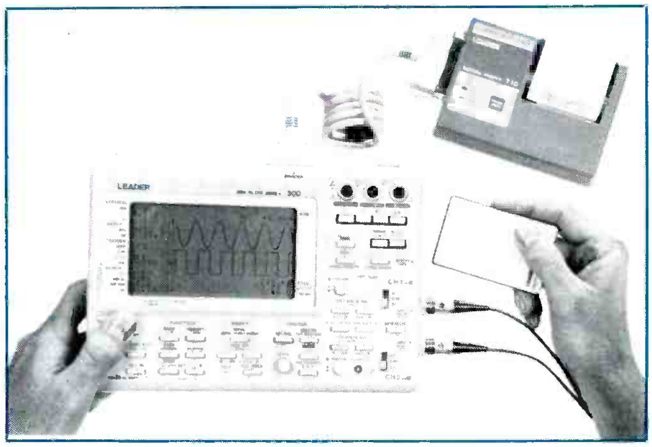
Borland is now shipping *Quattro Pro* Version 2.0, which includes "Solve for," a powerful goal-seeking technology that solves "what if" scenarios simply. Other new features include database connectivity, which lets users easily access and manipulate data in Borland's *Paradox* database program. The program has enhanced presentation graphics, including the ability to create "branching" slide shows, three-dimensional graphs and 35-mm color slides. *Quattro Pro* 2.0 has a suggested retail price of $495. Registered owners of *Quattro Pro* 1.0 can upgrade directly from Borland for $79.95. Those who purchased *Quattro Pro* 1.0 after July 18, 1990 are eligible for a free upgrade. Owners of other high-end spreadsheet programs can upgrade for $99.95.

CIRCLE NO. 18 ON FREE CARD

Battery-Powered DSO/DMM

Leader Instruments' Model 300 is a battery-powered combination digital storage oscilloscope, digital multimeter and eight-bit logic analyzer in a single package. The 30-MS/s DSO features dual, add, subtract and X-Y modes, peak-to-peak voltage of Channels 1 and 2, frequency readout and full automatic set-up and automatic ranging for both timebase and volts/division for each channel.

On-board memory consists of 1.8K words per channel and storage of 20 waveforms as standard and up to 80 waveforms with an optional plug-in accessory IC card. The IC card lets a user save waveform information in the field for later observation and analysis. The large high-contrast/wide-viewing-angle super-twist LCD display panel measures 4½ × 2½ inches. It displays timebase, sensitivity for both channels, vertical mode, sweep mode, memory length, trigger slope and source, type of filter, trigger position, bank number and display mode setting conditions.



A data-logging function takes long-term measurements of dc and ac voltage and current, low-power resistance, diode-test and continuity check. Measurements and setting conditions can be stored in the optional IC card or printed on an optional dedicated Model 710 printer for hard-copy documentation. Power is supplied by four AA cells. Indicators are provided for low-battery and power-on conditions, and a battery-saver circuit is built-in.

The compact Model 300 DSO/DMM measures 9⁷⁄₁₆"W × 6½"H × 1¾"D and weighs 2.6 lbs without battery. $1,995.

CIRCLE NO. 21 ON FREE CARD

Disks

Maxell introduced the Super RD, an air-tight dual-interlocking flex-shutter floppy disk in MF2-HD blank and formatted configurations. This flex-shutter is claimed to more firmly adhere to the shell to keep out all types of particles that can contaminate the disk surface and lower output performance.

Other improvements include dispersion of the high-energy magnetic particles through Maxell's Neo Cross Linkage Magnetic Layer. With a better S/N ratio, which enhances compatibility between different drives, Super Rd reportedly can always produce a full-power signal to the read/write head. This enhances compatibility between machines. Also, Maxell says its HB lubricant and HT binder offer better magnetic-head protection. The HB lubricant provides smoother contact between the magnetic head and disk. The HT binder also reinforces smooth movement by bonding the lubricant and other components of the magnetic layer strongly together.

CIRCLE NO. 22 ON FREE CARD

Software Telephone Line Switching & Barcodes

RemoteControl, an IBM/compatible software program from Electronic Technologies, allows a computer modem and answering machine or fax machine to share a single telephone line without an electronic switch box. When used with a standard answering machine, the program has the ability to call any digital-display or tone-only pocket pager after each voice message received. *RemoteControl* sells for $35 and requires no external power or special hardware. It is compatible with virtually any modem host communications program and any PC fax board.

CIRCLE NO. 23 ON FREE CARD

BarZIP, also from Electronic Technologies, prints postal barcodes on labels and envelopes. It is a small TSR that can add postal barcode printing capability to existing label printing programs, database programs, accounting programs and many other software packages. A companion program, *Bar:ReplyMail*, can print camera-ready artwork for Business Reply Mail on any HP II+ or compatible printer. *BarZIP* prints on any IBM or compatible graphics dot-matrix printer, as well as HP II-compatible laser printers. These programs are priced at $195 each.

CIRCLE NO. 24 ON FREE CARD

Modern Electronic Instrumentation And Measurement Techniques

By Albert D. Helfrick and William D. Cooper
(Prentice Hall. Hard cover. 446 pages. $50)

The textbook is an update of *Electronic Instrumentation And Measurement Techniques* to bring it into alignment with modern test equipment and measuring procedures. Such basic measurement techniques as accuracy, precision and standards have been retained. Less emphasis is placed on moving-coil meters since there is a trend away from using them. Relatively new equipment, such as the digital storage oscilloscope and digital spectrum analyzer, are covered in detail. A new chapter on fiber optics has been added. The book retains a textbook flavor, with numerous worked out examples, references and review questions at the end of each chapter.

Serial Protocol Analyzer

Global Specialties' Model GS500 battery-powered portable Analyzer is used for troubleshooting asynchronous serial data communication systems. It can assist in baud-rate analysis, data word formatting, ASCII and hex data monitoring and testing data generation. It operates in both automatic and manual modes and is small enough for field-service applications.

The system consists of a GS500 Protocol Analyzer, GS501 Display Module and GS502 Break-Out Box. The analyzer can be used independently or be connected to a standard oscilloscope to provide a display of alphanumeric text. Attaching the Display Module allows the Analyzer to be used independently of an oscilloscope. The Break-Out Box provides full breaking and patching of 25 lines plus data monitoring of the transmit and receive lines via the Analyzer. Using the test data generation mode, the system can check operation of printers, terminals and other devices when a transmitting device is not available. $179.95, basic GS500 Analyzer; $99.95, GS501 Display Module; $119.95, GS502 Break-Out Box.

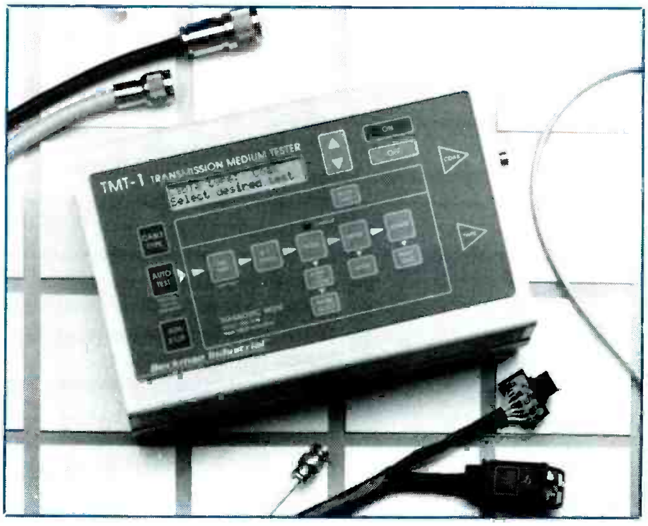
CIRCLE NO. 28 ON FREE CARD

Mouse Alternative

ALTRA introduced FELIX, an alternative to the mouse, for controlling personal computers. FELIX provides full-screen, precise cursor control via a movable button that floats on a control surface that measures only 1 square inch in area. Included control software provides high-resolution performance of up to 4,000 dpi, as well as numerous time-saving window management and control features. FELIX is available for the Macintosh SE and Macintosh II lines of computers, with other models presently under development for IBM and compatible PCs. $169.

CIRCLE NO. 27 ON FREE CARD

All-In-One LAN Tester



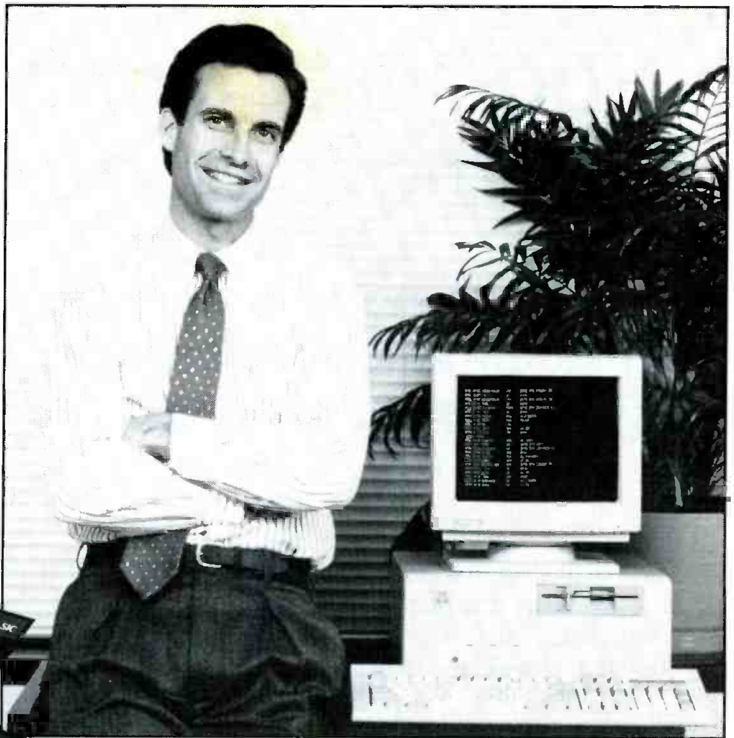
Beckman introduced the TMT-1 Transmission Medium Tester for use in LAN certification. Housed in a 9.5″ × 6.3″ × 2.0″ enclosure and weighing less than 5 pounds, it is designed to verify the capability of installed LANS for conducting high-reliability information traffic. It performs a series of electrical tests in automatic sequence or individually under operator control.

Separate connectors permit the TMT-1 to conveniently test coax and eight-line twisted-pair LANs. Electrical testing occurs with operator prompts, while test results are displayed on a two-line 20-character LCD or printed out via an optional portable printer.

Tests conducted include line mapping, dc resistance, noise, impedance and length. Firmware also performs automatic analysis of reflected signals. Other applications of the TMT-1 include telephone wire servicing, since it can detect faults and their locations within a line, frequency and amount of noise. It can also alert a LAN operator that someone is tapping into the LAN.

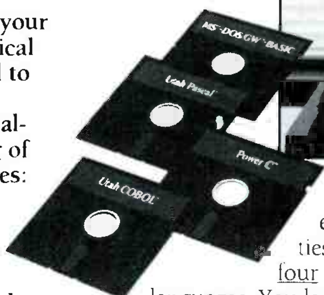
CIRCLE NO. 29 ON FREE CARD

Now with NRI's new training you can enjoy the rewards of a career in computer programming



A top-paying career in computer programming is no longer out of your reach. Now you can get the practical training and experience you need to succeed in this top-growth field.

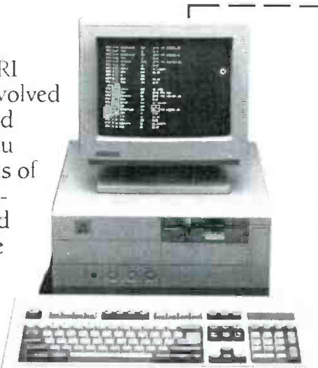
It's training that gives you real-world programming skills in four of today's hottest computer languages: BASIC, Pascal, C, and COBOL. Hands-on training that includes a powerful IBM AT-compatible computer, modem, and programming software you train with and keep. Comprehensive, at-home training that gives you the competitive edge to succeed in one of today's leading industries. The kind of experience-based training only NRI can provide.



As a trained computer programmer of the '90's, you can enjoy long-term career success. In fact, the Bureau of Labor Statistics forecasts that during the next 10 years job opportunities will increase by 71.7 percent for the skilled computer programmer. With NRI training you can be one of the increasing number of computer programmers using their skills to build a top-paying career—even a business of their own—in this professionally and financially rewarding high-tech field.

▼ The only programming course that includes a powerful AT-compatible computer system and programming software you keep

Right from the start, NRI training gets you actively involved in the challenge of real-world computer programming. You learn how to create the kinds of full-featured, powerful programs today's employers and clients demand. And, unlike any other school, NRI lets you experience first-hand the power of an IBM PC/AT-compatible computer system with modem, a full megabyte of RAM, disk drive, and monitor—all yours to train with and keep.



Plus you explore the extraordinary capabilities of not one or two but four in-demand computer languages. You learn to design, code, run, debug, and document programs in BASIC, Pascal, C, and COBOL. In the process you become uniquely prepared for the wide variety of programming opportunities available today.

▼ No previous experience necessary

Immediately, you start getting the money-making job skills you need to secure a future in computer programming—no matter what your background. With NRI training you move easily from computer novice to computer professional with step-by-step lessons covering program design techniques used every day by successful micro and mainframe programmers.

You'll find no heavy textbooks to plow through. No night classes to attend. Instead, NRI's at-home, step-by-step training covers all the bases, guiding you from the important fundamentals to real-world methods and techniques. With the help of your NRI instructor—offering one-on-one, personal guidance throughout your course—you quickly gain the skills you need to handle with confidence a wide variety of programming applications. You even use your modem to "talk" to your instructor, meet other NRI students, and download programs through NRI's exclusive programmers network, PRONET.

▼ Send today for your FREE catalog

Now you can have the professional and financial rewards of a career in computer programming. See how NRI at-home training gives you the experience, the know-how, the computer, and the software you need to get started in this top-paying field. Send today for your FREE catalog.

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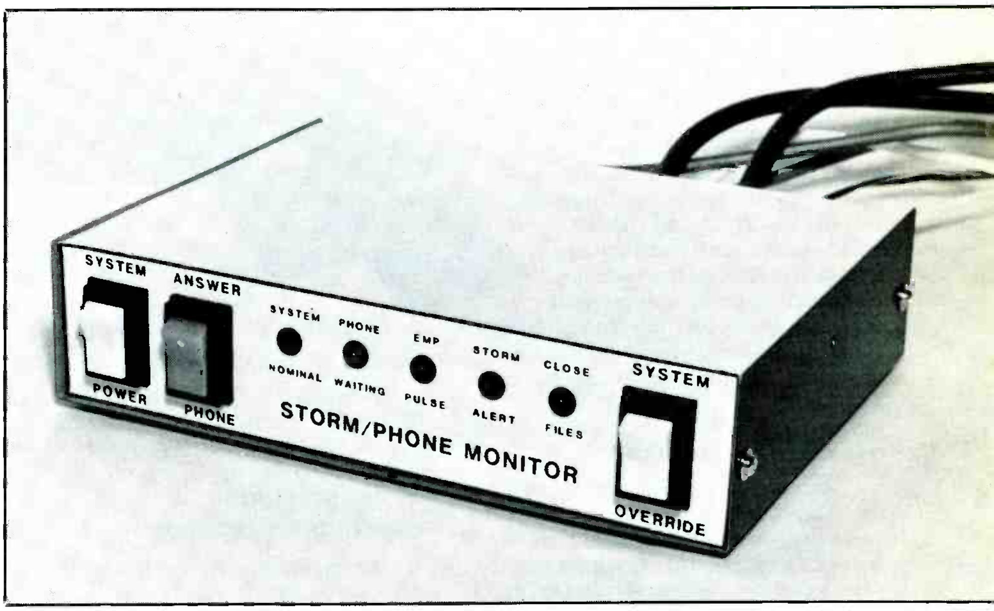
Lightning Storm Monitor With Automatic Computer Disconnect

Alerts you to nearby electrical-storm activity, then automatically closes files, saves whatever is in RAM to disk and powers down your computer

If you're like me, nothing is quite as scary as the prospect of losing your computer, modem and data to the effects of lightning. Every year countless thousands of personal computers are severely damaged by lightning-induced line-voltage transients. Most of us run to unplug our machines at the first signs of an approaching electrical storm, but what to do when you're asleep or away from home? This is where the Storm Monitor can really pay off.

By monitoring the 550-to-1,600-kHz portion of the electromagnetic spectrum for EMP (electromagnetic pulses), the Storm Monitor detects electrical storms while they're still miles away. When dangerous lightning is detected, the project automatically turns your system off and disconnects it from the 117-volt ac wall source.

As an additional benefit, the Storm Monitor can be expanded to include an internal modem disconnect and automatic computer "Power Master" unit.



Description

The Storm Monitor is a self-contained EMP monitor and automatic power-line disconnect unit. To make the Storm Monitor easier to understand, let's break the unit down into two distinct parts. The first section is the EMP Detector.

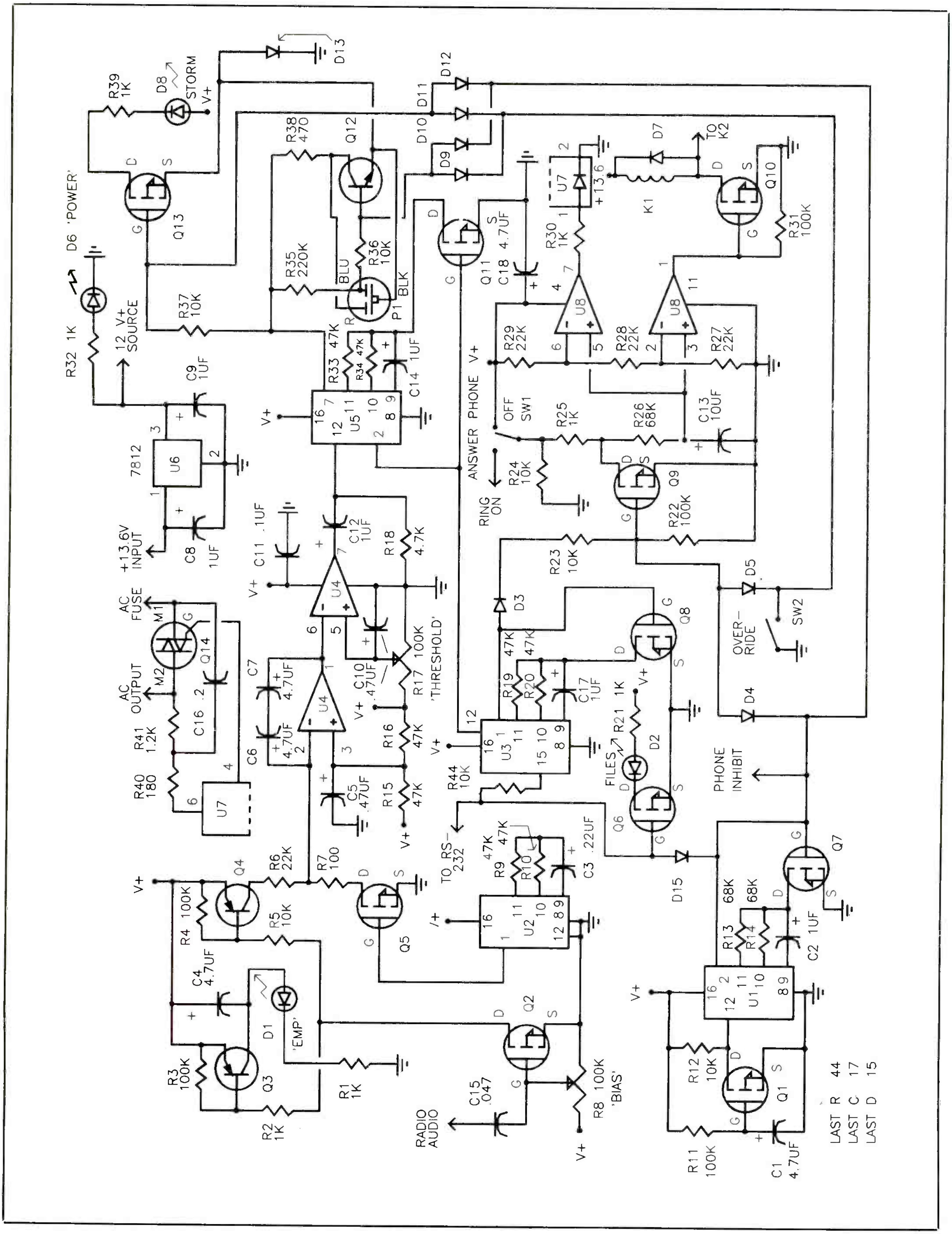
This unit consists of a standard AM (amplitude-modulated) radio enclosed in a small case at the end of a 10-foot length of cable. By moving the EMP Detector away from your computer, stray r-f (radio-frequency) interference generated by the logic circuitry inside your computer is reduced, relative to the Detector. This gives the EMP Detector a chance to "listen" to other non-local r-f signals, namely lightning.

When lightning occurs, extremely strong electromagnetic pulses are created. These pulses sound like the "pops" and "static" you've heard when listening to an AM radio. The second section of your Storm Monitor, called the Control Unit, takes advantage of this annoying side-effect (for AM radio listeners, at least) by measuring the relative strength, duration and discharge rate of the lightning strikes.

By integrating these pulses, the Storm Monitor can make automatic "judgments" about approaching storms and take the necessary steps to disconnect your computer equipment. The concept behind the Storm Monitor is very simple and so is the hardware, so let's get started building your own Storm Monitor.

Before you begin actual construction, it's important that you fully understand the Storm Monitor's circuit operation. This will take only a few minutes now and can save you hours of frustration later. Let's start with the EMP Detector.

•*EMP Detector Unit.* Remember that "EMP" stands for electromagnetic pulse. All voice and music "radios" operate by receiving or "converting" electromagnetic signals into audio baseband. Various modulation techniques have evolved from the earliest "spark-gap" transmit-


D13
D12
D11
D10
D9
R39 1K
D8
STORM
V+
R38 470
Q12
D6 'POWER'
Q13
R35 220K
R36 10K
BLU
BLK
P1
R37 10K
12 V+ SOURCE
R32 1K
C9 1UF
R33 47K
R34 47K
C14 1UF
U5
7812
U6
+13.6V INPUT
C8 1UF
C11 .1UF
C12 1UF
R18 4.7K
U4
AC FUSE
M1
M2
Q14
AC OUTPUT
C16 .2
R41 1.2K
C7 4.7UF
C6 4.7UF
C10 .47UF
R17 100K 'THRESHOLD'
R16 47K
R15 47K
C5 47UF
R40 180
U7
Q4
R6 22K
R7 100
Q5
R4 100K
R5 10K
C4 4.7UF
D1 'EMP'
Q3
R3 100K
R2 1K
R1 1K
Q2
C15 .047
RADIO AUDIO
R8 100K 'BIAS'
TO RS-232
R9 47K
R10 47K
C3 .22UF
U2
R44 10K
U3
R19 47K
R20 47K
C17 1UF
R21 1K
FILES
D2
Q6
Q8
D3
R23 10K
RING ON
ANSWER PHONE
OFF SW1
R24 10K
R25 1K
R26 68K
C13 10UF
Q9
R22 100K
Q11
C18 4.7UF
R29 22K
R28 22K
R27 22K
U8
R30 1K
+13.6
K1
D7
TO K2
Q10
R31 100K
D5
SW2
OVER-RIDE
D4
PHONE INHIBIT
D15
Q7
R13 68K
R14 68K
C2 1UF
U1
R12 10K
Q1
R11 100K
C1 4.7UF
LAST R 44
LAST C 17
LAST D 15

PARTS LIST

Semiconductors
D1,D2,D8—Red light-emitting diode
D3,D4,D5,D9 thru D13,D15—1N4148 small-signal silicon diode
D6—Green light-emitting diode
D7—1N4004 silicon rectifier diode
D14—Yellow light-emitting diode
Q1,Q2,Q5 thru Q11,Q13—VN0300 field-effect transistor (Siliconix; Cyberlab Part No. 3124)
Q3,Q4—MPSA56 pnp silicon signal transistor
Q12—2N2222 npn general-purpose silicon transistor
Q14—ECG-5635 or similar 10-ampere triac
U1,U2,U3,U5—CD4060 CMOS counter/oscillator
U4,U8—LM358 dual operational amplifier
U6—7812 fixed +12-volt regulator
U7—MOC-3010 optical-isolator driver (Radio Shack Cat. No. 276-134 or similar)

Capacitors
C1,C4,C6,C7,C18—4.4-μF, 16-volt axial-lead tantalum or electrolytic
C2,C8,C9,C12,C14,C17—1-μF, 16-volt axial-lead tantalum or electrolytic
C3—0.22-μF, 16-volt axial-lead tantalum or electrolytic
C5,C10—0.47-μF, 16-volt axial-lead tantalum or electrolytic
C11—0.1-μF, 16-volt axial-lead tantalum or electrolytic
C13—10-μF, 16-volt axial-lead tantalum or electrolytic
C15—0.047-μF, 100-volt Mylar
C16—0.2-μF, 250-volt Mylar

Resistors (¼-watt, 5% tolerance)
R1,R2,R21,R25,R30,R32,R39—1,000 ohms
R3,R4,R11,R22,R31—100,000 ohms
R5,R12,R23,R24,R36,R37,R44—10,000 ohms
R6—22,000 ohms
R7,R42—100 ohms
R9,R10,R15,R16,R19,R20,R33,R34—47,000 ohms
R13,R14,R26—68,000 ohms
R18—4,700 ohms
R27,R28,R29—22,000 ohms
R35—220,000 ohms
R38—470 ohms
R40—180 ohms, ½-watt
R41—1,200 ohms, ½-watt
R43—100 ohms, 1-watt
R8,R17—100,000-ohm, pc-mount trimmer potentiometer

Miscellaneous
F1—6-ampere slow-blow fuse
K1—12-volt dc relay with 10-ampere dpdt contacts
MOV1—MOV Varistor (Radio Shack Cat. No. 276-568C or similar)
P1—Piezoelectric alarm transducer (Radio Shack Cat. No. 273-064 or similar)
SW1—Dpdt rocker, toggle or slide switch
SW2,SW3—Spst rocker, toggle or slide switch
Printed-circuit board; sockets for all DIP ICs; AM pocket radio (Radio Shack Cat. No. 12-201 or similar); suitable enclosure; 13.6-volt dc power-supply module (Radio Shack Cat. No. 273-1653A or similar); 3.5-mm phone plug; three-conductor 117-volt ac line cords (one with plug, the other with socket); holder for F1; 9-volt battery snap connector; heat sink for triac (see text); ½" threaded spacers; grommets; plastic strain reliefs; machine hardware; hookup wire and ribbon cable; solder; etc.

Note: The following items are available from U.S. Cyberlab, Inc., Rte. 2 Box 284 Production Facility, West Fork, AR 72774 (tel.: 501-839-8293): Complete kit of parts minus IC sockets and power supply, $99.95; assembled Storm Monitor with power supply, $134.95. Also available: ready-to-wire pc board, $19.95 and machined enclosure with finished front panel, $19.95. Add $2.95 P&H for pc board, $4.95 P&H for enclosure or $6.50 for full kit and assembled unit. Arkansas, residents, please add 5% state sales tax. MasterCard and Visa accepted.

ters and receivers. These primitive devices were essentially miniature "lightning generators." They created tuned "sparks" that could be received miles away.

Amplitude-modulation (AM) radios have always been plagued by EMP interference. Static has interrupted the signals of countless programs, much to the frustration of distant listeners. So it's not surprising that our EMP Detector Unit is simply an AM radio connected to the Control Unit via an earphone plug and 9-volt battery clip! By tuning your EMP Detector to a "quiet" portion of the AM band (lower portion of the 550-to-1,600-kHz band is usually best), the Storm Monitor will be able to detect distant EMP signals created by lightning. The EMP Detector Unit is powered by the Control Unit and located away from your computer system. You'll find your computer to be quite an EMP generator itself!

• *Control Unit.* The "brain" behind the scene is the Control Unit's Logic Card. This circuitry "listens" to the audio output of the EMP Detector and makes sense of what it hears. Detected EMP pulses are integrated in a unique "charge-pump integrator." This analog "storm-threat level" is continuously compared with a standard reference. When the storm-threat confidence is high, the Control Unit automatically begins a sequence of events to power down as follows:

(1) Alerts you that a storm has been detected.
(2) Gives you an opportunity to override power down.
(3) Alerts the computer that a storm has been detected.
(4) Allows the computer to close files and dump RAM to disk.
(5) Opens a solid-state relay (triac) to power down the computer.
(6) Places a mechanical relay in a "safe path" mode.
(7) Continues to monitor the storm for signs of passing.
(8) Restores power when the storm has passed.

This is quite a sequence of events for our "analogic" brain. You might think that this is a natural job for a microprocessor. However, because the microprocessor itself generates EMP, and because you can't afford any glitches during the storm, good 'ole "analogic" comes to the rescue. Let's look at the Control Unit in more detail.

How It Works

Power is sent to the EMP Detector Unit, while audio is returned through a 10-foot shielded cable. Audio applied to *C15* (see Fig. 1) is biased by trimmer control *R8* to an appropriate level for *Q2*. Because of *Q2*'s extremely high gain, EMP signals are amplified and inverted. The input bias adjustment provided by *R8* just turns off the drain of *Q2* when no EMP signals are present.

When pulses occur, the drain of *Q2* pulls down the bases of *Q3* and *Q4*. This base-emitter current results in increased collector current and consequent voltage "pull-up" at the collectors. Transistor *Q3* lights the EMP LED to indicate received EMP detection pulses. Capacitor *C4* lengthens the pulses to increase visibility of the LED.

In a similar manner, *Q4* pulls the collector end of *R6* up close to +12 volts. As you see, each time an EMP pulse is detected, a resulting positive-going pulse is applied to pin 2 of *U4*. Also notice that pin 2 of *U4* connects via *R7* to *Q5*, which is controlled by the astable operation of *U2*. This CD4040 timer is allowed to free-run, constituting the "sample time base" of the Storm Monitor. Every 45 seconds or so, the output of *Q2* changes state (on-off-on-off . . . .).

FET *Q5* acts as an open-drain level shifter. That is, each time the gate of *Q5* is made high, the drain pulls down input pin 2 of *U4*, through *R7*. This cancels received EMP detect pulses and resets the integrator circuit formed by *U4* pins 2, 3 and 1.

For example, assume that the *U2* output to *Q5* goes high for 45 seconds. During this period, no EMP pulse effects can be passed along to *U4* due to the shunt effect through active *Q5*. Since the drain of *Q5* is low, it also charges *C6* and *C7*, which resets the integrator.

During the next 45-second cycle, the output of *U2* is low. The output, applied to *Q5*, releases input pin 2 of *U4* to control from *Q4* and the EMP detect pulses. Each time an EMP detect pulse strobes pin 2 of *U4*, it "bumps" the charge level of *C6* and *C7*. As these pulses are integrated, a voltage is pumped-down at input pin 6 of comparator *U4*.

Trimmer *R17* is adjusted for an appropriate level and compared with the integrator input. When the voltage level drops below the comparator threshold, output pin 7 of *U4* is pulsed high. This high pulse is coupled through *C12* to input pin 12 of counter *U5*. By configuring *C12* and *R18* at the reset input of *U5*, *U5* can be forced to reset and start a new 5-minute storm timing cycle.

So far, you know that during normal operation (no storm present), the EMP Detector Unit receives no EMP pulses and produces no detect pulses of its own. With no activity at *Q2*, nothing happens. The drain of *Q2* remains open, the EMP LED doesn't light and no positive pulses appear at pin 2 of *U4*. Integrated circuit *U2* doesn't know nor care what's happening in the outside world and continues to cycle on and off continuously. Any drift that might have accumulated in the integrator is reset every 45 seconds. In turn, no storm-detect pulses are created by *U4*, and *U5* never gets reset.

When a storm approaches, EMP pulses are received and accumulated in the *U4* circuit. If the storm is nearby, the number of EMP pulses and their duration and rate rapidly accumulate as a representative analog voltage. If the resulting integrated voltage drops below the preset threshold, *U5* resets and a sequence of events is triggered. Now let's look at the storm-detect and power-down sequences.

As you already know, *U5* is reset by *U4* when a storm is detected. Counter *U4* has an internal oscillator. Reset action on pin 12 forces the count output lines to 0. With output pin 2 connected to the gate of *Q11*, *U5* counts up from 0 until the pin 2 output line goes high. With the gate of *Q11* goes high, its drain pulls the oscillator control components to ground. This stops *U5* from oscillating and, consequently, counting.

Capacitor *C14* sets *U5*'s time-out to about 6 minutes. This timer serves as a master controller for the power sequence. Remember that *U2* creates a 45-second sample-and-reset cycle for the *U4* EMP integrator circuit. As long as an electrical storm is present, pulses are generated during the 90-second sample cycle and coupled across *C12* to reset *U5*. Continuous reset action keeps *U5* from ever reaching its 6-minute time-out. Therefore, output pin 2 of *U5* keeps the oscillator running and holds pin 12 of *U3* low.

When the storm passes, the 90-second storm-alert pulses stop at pin 12 of *U5*. With no further resets to force the count to 0, *U5* eventually times out after the full 6 minutes have elapsed. This additional delay adds some hysteresis to the circuit. Otherwise, lulls in a storm could power your computer back up in the middle of a storm.

While *U5* is timing-out it also holds reset pin 12 of *U3* low. This lets *U3* begin its own timing cycle that lasts for approximately 3 minutes. Two outputs pins (1 and 15) are used on *U3*. FET *Q8* and associated oscillator circuitry should look familiar to you from *U5*. Its function is the same in that after the 3-minute time-out the gate of *Q8* goes high and prevents further oscillation. Diode *D3* routes this logic high on to the gate of *Q9*.

FET *Q9* and *U7* create a "soft" on/off control circuit. Also, output pin 15 of *U3* is routed off the Control Unit Logic Card to the Phone Interface card RS-232 connection. Pin 15 also drives the CLOSE FILES LED through *Q6*. This 45-second strobe output signals your computer that power-down is imminent and that it should halt execution of the current program and start "flushing" RAM contents to disk for later retrieval. (We'll cover operation of the Phone Interface module next month.) This 45-second cycle is repeated twice before locking out.

After the CLOSE FILES LED extinguishes for the second time (after 3 minutes) the system automatically powers down your computer.

The soft on/off circuit may look complicated at first glance, but its operation is very straightforward. Assume for the moment that *Q9* isn't in the circuit and ignore the fact that switch *SW1* is shown in the OFF position. This nomenclature is relative to the phone monitor operation of the unit. With *SW1* connected to the V+ line, *C13* begins to charge through *R25* and *R26*. When the switch is opened, *R24* provides a discharge path for *C13* to ground.

In a similar manner, *Q9* also acts as a switch to discharge *C13* to ground through *R26*. This RC network provides a slow ramp-up or ramp-down voltage with which to drive the comparator circuit made up of *U8*, *R27*, *R28* and *R29*.

Window comparator *U8* monitors the charge voltage at the positive (+) side of *C13*. When *C13* fully discharges, output pins 1 and 7 of *U8* go low. When a voltage is applied to the charging circuit (*SW1* set to OFF or Phone Mon. high), the potential on *C13* begins to rise and, when it reach-

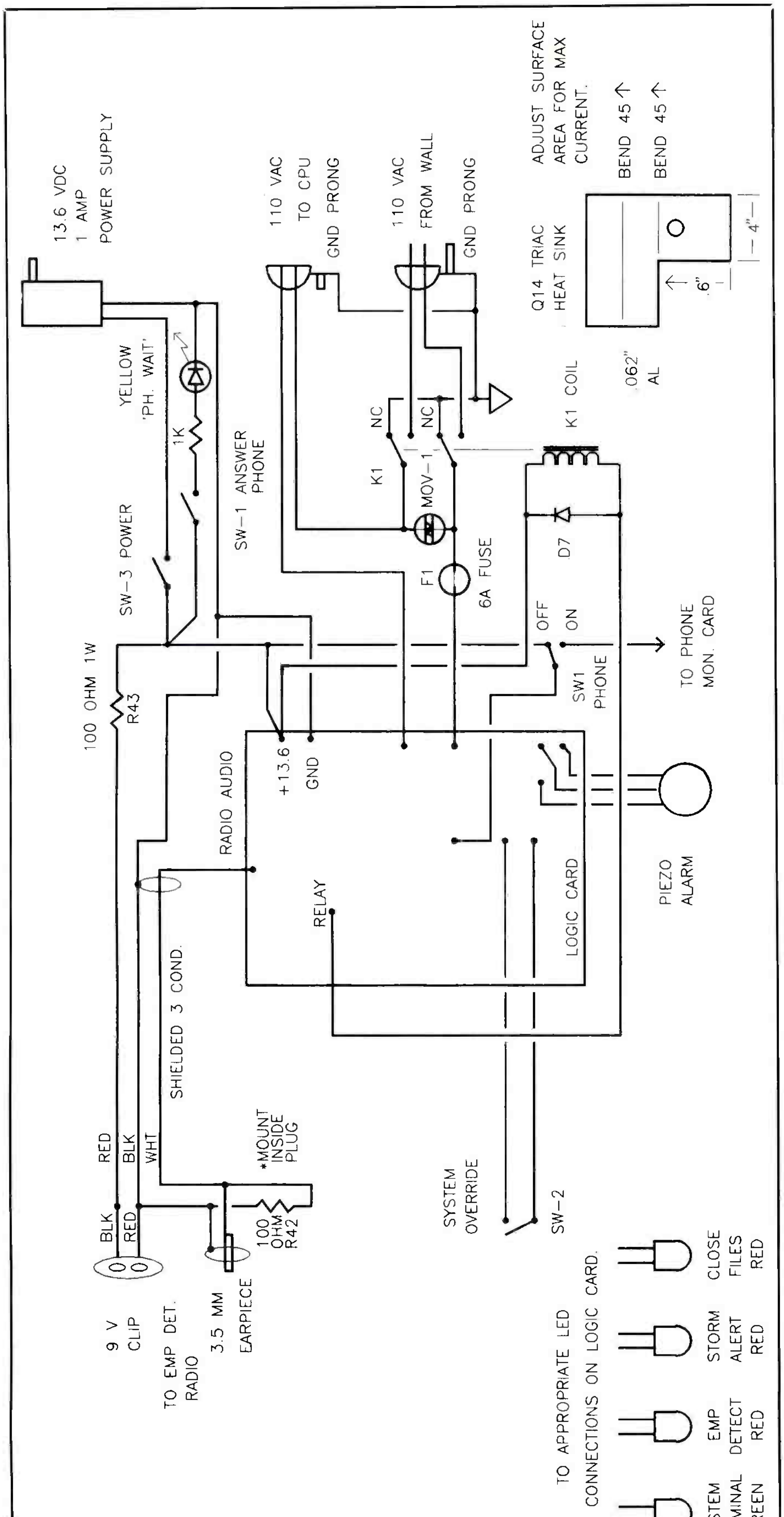


Fig. 2. Overall system wiring diagram.

es 4 volts, sends high output pin 1 of *U8* and energizes *K1*. The relay then routes 117 volts to triac *Q14*. A few hundred milliseconds later, the potential across *C13* rises to above 8 volts and triggers high output pin 7 of *U8*. This action forward-biases opto-isolator *U7* and turns on *Q14*.

By soft starting the relay, arcing and consequent pitting of the contacts are avoided. A relay like *K1* is needed to physically remove the 117-volt ac path from the circuit. The reason for use of an electromechanical relay in this circuit is that a triac-only design wouldn't afford the same degree of protection against lightning. Note that the relay is also configured to provide a further measure of protection in that it not only disconnects the 117 volts ac, but also shorts together and to the ground return the line inputs to the circuit.

If a high-voltage lightning surge does make it into your house through the 117-volt ac power line, the Storm Monitor will provide a direct path to ground for the transient that follows. This routes as much of the charge away from your computer as possible. Transient absorber *MOV1* in Fig. 2 wires directly across the circuit to protect against stray transients.

Now let's turn to the last two areas of the circuitry. Locate *U1* at lower-left in Fig. 1. FET *Q1* provides a power-on reset for *U1*. That is, when you power up the system, *C1* begins to charge through *R11*. When the potential across *C1* rises above 1.5 volts, *Q1* switches on and holds low reset pin 12 of *U1*. This allows *U1* to hunt for a little over 6 minutes and at the end of that period generate a high output at pin 2 to lock the oscillator off via shunting action from *Q7*. This simple 7-minute timer function holds low diodes *D10* and *D12*, overriding the initial random power-on state of the system.

OVERRIDE switch *SW2* performs the same function through *D9* and *D11* when you want to take your chances and ride out the storm. When you first turn on the Storm Monitor, it emits a faint pulsing sound through the piezoelectric alarm buzzer to assure you that the circuitry is working properly, even though the unit is held safe by *U1* for the first 6 minutes.

FET *Q13* drives the STORM LED,

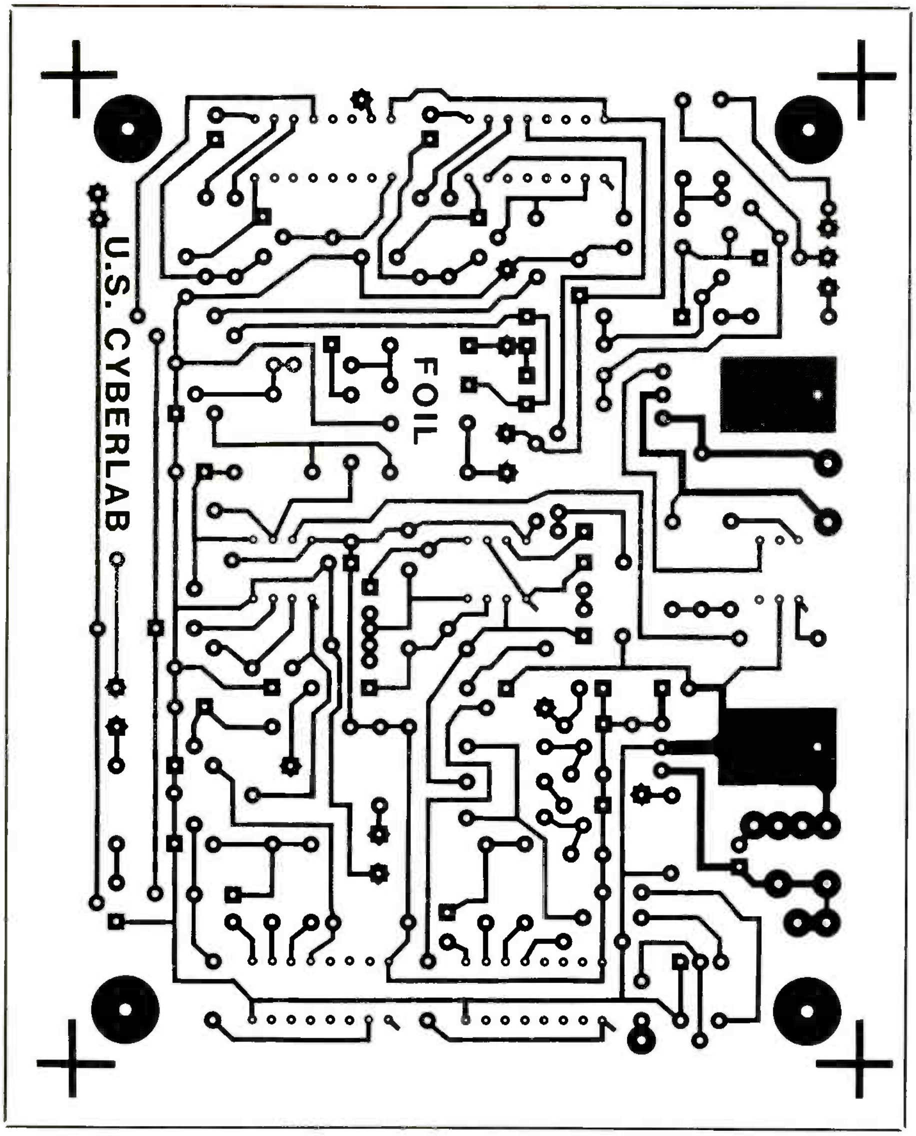


Fig. 3. Actual-size etching-and-drilling guide for fabricating the required printed-circuit board.

which blinks on and off during the entire storm-alert phase. Likewise, *Q12* drives piezo alarm *P1* to alert you that an electrical storm is approaching and a forced power-down is imminent.

Construction

The Storm Monitor is best housed inside a metal enclosure, which you prepare by drilling the various component mounting holes. The printed-circuit card can be fabricated using any applicable method. Attempting to build the Storm Monitor on perforated board isn't recommended because of the complexity of the circuit and creation of ground loops that could become a problem.

For those of you who wish to fabricate your own pc board, the etching-and-drilling guide for it is shown actual-size in Fig. 3. If you prefer not to fabricate your own board, you can obtain a ready-to-wire one from the source given in the Note at the end of the Parts List.

When you have the pc board ready, mount the various components on it according to Fig. 4. Start with the IC sockets and proceed to installation of the resistors and capacitors. Do *not* plug the ICs into the sockets just yet. Proceed with installation the transistors, triac and diodes.

Make sure as you go along that polarized capacitors and diodes are properly oriented and that the transistors and triac are properly based. Make sure to attach the heat sink to triac *Q14*, using thermal paste to assure good thermal coupling.

You can fabricate a heat sink for the triac from 0.062″-thick aluminum stock. Cut it to the shape shown at the lower-right in Fig. 2. This done, make two 45° bends in the aluminum so that the back piece stands straight up. While making the heat sink, be careful to avoid bending it at an angle that causes shorts to the fuse holder or relay contacts. The heat sink detailed in Fig. 2 provides good performance for the average XT or AT computer with an EGA monitor (about 1 ampere on the 117-volt ac line). If your computer system includes a printer (and especially if it's a laser printer), increase the surface area of the heat-sink tab. The triac specified in the Parts List can safely handle up to 10 amperes, but for it to do so requires a larger heat sink.

Mount the front panel of the Storm Monitor with spray adhesive. For the front-panel overlay, you can photocopy Fig. 5 on heavy card stock and use it as the front panel, instead of having to paint your enclosure and apply dry-transfer legends. Carefully cut out the component mounting holes with a hobby knife after the panel art is in place on the machined front panel of the enclosure.

Now mount the three switches on the front panel (see lead photo and Fig. 6). Make certain you install a double-pole, double-throw switch in the ANSWER PHONE switch location. The other two switches are single-pole, single-throw types.

Finally, you can mount the five LEDs using panel-mount escutcheons. Alternatively, you can simply cement the LEDs into place with fast-setting epoxy or silicone adhesive.

Use ribbon cable to connect the various indicator LEDs to the Logic Card and No. 22 stranded hookup wire to connect the switches. Next, run the 13.6-volt dc power supply cord through a grommet-lined hole in the rear panel of the enclosure and connect it to the Logic Card and POWER switch.

Now connect the 117-volt ac line cords and relay into the circuit. Exercise extra care when wiring the line cords and relay circuit. Look over Fig. 1, Fig. 2 and Fig. 6 to make certain you understand how to wire this part of the circuit.

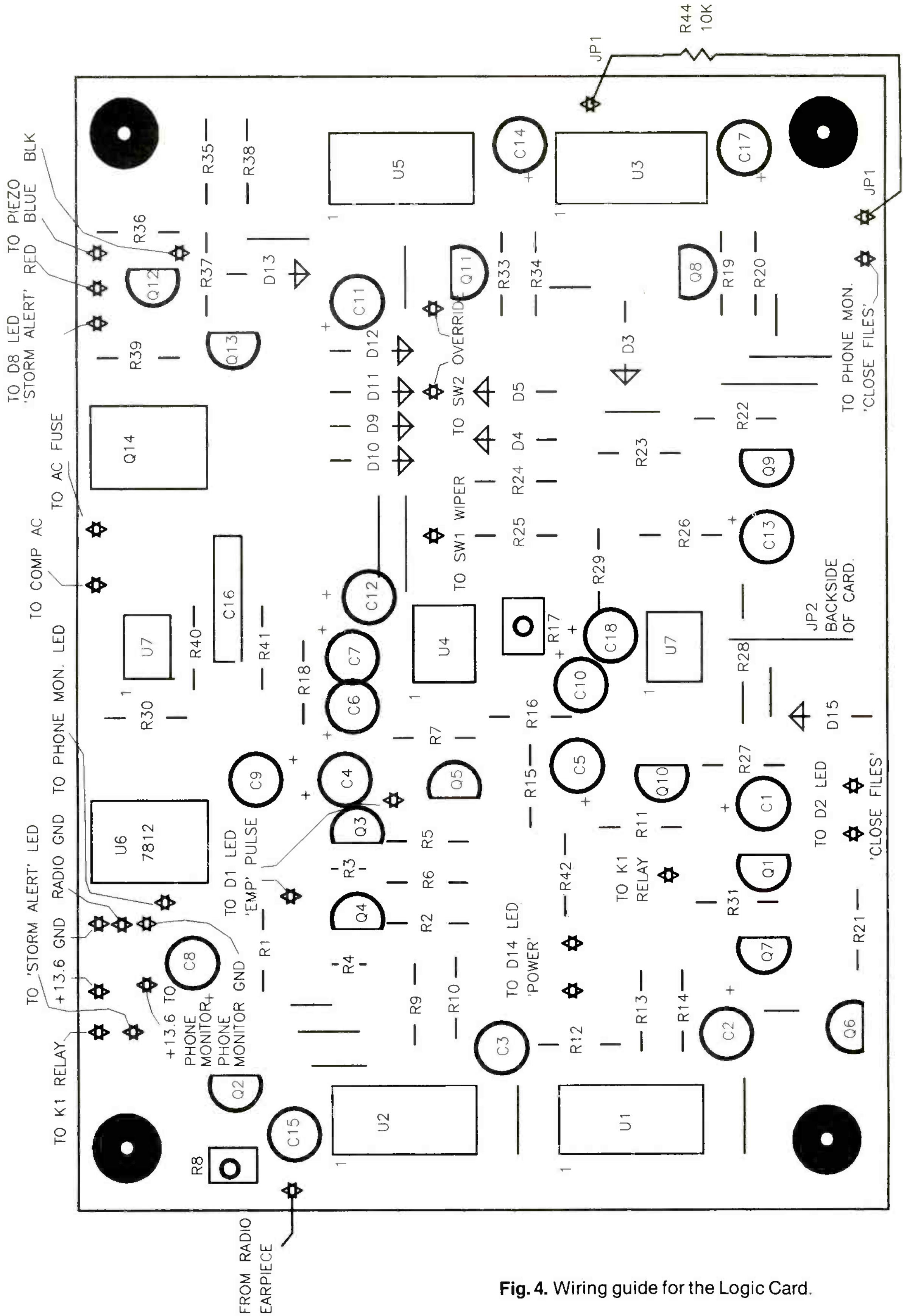


Fig. 4. Wiring guide for the Logic Card.

Start wiring this circuit by routing the two line cords through the Storm Monitor holes you drilled for them through the rear panel of the enclosure. Line the holes with rubber grommets and tie strain-relieving knots in the cords inside the enclosure or secure the cords in place with plastic strain reliefs. Whichever method you choose, leave about 4″ of cord inside the case.

Strip back the outer cable jacket and separate the three conductors. For safety, both to your computer system and yourself, make sure to use three-conductor line cords terminated in a three-prong plug and a three-contact receptacle.

Mount the fuse holder in its hole in the rear panel. Wire the relay into the circuit. Place heat-shrinkable tubing on the leads of the MOV to prevent them from shorting to each other or anything else inside the project.

With the 117-volt ac circuit wiring finished, double-check everything with an ohmmeter to make sure you haven't made any errors. When you're absolutely certain that this circuit is wired correctly, use epoxy cement to secure the relay to the top panel inside the enclosure, as illustrated in Fig. 6.

Using the full 10-foot length of shielded three-conductor cable, solder the center terminal of a 3.5-mm phone plug to the center (white) shielded conductor of the cable. Solder the shield to the outside terminal of the plug (black). Then connect *R42* across the plug, as indicated in Fig. 2, to provide a load for the radio's amplifier. Connect the cable to the earphone jack of the radio.

Connecting a 9-volt battery snap connector to the shielded cable is very important. This connector must snap onto the 9-volt battery connector in the radio. Because of this arrangement, you must wire the battery snap connector to the shielded cable in reverse polarity.

Slide 1″ lengths of small-diameter heat-shrinkable tubing over the leads of the snap connector. Then connect and solder the red (positive) supply lead in the shielded cable to the black lead of the battery connector. Connect and solder the black (negative) supply lead in the shielded cable to the red lead of the battery connector. Slide the tubing over the joints to completely cover them and shrink into place.

Route the free end of the cable through a grommet-lined hole in the rear panel of the enclosure and tie a strain-relieving knot in it inside the enclosure, leaving about 8″ of free cable inside the enclosure. Slide a 1″ length of small-diameter heat-shrinkable tubing over the end of the red conductor in this cable, connect this conductor to *R43* and solder the connection. When the connection has cooled, slide the tubing over it and shrink into place. Plug the black conductor and shield of the cable into the proper hole in the Logic Card and solder into place.

Testing & Calibration

Begin your tests by checking the Logic Card. Using an oscilloscope, dc voltmeter or multimeter set to the dc-volts function, place the "signal" or "hot" probe on the left (input) pin of the 7812 voltage regulator. Bump the POWER switch on and then off again quickly. Watch for the dc voltage on the scope screen or meter display to rise to about + 13.6 volts. If you get no indication, there's probably a short-circuit on the Logic Card. Recheck your work, correct the problem and repeat this test.

When you do obtain a fairly clean + 13.6 volts at the input, move to the output pin of *U6* and note if + 12 volts is present here. If this also looks good, move around the Logic Card checking the various V+ pins on the IC sockets for + 12 volts.

When you have the correct indications at all locations, power down the project and plug the ICs into their respective sockets. Make sure each is properly oriented and that no pins overhang the sockets or fold under between ICs and sockets.

Power up the project once again and listen for a faint beeping sound coming from the piezo alarm. Only the SYSTEM NOMINAL LED should be on at this time. After a few seconds, the CLOSE FILES LED might come on, which is normal on initial power-up. After about 6 minutes, the unit should be completely silent as it waits for EMP activity.

The first step in calibrating the Storm Monitor is to adjust the bias on *Q2*, using your scope or meter to

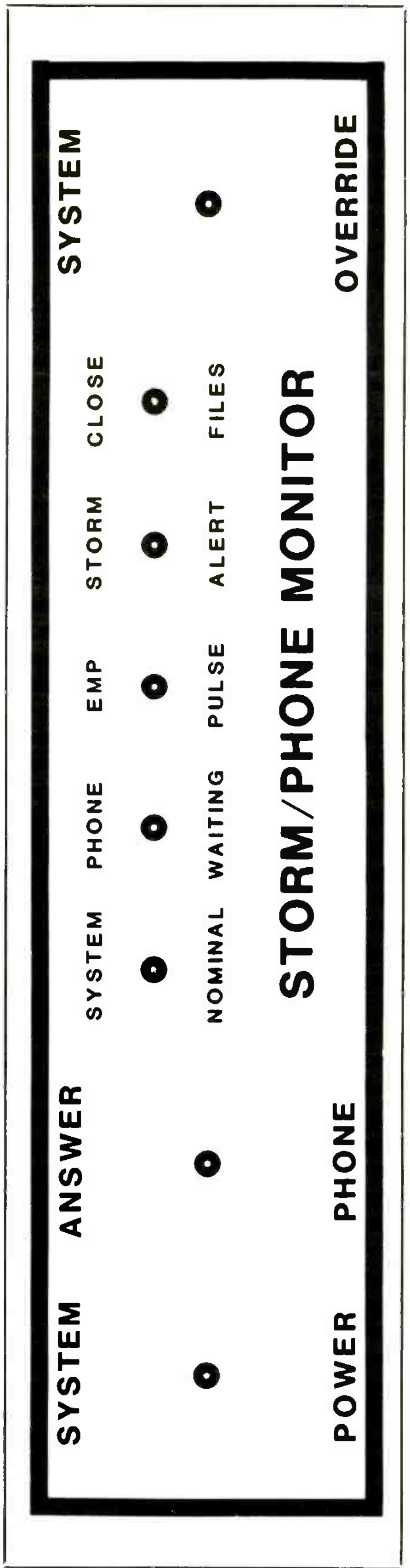


Fig. 5. Actual-size front-panel artwork. Photocopy this on heavy card stock and use it as the front panel for the Storm Monitor.

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2 Serial
1 Parallel Port

$ 1379

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1.2, 1.4 Floppy
125 MB IDE Drive
VGA Package (640X480)
101 Keyboard
2 Serial, I Parallel Port

$ 1999

DTK 486-25

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1.2, 1.4 Floppy
125 MB IDE Drive
VGA Package (640X480)
101 keyboard
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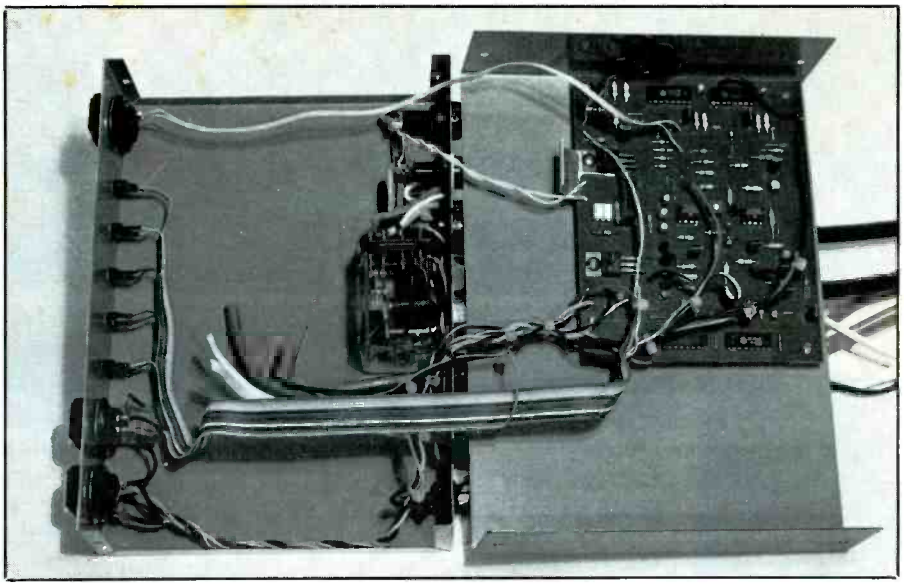


Fig. 6. Interior view of the finished project.

monitor the drain of this FET (metal tab on case). Adjust trimmer *R8* and observe on your metering device as the potential begins rising toward +12 volts. Stop adjusting the trimmer when the display peaks around +12 volts.

Connect the 9-volt battery to the AM radio via the connector-to-connector arrangement. Don't connect the 3.5-mm plug to the earpiece jack yet. Turn on the radio and adjust the volume until you clearly hear the audio. Then tune the radio until you find a spot that has no music or other noise. This dead spot is your initial test setting. Now turn down the volume completely and connect the 3.5-mm plug to the earpiece jack.

While watching the EMP PULSE LED, slowly increase the volume of the radio until the LED just begins to flicker. At this point, back off on the volume until the LED just completely extinguishes.

The best EMP generator I've found is a Weller soldering gun. If you hold this within about 3 feet of the radio and rapidly pull and release the trigger switch, the soldering gun will create a reasonable facsimile of distant lightning. (You could also use a hair dryer or soldering iron to create EMP signals.) As your simulation begins, your artificial lightning will be detected and displayed by the EMP PULSE LED. This LED will flicker in time with on/off switching.

Final calibration involves setting THRESHOLD trimmer *R17*. Use your scope or meter to monitor the voltage at pin 5 of *U4*. As an initial setting, use about 6.5 volts. If you want your Storm Monitor to be more sensitive to approaching storms, set this voltage higher (typically 7.5 volts). If you want less sensitivity, set this voltage lower (about 4.5 volts). The more EMP detected, the lower the voltage applied to pin 6 of *U4*, and the lower the reference voltage at pin 5, the more lightning-induced EMP that must be accumulated.

To test your Storm Monitor Logic Card, turn off the project for about 10 seconds. Then turn it back on. Let the project cycle through its initial 7-minute inhibit cycle. Make sure the ANSWER PHONE switch is set to OFF. Now simulate some lightning by rapidly switching your soldering gun on and off. Wait a second or two and begin again. Depending upon the state of the sampling cycle provided by *U2*, it may take as much as a minute for the Storm Monitor to detect your lightning. When it does you'll hear the piezo alarm start pulsing and the STORM ALERT LED will flash.

Watch the CLOSE FILES LED as the project performs its two 90-second cycles. At the end of 3 minutes, the Storm Monitor will deenergize the relay (you'll hear its contacts drop out). Without any further "lightning" from your soldering gun, the Storm Monitor will reset the relay and cancel the alarm after another 3 minutes has passed. If you don't want to override the operation of the Storm Monitor, simply throw the OVERRIDE switch at any point.

Now it's time to test the 117-volt ac circuit. First, again double check all the wiring. Then with the POWER switch set to OFF, plug the project's line cord into a 117-volt ac outlet. When you do this, nothing should happen! Next, plug a table lamp into the ac receptacle on the Storm Monitor. Again, nothing should happen. Setting the POWER switch to ON, you should first hear the relay energize and then the light should come on. Now set the ANSWER PHONE switch to ON. Because the Phone Monitor card isn't installed, the light should switch off and the relay should de-energize.

Using It

As you assemble the Storm Monitor's enclosure, take care to avoid letting anything short together. Place rubber feet on the bottom of the enclosure. Then move the project to your computer. Connect your computer system to the 117-volt ac receptacle on the Storm Monitor and the Storm Monitor power-supply module to a convenient 117-volt ac wall outlet. Do *not* plug it into the same power strip that feeds 117 volts ac to your computer! If you do this, the Storm Monitor would never be able to turn itself on! Next, plug the Storm Monitor ac line cord into the wall socket.

Power up the project and set the SYSTEM OVERRIDE switch to ON. Switch on your computer power and let it initialize. Don't try to run any programs yet; just let the computer idle for now. Locate the EMP Detector radio as far from your computer equipment as possible. Unplug the 3.5-mm earpiece connector and increase volume level until you can hear the audio. Chances are you'll hear your computer singing along, creating its own special type of noise.

Tune the radio to locate a quiet spot on the dial. Then, while watching the EMP PULSE LED, plug in the 3.5-mm plug and begin turning down the volume until the sound level is set so that it's just below the level that causes the EMP PULSE LED to flicker. An occasional flicker is okay, but constant noise isn't. (If you have difficulty locating a quiet spot on the dial, move the radio around the room until you find a null point where your computer doesn't interfere.) Now wait a few minutes until the initialization sequence has completed. Watch for any sudden or unexpected EMP pulse activity. This could indicate interference from around the house, from such sources as air dryers, light dimmers, etc. These noise sources must be tracked down or tuned out on the radio dial.

When you're satisfied that no significant EMP is being detected, set the SYSTEM OVERRIDE switch to OFF. Your computer system is now under the control of the Storm Monitor. You can test the project with your soldering gun. After a few seconds of "popping" the trigger, the Storm Monitor will light the STORM ALERT LED and sound the piezo alarm. At this point, you have 3 minutes to close up shop or activate the system-override option.

Keep in mind that no device is completely immune to the effects of lightning. Don't let the Storm Monitor give you a false sense of security. It won't keep lightning from striking your power or phone lines. If your lines do take a direct hit, the Storm Monitor may be damaged. Hopefully, with the safeguards incorporated into the project, it will save your *computer* from damage. After all, it's easier and a lot less costly to repair the Storm Monitor than it is a computer.

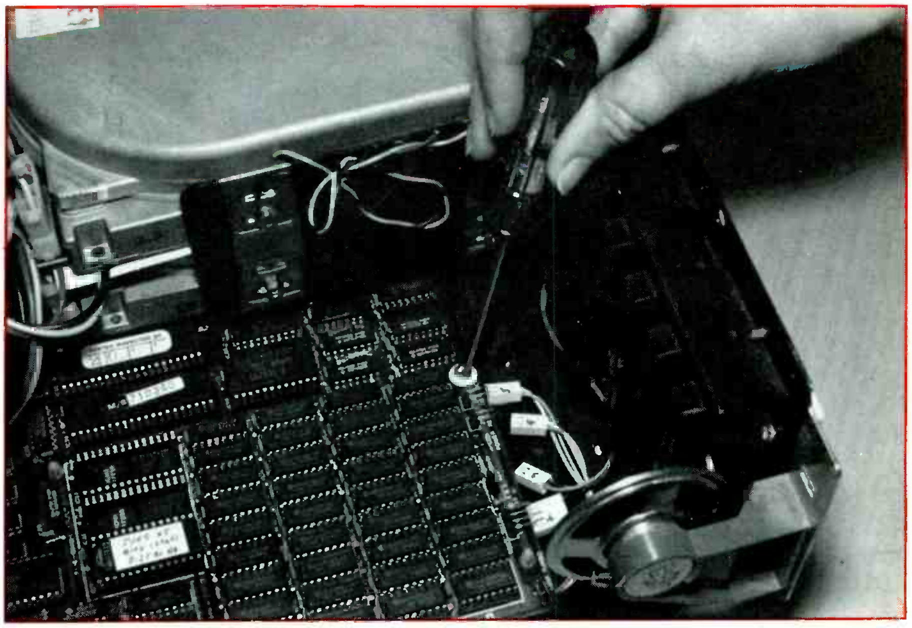
Always remember, too, that the best protection for the Storm Monitor and your computer is to unplug both before lightning has a chance to strike. If you're away from home and can't unplug them, the Storm Monitor is the next best thing.

(Unplugging electrical equipment during an actual storm can be dangerous. A number of people have been injured as they were unplugging electrical equipment at the moment lightning struck their incoming power or telephone lines. Consequently, if the threat of lightning is imminent, don't take chances.)

When used as an early detection system and last line of defense, the Storm Monitor will give your computer system the protection it deserves! ■

New Motherboards Boost XT Performance

How to change an XT into an AT powerhouse



If you got an early start into the world of IBM PC compatibles, or began later on a modest budget, chances are your first system purchase was an XT (Extended Technology) compatible. If you're still trudging along with it, you're probably increasingly frustrated by the machine's low performance when running newer software and by its total inability to run much of the more advanced software that has reached the market in recent years. Programs like Microsoft *Windows* 3.0 and OS/2 require at least an 80286 processor, for example, and don't really shine until they're playing happily through an 80386 processor. Some popular spreadsheets also require 286 power, such as Microsoft *Excel* and Lotus *1-2-3* Release 3.1. Even my trusty *WordPerfect* 5.1 program runs too slow on an XT for my taste.

It's easy to complain about your XT's problems and limitations, but it may not be in your budget to rush out and buy a new AT (Advanced Technology) or better to remedy the situation. There's another alternative, however, that can give you the power you need without buying a whole new system: simply replace the motherboard in your existing system. By selecting a 286, 386SX or 386DX motherboard that meets your processing needs, you can upgrade your XT to the functionality of a high-powered AT at a substantial savings in money. Then, as your needs increase and your budget allows, you can add new disk drives, video subsystems and other options to increase the functionality of your new system.

Before you begin this project, you should compare the cost of upgrading your existing system to buying a powerful new AT or 386 system to ascertain that it makes sense for you to upgrade. You'll usually find that it's substantially more economical to upgrade your existing XT with a new motherboard because you can retain your existing chassis, power supply, hard-disk drive, floppy-disk drive, video adapter, video monitor and keyboard. (If you have an XT/AT switchable or auto-switch keyboard, you can also keep your existing keyboard.)

You must also determine if your XT chassis can accommodate an AT replacement motherboard. Although a full-size AT motherboard won't fit into an XT chassis, there are many "mini AT" or "baby AT" motherboards available from which to choose that are expressly designed to fit into XT cabinets. Unfortunately, dimensioning isn't exact, and the slightly larger mini-AT board size causes a problem in some XT cabinets. A standard XT motherboard measures 8.5″ × 12″, while the standard mini AT motherboard size measures 8.5″ × 13″. Thus, the mini AT board is 1″ longer toward the front of the XT cabinet. While the extra inch isn't a problem with most XT cases, I did come across a true-blue IBM XT that has a foot supporting its left-most drive bay, preventing the larger mini AT motherboard from being installed (a little metalwork was required to make the case more accommodating). So check dimensions accurately to ensure that the replacement you choose fits.

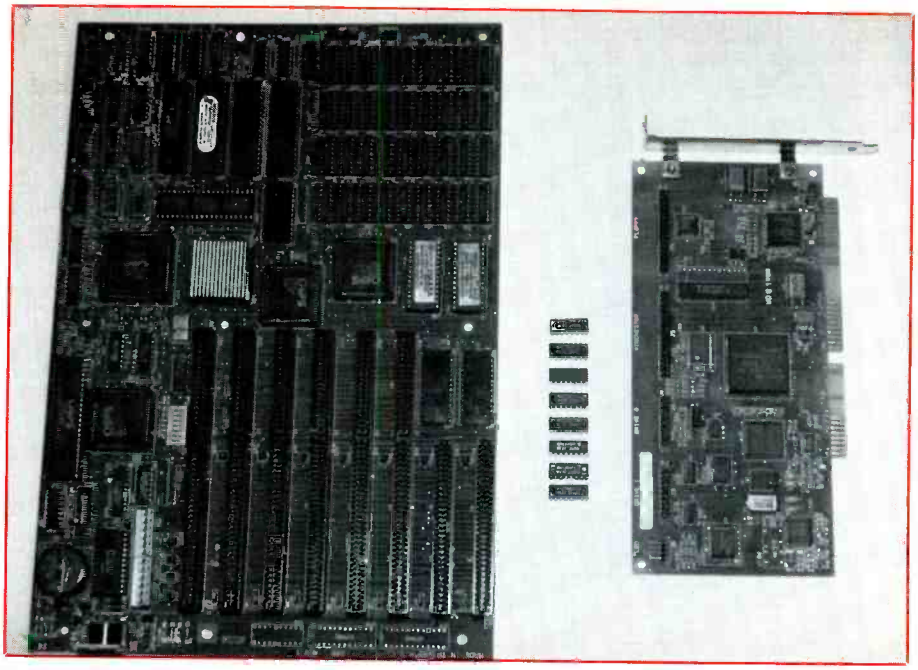
What You Need

To upgrade your XT, you need a few new items, the most obvious of which is a new motherboard. There are many motherboards from numerous sources from which to choose. Decide on the type of processor and speed you want (within the limits of your pocketbook), then start looking around for the best deal. Unless a 12-MHz 286 motherboard maxes out your budget (typically \$150 to \$200), I suggest you buy at least a 16-MHz 386SX motherboard (typically \$375 to \$450). This will give you the increasingly valuable ability to run 386-dependent software, while paying little more than the cost of a roughly comparable 286 motherboard.

Most motherboards are sold without memory (0K); so you'll want to keep the add-in memory cost in mind as well (which, at about \$50 per megabyte, is currently quite low). The manual that comes with the motherboard will specify the speed and type (DIP, SIP, SIMM, etc.) of memory devices required for that motherboard. Make sure you buy memory that's rated at least as fast as specified (lower numbers are faster—for example, 80 ns is faster than 100 ns). Don't waste money by buying devices whose speed is so fast that the CPU clock can't take advantage of it. I suggest that you buy your motherboard from a company you trust—one that can provide technical assistance if required.

Features worth looking for on a replacement motherboard include shadow-RAM support for the main ROM BIOS and the video BIOS (for best performance), Setup in ROM (unlike XTs, ATs must have a Setup utility for configuring the system) and 8-MHz timing on the expansion bus. All these features are standard on most modern replacement motherboards. You'll also want to make sure the motherboard supports the amount of main system (DRAM) memory you desire.

XT hard- and floppy disk-controllers don't adequately support the functionality needed in an AT environment and must, therefore, be replaced with an AT controller board that combines these functions. Many boards designed for an AT system are 0.3″ higher than standard XT boards, causing a problem in a lot of XT cases. Make sure you get an AT dual hard/floppy controller board that uses a standard XT card profile (4.2″ from the bottom of the connector to the top of the board), like Western Digital's 1006VMM1 (MFM) and 1006VSR1 (RLL) controllers.



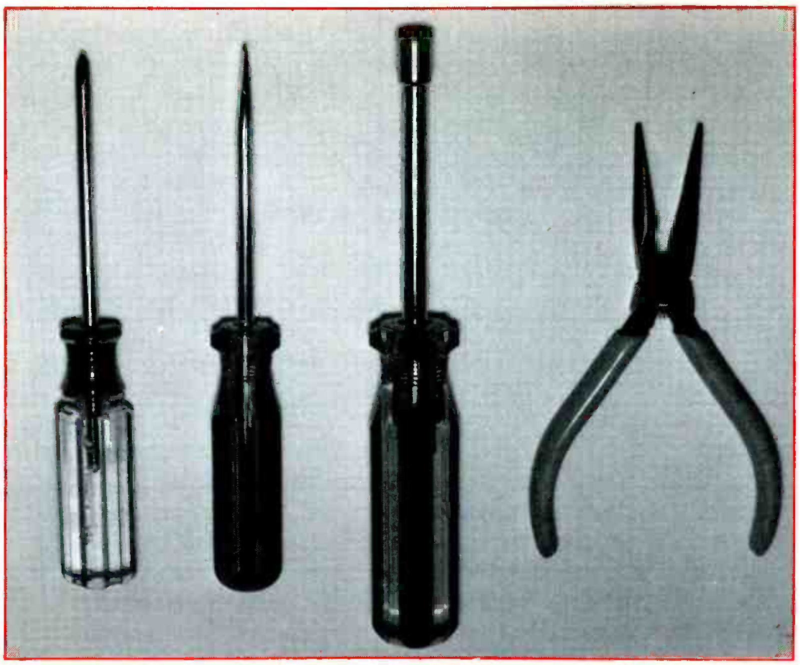
The minimum you need to upgrade an XT- to an AT-type machine are, left to right, an 80286 motherboard, at least one bank of RAM memory chips and a combined dual-floppy/hard-disk controller card.

You must also make sure you get a controller that matches the encoding format of your hard drive. A majority of XT hard drives use MFM encoding, although many use RLL (which provides a 50% improvement in data storage density and transfer rate over MFM).

In moving up to an AT motherboard, you may also have to change your serial I/O controller board since you likely have serial ports on your XT. While XT systems use the 8250 UART for serial I/O, ATs use the similar 16450 UART, which is just different enough to upset some AT applications if the 8250 is used. You can probably get by with your existing XT serial ports for most applications, though, if you aren't ready to spring for a new serial I/O board. Do keep in mind, though, that an XT controller's interrupt usually conflicts with a standard AT's second parallel port.

Another optional component that may be worth buying is a 1.2M 5¼″ floppy-disk drive or a 1.44M 3.5″ drive. Your new AT system will work fine with your existing 360K floppy

Another necessity is an AT-compatible keyboard, like the Northgate OmniKey model shown here.



The only tools you need to perform the upgrade task are these.

drive, but the AT world is really oriented toward the higher-capacity drives, and you'll miss out on some of the important value of your new AT system without a high-capacity drive installed. Again, if your budget can't support the additional $75 to $100 needed to purchase a new floppy drive, you can always add it later.

As mentioned above, if your keyboard doesn't support AT operation (either switchable or auto-switch), you'll also have to purchase a new keyboard that does.

Replacing Your Motherboard

Before you begin open-case surgery, you must have a few tools on hand (but they needn't to be sterile). You generally require a medium Phillips screwdriver, a regular flat-blade screwdriver and needle-nose pliers. Your specific requirements may vary, depending on the construction of your system. Since most PC compatibles use screws with hexagonal heads in many places, a compatible hex nutdriver (typically ¼″) will also make things go more easily.

Because the integrated circuits used on motherboards are static-electricity-sensitive, you must take precautions to prevent causing damage that can result from from static discharges through the devices. Ideally, you should wear a ground strap on your wrist. Barring this, touch something that's grounded before handling your motherboards. You can, for example, touch the case of your power supply before removing the ac power cord. Spritzing some static-eliminating spray around your work area is worthwhile, too.

Once you have a grounding strategy, remove the cover of your XT (most XTs have five screws at the rear that hold the cover in place). With the cover removed, touch the case of your system's power supply (if this is your grounding method) then remove the ac power cable. Disconnect the various cables attached to installed expansion boards. You may find it helpful to label each cable with legends on strips of masking tape, indicating which board it came from and confirming the pin-1 position (usually identified by a colored stripe on the ribbon cable). With the cables disconnected, remove the expansion boards from you XT motherboard and either place them on an antistatic bag (such as the one your new motherboard comes in) or component-side down on a soft surface, such as a towel.

Now disconnect the cables plugged into the motherboard, including those that go to the power supply, speaker, keyboard and any front-panel devices that may be present (for LEDs, a keylock switch, etc.). Remove any other impediments, as needed, to achieve access to the entire motherboard. This may involve removing the speaker and/or a disk drive. If you must remove a disk drive, it will generally have two to four retaining screws (two on either side) that must first be removed, and the drive's power cable must be disconnected. You should be able to keep the drive interface cables attached as you remove the drive, if desired. It may be necessary to remove the drive just to access the mounting screw under the drive bay.

There are many variations on how XT motherboards are secured to the chassis. I'll describe the two most common methods. If your motherboard doesn't adhere to one of these methods exactly, it's probably some combination or variation. One method simply uses screws from the top of the motherboard that drive into standoffs mounted on the base of the chassis. The motherboard typically has nine mounting holes; so there may be as many as nine screws securing the motherboard to the chassis.

Another securing method follows the IBM approach. Plastic pegs with a thin, round, flat bottom are inserted into most of the motherboard's mounting holes. As the motherboard is placed onto the cabinet base, these pegs extend into corresponding raised slots on the base of the cabinet. The board is then slid to the right (as you face the system from the front) to secure it so that it can no longer be lifted up, and a couple of securing screws are placed through remaining mounting holes into standoffs to keep the board from moving. To remove an XT motherboard mounted this way, you must remove the securing screws, slide the motherboard to the left (about ⅜″) and then lift it up.

Some motherboards use standoffs secured to the base of the cabinet with screws that enter from the bottom of the cabinet instead of standoffs that are permanently attached to the XT base. If your system has screws on the bottom, you may be able to unscrew the standoff under the left drive bay from the bottom of

the cabinet, instead of having to remove the drive to gain access to the mounting screw from the top of the motherboard.

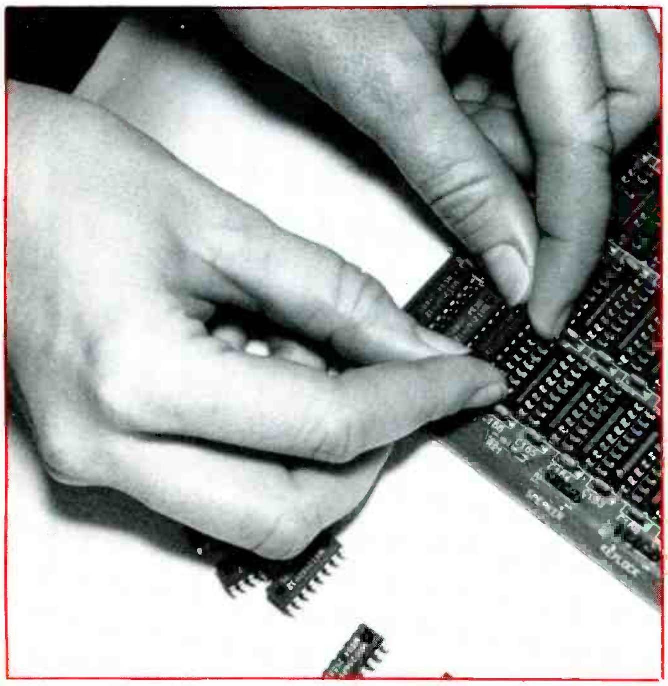
Once you remove the XT motherboard, place it in an antistatic bag and move it out of the way. Before installing the new AT motherboard, plug the memory devices into their sockets according to the instructions provided in the manual supplied with the motherboard. If jumpers or DIP switches must be configured (there may not be), do this now as well. Once memory is installed and the AT motherboard is configured, install the board in the chassis, using the same mounting method as the XT motherboard you removed. If not all mounting holes on the new motherboard exactly match your cabinet's mounting locations, use only those holes that do line up. Some replacement motherboards include extra holes to facilitate mounting in a wider variety of cabinets.

With your new motherboard installed, connect to it whatever cables you disconnected from the old motherboard. Start with the two power-supply cables, being especially careful to install them correctly (unless you're interested in a costly fireworks display later). When the power-supply cables are installed correctly, four black wires meet at the center. Also, make sure you don't inadvertently shift the power cables in either direction by one pin. There should be no gap (that is, a spare connector pin) between the power-supply cables, and there should be no "left-over" pins on either end once both cables have been connected.

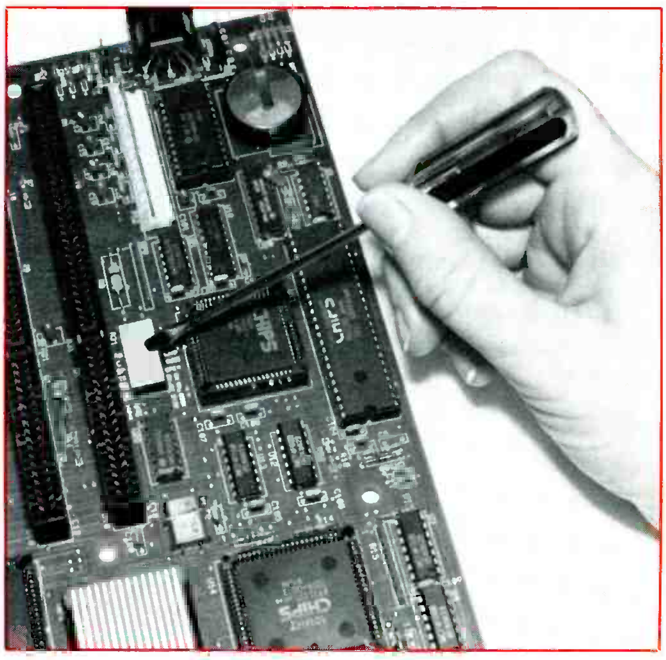
After connecting the power-supply cables, connect the speaker and, if supported by your cabinet, the front-panel LED and keylock cables to the new motherboard. Refer to your AT motherboard's manual for the locations of its connectors for these functions. If you connect LEDs, polarity is important for proper operation. If your LEDs don't light when they're supposed to, try reversing the polarity (by swapping the wires). If you removed a disk drive to permit access to the motherboard for replacement, reinstall the drive now. Be sure to reconnect the power cable to the drive.

Now you reinstall your expansion boards, but wait until this is done before installing your XT floppy- and hard-disk controllers. Don't be surprised if some of your expansion cards don't quite fit properly in their new expansion slots. Some older XT boards have a "skirt" that prevents them from being installed in a 16-bit expansion slot (the slots with the extension connector that supplements the standard "8-bit" expansion connector used in an XT). If you have boards like this, install them in your motherboard's 8-bit expansion slots; most AT motherboards include two 8-bit slots that lack the 16-bit extension connector. Once you install the boards, reconnect any internal cables to your expansion cards, as required.

Now install your new AT dual hard/floppy-disk controller board into an available slot. Refer to the board's manual to determine which of its connectors is for the floppy disk drives and which are for the hard-disk drives. Being careful to make sure you have the proper pin-1 orientation, connect the floppy-disk drive cable to the controller board's corresponding 34-pin connector. Then connect your hard drive's 34-conductor control cable to the board's 34-pin hard-drive connector and the drive's 20-pin data cable to the appropriate drive 0 data connector. If you place the cable on the wrong (drive 1) 20-pin data connector on the



Before you mount the motherboard into the system-unit chassis, you must install whatever RAM memory chips you decided to use.



Another task you should perform before mounting the motherboard inside the system-unit chassis is to set any DIP switches that must be programmed to configure the system.

controller board, your hard drive won't be operable.

Carefully examine your hard-disk drive to see if a Drive Type number is specified on the label. AT systems require this number for the Setup utility to determine the number of heads, cylinders, sectors/track and precompensation for the drive. If the drive type number isn't specified, write down the model number of the drive. If the number of heads and cylinders is specified, write these down as well. You can assume 17 sectors/track if you have an MFM drive and 26 sectors/track if you have an RLL drive. If your drive doesn't give the number of heads and cylinders, contact the drive supplier or manufacturer to obtain this information (and the precomp, if any). Your motherboard's manual may provide the types of many popular hard-disk drives.

Assuming you don't have the drive type number, you can use the information you obtained to determine an appropriate type for your drive. The motherboard manual may list the drive types supported in its BIOS, along with the number of heads, cylinders, sectors/track and precomp for each drive type. If it isn't in the manual, all modern ROM BIOS Setup utilities (see below) provide this information as you step through the list of supported drive types. Look through the drive types until you find one that has the exact number of heads and sectors/track and the same number of cylinders or fewer. Try to get as close as possible to the same number of cylinders without going over (the fewer the number of cylinders, the less of your hard-disk space you can actually use). If you know the precomp, try to find an entry that has the same or a close precomp value. If you don't know the precomp value, look for an entry that either specifies no precomp (preferred) or disregard the precomp altogether.

With your system internals back in place and reconnected, you can now replace your chassis cover and the power cable into an ac outlet. Also plug your AT keyboard into the keyboard connector of your new motherboard. If you're using a switchable XT/AT keyboard, make sure it's set for AT operation. Now try the "smoke test" by turning on power. Your system BIOS should boot and display its initial messages on your display monitor. The BIOS will probably also give you some message indicating that you must run Setup to configure your system.

Run your motherboard's Setup utility. This will either be in ROM or on a separate disk included with the motherboard. Check your manual to determine how to run your motherboard's specific Setup utility. Go through the Setup options to set the time, date, floppy-disk drive type(s) and memory size (unless the BIOS determines the memory size itself). You must now select the correct hard-drive type according to the instructions outlined above. Once everything has been set correctly, save the new configuration information (according to the instructions indicated by your Setup utility). Your system should reboot, and you should now be able to boot from your hard-disk drive!

If your system doesn't boot from the hard disk, insert a bootable floppy disk into floppy drive A: and boot from it. Once the system boots, see if you can access the hard drive. If hard-disk problems persist, take the cover off your system again and double-check cable connections and power to the hard disk. Also double-check the drive type and its corresponding hard-disk parameters.

For complete testing of your new system, you can use one of the PC diagnostic programs on the market, such as *QAPLUS* (from DiagSoft), or *PC Probe* (from Landmark).

Conclusion

If you completed the upgrade correctly, you should have no trouble running your new AT system. Higher performance is now at your fingertips, and a whole new world of applications and opportunities is available to you. If you wish, you can enhance your system even further with a super-VGA graphics subsystem, a 1.44M 3½" floppy drive or other peripheral devices. Sit back and enjoy the ride! ■

Roger C. Alford

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A Low-Cost Development System

Motorola's MC68HC11 microcontroller and its M68HC11EVB Evaluation Board

One of the first steps in designing a microcontroller project is deciding which microcontroller IC to use. One popular choice is Motorola's MC68HC11, whose features include an on-chip eight-channel analog-to-digital (A/D) converter, an EEPROM area for nonvolatile yet erasable storage and built-in timing functions.

To help users get acquainted with the MC68HC11, Motorola offers a low-cost development system in its M68HC11EVB evaluation board. The M68HC11EVB provides a convenient way to experiment with and test and debug programs for the MC68HC11 microcontroller.

This article on the MC68HC11 and its evaluation board includes a look inside the MC68HC11 chip and a description of how the evaluation board can help you learn about and how to develop programs for the MC68HC11 microcontroller.

MC68HC11 Microcontroller

The MC68HC11 is a true single-chip microcomputer. Figure 1 is a block diagram of what the IC contains and, as you can see, there is a lot to it. In the space here, I can only point out the major features. You will find more details in the manuals listed at the end of the article.

The term MC68HC11 actually refers to a family of eight-bit microcontrollers. Variations among the family members are mostly differences in the amount and type of on-chip memory. For example, the MC68HC11A8 version has 8K bytes of mask-programmed ROM, 256 bytes of RAM and 512 bytes of EEPROM, while the M68HC811E2 has no user ROM, 256 bytes of RAM and 2,048 bytes of EEPROM.

The MC68HC11 executes all instructions of Motorola's older M6800 and M6801 microcontrollers, as well as over 90 new instructions. Additions include instructions that access a new, second 16-bit index register (for easier data moves and calculations); bit-manipulation instructions that AND, OR and complement single bits of data; 16-bit division instructions; and other instructions that make it easier to exchange register contents and perform arithmetic operations.

Because the MC68HC11 has more than 256 instructions (the maximum that can be decoded with eight bits), some instructions are read in two steps: first a prebyte, followed by the instruction itself.

The on-chip ROM may be mask-programmed at the factory with a user-provided program. But this is practical only for high-volume applications, where large quantities of ICs are needed, all with the same program.

For experimenting, prototyping and low-volume applications, other options are available. A program can be stored in an EPROM or other memory IC external to the microcontroller. Or you can use the MC-68HC811E2 version of the chip, and store a program in its on-board 2,048 bytes of EEPROM.

Another option is to use the MC68HC711D3 or -E9 version, each of which contains one-time-programmable (OTP) memory. The OTP memory is user-programmable, but only once. It cannot be erased; so its use is limited to programming finished products, where no program changes are expected.

In addition to the main program area, a separate ROM area in the MC68HC11 contains a bootloader program for downloading short diagnostics or other programs. You do this using the MC68HC11's special bootstrap mode.

On-chip RAM provides temporary data storage, while EEPROM provides nonvolatile, yet easy-to-alter, storage. Unlike RAM data, EEPROM data is retained when power is removed. Because the EEPROM can withstand only a limited number of erase/write cycles (10,000 or so), the EEPROM area is intended for information that may change occasionally, such as calibration tables, configuration data, serial numbers, product history information or program memory.

The MC68HC11 also contains a special CONFIG byte of EEPROM, which allows you to enable or disable different options, including ROM, EEPROM, a computer operating properly (COP) watchdog system and a security feature that prevents reading of on-chip memory. The CONFIG byte also selects different modes of operation for the chip.

For monitoring analog voltages, the MC68HC11 has a built-in eight-bit A/D converter with eight analog inputs. The converter translates each analog input signal into an eight-bit binary number.

Two reference inputs set the range of the A/D converter. A range of 2.5 volts or larger is recommended, with a lower limit of 0 volt and an upper limit of 6 volts. For voltages outside the recommended limits, you must provide external signal-conditioning (amplifiers, attenuators or level shifters) to bring the inputs into the proper range.

The converter uses a successive-approximation charge-redistribution method, in which sampled voltages are stored in on-chip capacitors. This eliminates the need for a separate sample-and-hold circuit.

With an 8-MHz crystal as a timing reference, an A/D conversion requires only 16 microseconds. The

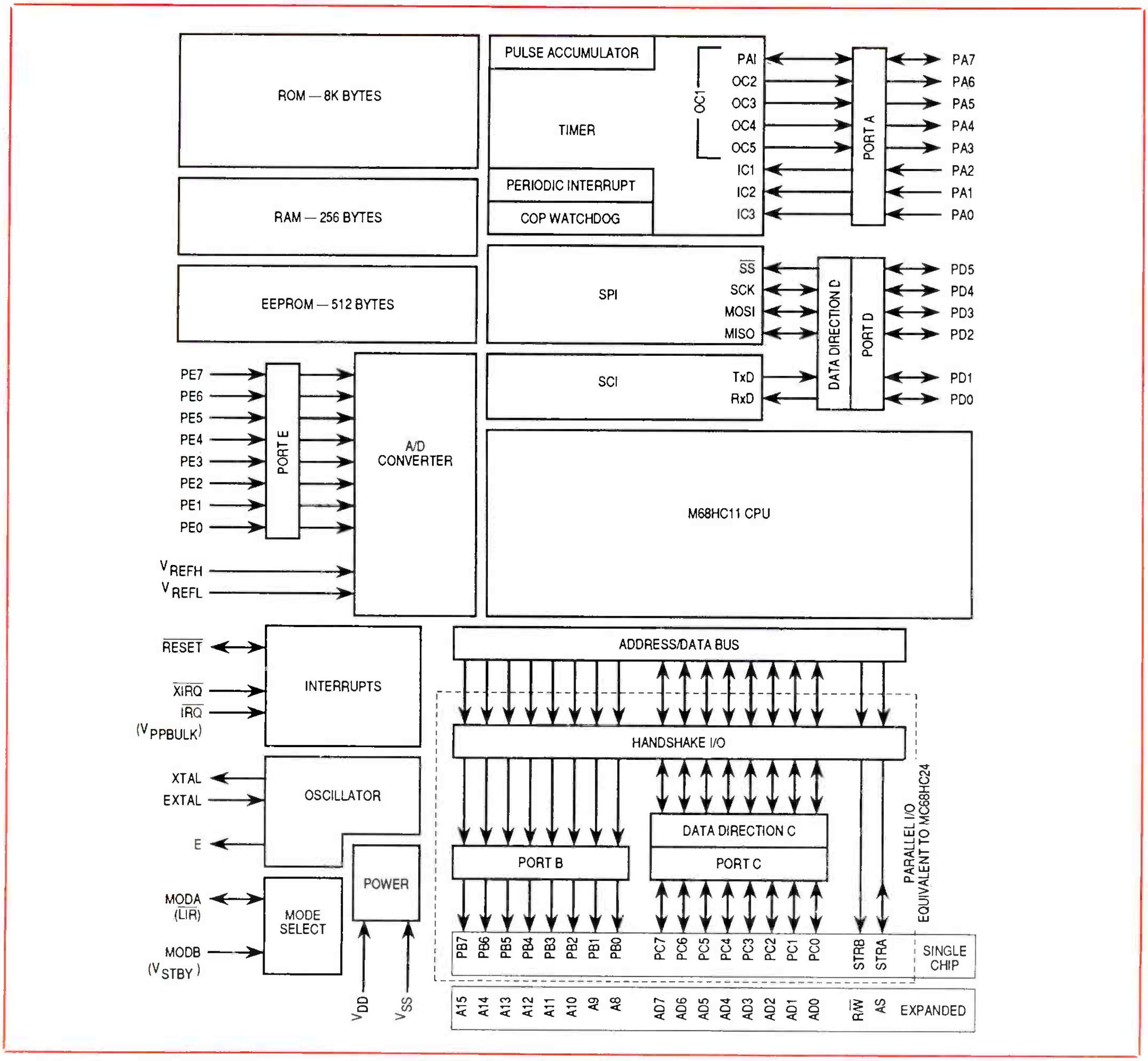

Fig. 1. MC68HC11 microcontroller contains ROM, RAM, EEPROM, timers, serial and parallel I/O systems and an eight-bit, eight-channel analog-to-digital converter. (Source: Motorola MC68HC11 Reference Manual)

MC68HC11's Reference Manual describes the A/D conversion process in greater detail.

In addition to the A/D converter system, the MC68HC11 contains other features for easy communication with off-chip circuits and devices. These include asynchronous and synchronous serial communication interfaces, a 16-bit timer and a parallel I/O subsystem.

The SCI is a universal asynchronous receiver-transmitter (UART) interface intended for communicating with off-board serial peripherals, such as a modem or the serial port of a personal computer. The SPI is a high-speed synchronous (clocked) interface for easy interfacing with LCD drivers, shift registers and other serial devices.

The on-chip parallel I/O subsystem has different functions that depend on the chip's mode of operation. Which mode you use depends on how much external memory you require. In single-chip mode, program memory is on-chip and the parallel subsystem reads and writes to two eight-bit ports. In expanded mode, the parallel subsystem becomes a multiplexed address/data bus for reading and writing to up to 64K bytes of external memory. External memory can consist of program memory, data memory or other components.

The MC68HC11's timing functions include special input-capture and output-compare capabilities. Input-capture automatically records the time when a transition is detected at an input pin and can be used to measure the period, frequency or pulse width of a signal. Output-compare can be used to program an action to occur at a specific time, produce a pulse of a specific length or generate a specific delay.

The MC68HC11 is available in two package types: a 52-pin PLCC package and a 48-pin DIP. In the DIP package, four of the eight A/D inputs are eliminated. All MC68HC11s use high-density CMOS (HCMOS) technology, which has low power consumption, along with high operating speeds and high noise immunity. Single-quantity prices for the chip are in the $15 to $25 range.

With an 8-MHz crystal as a timing reference (which is divided down on-chip to give a 2-MHz internal bus speed), power consumption of the IC is 15 milliamperes in single-chip mode and 27 milliamperes in expanded mode. Special programmable "wait" and "stop" modes can reduce power consumption to as low as 100 μA when the chip is inactive.

Evaluation Board

If the MC68HC11 sounds like a useful chip, you're probably interested in a convenient way to experiment with it, and this is provided in the M68HC11EVB evaluation board shown in Fig. 2.

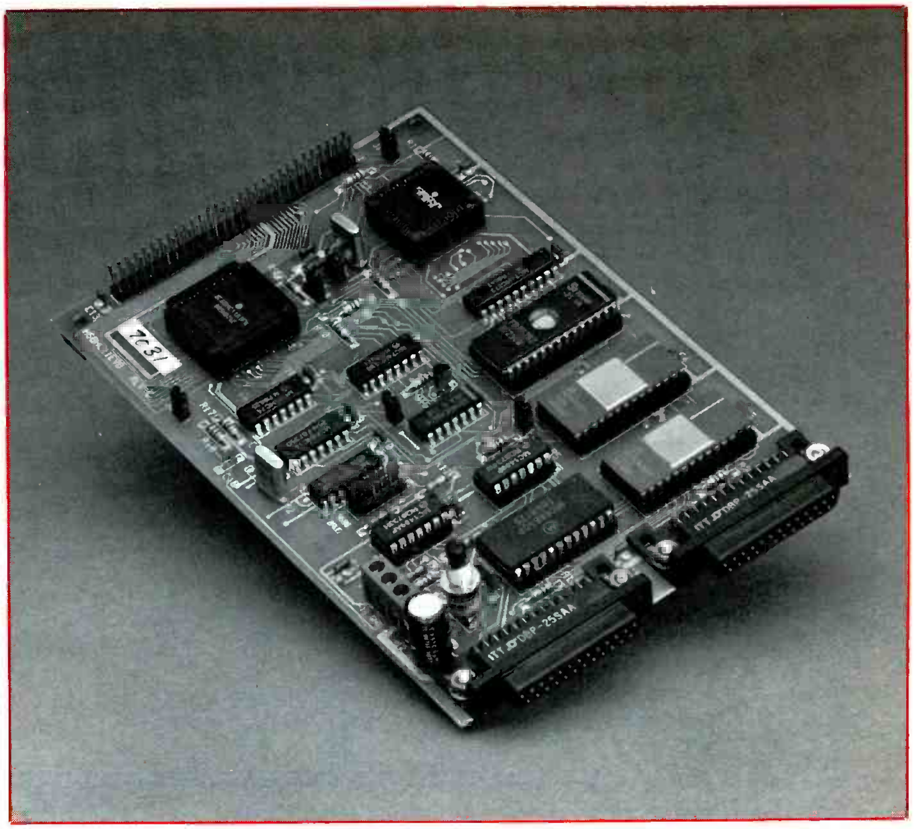

Fig. 2. Motorola's M68HC11EVB evaluation board can be used to experiment with and develop user programs for the MC68HC11 microcontroller.

The evaluation board is a low-cost tool for debugging MC68HC11 programs and circuits. List price is $168, but students, professors and schools are eligible for a special discounted price of just $68.11.

Along with the evaluation board, you get a cable for connecting the board to a target system, the evaluation board's user manual, the MC68HC11 Reference Manual, several application notes and MS-DOS floppies (5¼" and 3½" disks are included) with an assembler, Kermit terminal-emulation software and example programs.

Communication with the evaluation board is via a serial interface to a personal computer or computer terminal. Figure 3 is a block diagram of the evaluation board. Its major components include the following:

• MC68HC11A1 microcontroller in a PLCC package (contains 256 bytes RAM, 512 bytes EPROM and 0 bytes ROM)

• 8K of EPROM with a monitor program for use in loading, running, assembling and debugging user code

• 8K of RAM

• 28-pin socket for an additional 8K of RAM or EEPROM

•M68HC24 port replacement unit, which allows you to emulate single-chip operation (uses on-chip program memory), even though the MC68HC11 is operating in its expanded mode (using external program memory)

• MC68B50 ACIA (asynchronous communications interface adapter) for serial communications

Connections to the evaluation board include the following:

• Four screw terminals to +5 volts at 0.5 ampere, +12 volts at 0.1 ampere, −12 volts at 0.1 ampere and ground (GND). You must provide the power supplies.

• Two DB-25 connectors. One connects to the serial port of a personal computer or a computer terminal. If you use a personal computer, this is the only cable you need. The second connector is used when downloading programs from a mainframe or other remote computer. You must provide the cable or cables to the DB25 connectors. The cable connections are described in the user's manual.

• A 60-pin dual header on the evaluation board and its accompanying cable that allow you to plug your evaluation board into an MC68HC11 socket on a target system. The target system is an external circuit that normally would contain an MC68HC11. During project development, the evaluation board substitutes for the target system's MC68HC11.

This arrangement is useful if you are developing a project that will use the MC68HC11 in single-chip mode (using on-chip ROM). You can store a program in EPROM or other memory IC on the evaluation board and cable the evaluation board to the target system's MC68HC11 socket. The target system then acts as if it contained an MC68HC11 with a program stored in internal ROM. This allows you to try out programs using the evaluation board's memory—before you commit yourself to programming the MC68HC11's ROM.

The evaluation board's user manu-

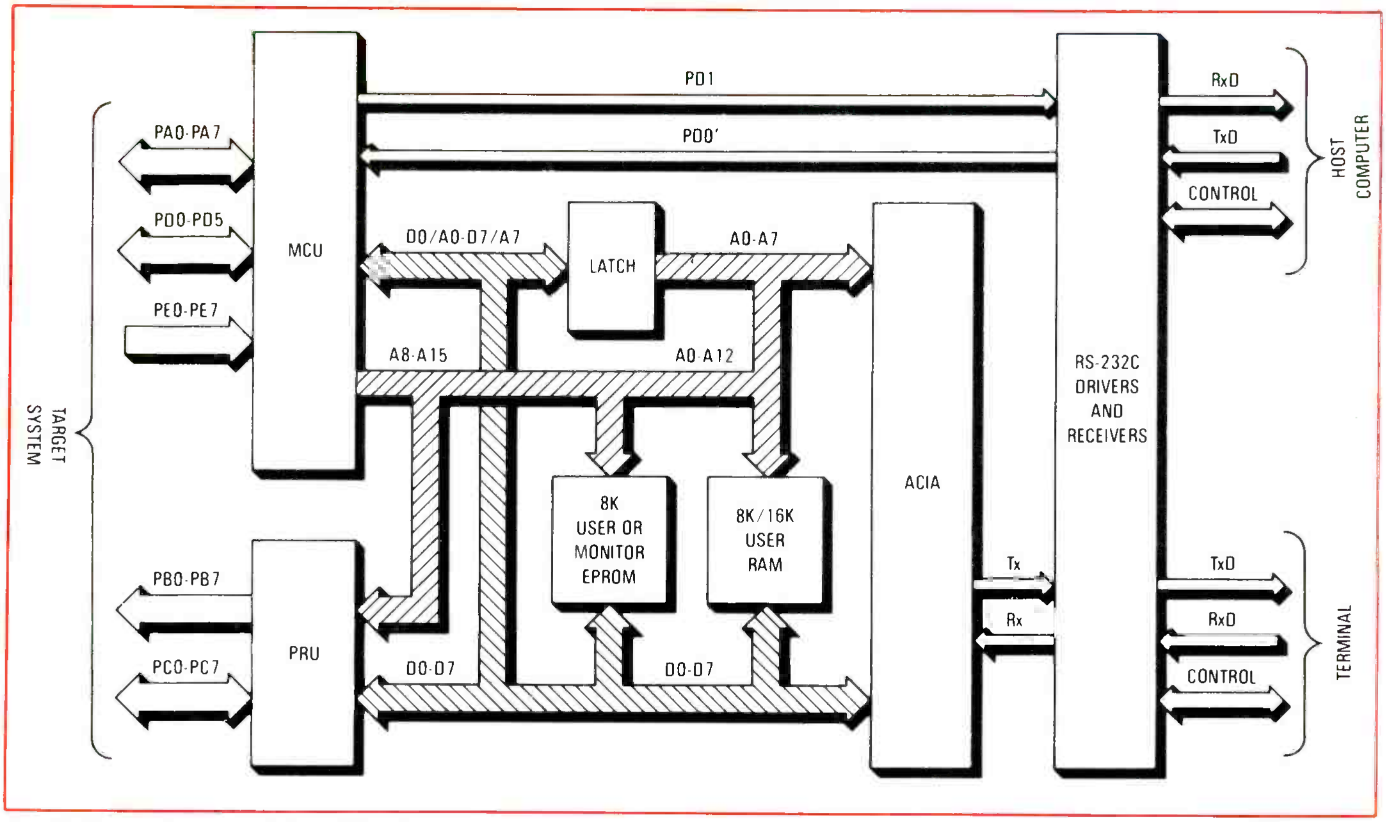

Fig. 3. Block diagram of the M68HC11EVB evaluation board for the MC68HC11 microcontroller. (Source: Motorola M68HC11EVB manual)

al includes installation and operating instructions, source code and user information for the BUFFALO monitor program in EPROM and a hardware description and schematic diagram of the evaluation board. A separate reference manual has chip details, including many application hints, instruction-set details, schematics of typical single-chip and expanded-mode configurations and other related information, such as a discussion of EEPROM technology.

The included floppy disk contains several files: the example programs from the reference manual (so you do not have to retype them), Kermit public-domain terminal software for communicating with the evaluation board and an assembler for translating source files into the S-record format required by the evaluation board.

Using the Board

The installation chapter of the evaluation board's user guide takes you through setting up the board's six jumper blocks and connecting your power supplies to the board. A checkout procedure shows how to power up the board and boot the BUFFALO monitor program. On boot-up, you see this prompt:

BUFFALO 3.3 (ext)—Bit User
Friendly Aid to Logical Operation

From here you can begin writing, running and debugging programs, using the monitor's 19 commands for loading and verifying programs, assembling, setting breakpoints and modifying and viewing memory. Figure 4 is a summary of the BUFFALO monitor's commands.

A full page in the user manual is devoted to describing each monitor command, along with examples. A final example guides you through assembling a program, setting breakpoints to stop execution at desired program steps and then executing the program and monitoring the results at the breakpoints. The example programs are a good way to familiarize yourself with the monitor.

The BUFFALO monitor contains a simple line assembler, which translates assembly-language mnemonics into executable code, one line at a time. For programs of more than a few lines, you'll want to use an assembler that will translate an entire program at once.

Conveniently, Motorola provides freeware assemblers for IBM compatibles, Macintosh and Amiga computers. These cross assemblers allow you to use a desktop computer to assemble code for the MC68HC11.

The evaluation board's disk contains an IBM-compatible assembler, and includes application notes that show you how to download assembled programs from a personal computer to the evaluation board, using the Kermit terminal emulator. Instructions for PROCOMM software and Macintosh MacTerminal and Red Ryder software are also included.

An easy way to become familiar with the assembler and downloading is to assemble one of the example programs using your personal computer, download the program to the evaluation board's memory and experiment with the program on the evaluation board. For example, one of the files illustrates seven uses for the MC68HC11's timer circuits. You can try the examples on the evaluation board and monitor the results with a logic probe or oscilloscope.

The evaluation board's disk contains only a brief four-page manual for the assembler. Better documentation, and more, is available via Motorola's freeware bulletin board.

Using a computer and modem, you can access the BBS and download all kinds of files, including a more detailed 31-page assembler manual, cross assemblers for other computer types and Motorola products, user-submitted programs for the MC68HC11, information on Motorola products and more. There is no charge to use the BBS, only the cost of your telephone calls to Texas.

User Comments

I found the evaluation board to be a good way to get acquainted with the MC68HC11. The setup and installation procedures are straightforward, with some exceptions—some concepts, like the differences between debugging mode (using the BUFFALO monitor) and evaluation mode (using a target system) aren't explained as clearly as they could be.

The documentation assumes you have some familiarity with microprocessors and assembly language. Even for those people who do have a background in these areas, learning about the many features of the MC68HC11 can be a little overwhelming. The evaluation board makes experimenting easy to do, however.

To get the most out of the evaluation board, I highly recommend accessing the freeware BBS. One BBS item I downloaded and enjoyed was a BASIC interpreter for use with the MC68HC11. As an example of how things can turn out to be more complicated than they first appear to be, here's what happened when I went to use BASIC11:

After downloading the BASIC11 file and using an un-archiving utility to extract its contents, I had two files: an S-record file containing the BASIC11 interpreter and a text file containing the BASIC11 user manual. Looking over the user manual made me want to try out BASIC11 even more. But before I could do so, I had to load the S-records into the evaluation board's memory, and the BASIC11 manual gave no clue about how to do this.

At first, I thought I could load BASIC11 into RAM using Kermit, as I had done with other files. But in reading the evaluation board's user manual, I learned that S-records consist of a series of character strings, each of which contains a loading address, and each of the addresses also affects a checksum value at the end of its string. This presented a bit of a problem.

The BASIC11 file was written to load at E000, which is the address of the monitor EPROM on the evaluation board. I couldn't remove the monitor EPROM because I needed its capabilities to load the S-records into memory. The loading address I wanted instead was C000, which is the address of the evaluation board's user RAM.

Because the S-records are ASCII text, they are easily examined. But altering the BASIC11 file so it would load at a different address would involve changing the address and the checksum in each of the character strings—not an easy process. Fortunately, I found a solution in another BBS program called OFFSET, which made the required changes for me automatically.

Before loading BASIC11 to the evaluation board, I replaced the evaluation board's RAM with a battery-backed RAM (so that it would retain its contents when powered down). I then used Kermit to load BASIC11 into the RAM.

After loading BASIC11, I removed the monitor EPROM from the evaluation board, moved the RAM containing BASIC11 into the monitor EPROM's socket and returned the original user RAM to its socket. With this arrangement, the evaluation board booted to BASIC11 on power-up, and I was able to write and run BASIC11 programs.

Useful BASIC11 commands include one that reads the A/D con-

```
ASM [<addr>]  Line assembler/disassembler.
    /         Do same address.            ^         Do previous address.
    CTRL-J    Do next address.            RETURN    Do next opcode.
    CTRL-A    Quit.
BF <addr1> <addr2> [<data>]  Block fill.
BR [-][<addr>]  Set up breakpoint table.
BULK  Erase the EEPROM.                     BULKALL  Erase EEPROM and CONFIG.
CALL [<addr>]  Call user subroutine.        G [<addr>]  Execute user code.
LOAD, VERIFY [T] <host download command>  Load or verify S-records.
MD [<addr1> [<addr2>]]  Memory dump.
MM [<addr>]  Memory modify.
    /         Open same address.          CTRL-H or ^   Open previous address.
    CTRL-J    Open next address.          SPACE         Open next address.
    RETURN    Quit.                       <addr>O       Compute offset to <addr>.
MOVE <s1> <s2> [<d>]  Block move.
P  Proceed/continue execution.
RM [P, Y, X, A, B, C, or S]  Register modify.
T [<n>]  Trace n instructions.
TM  Transparent mode (CTRL-A = exit, CTRL-B = send break).
CTRL-H  Backspace.                          CTRL-W  Wait for any key.
CTRL-X or DELETE  Abort/cancel command.
RETURN  Repeat last command.
>
```

Fig. 4. A list of the BUFFALO monitor's commands.

Products Mentioned

No. M68HC11EVB Evaluation Board
$168 (discounts available for students, professors and schools)
Motorola University Support
505 Barton Springs Rd.
Suite 450
Austin, TX 78704

M68HC11 Reference Manual
No. M68HC11RM/AD
MC68HC11A8 HCMOS Single-Chip Microcontroller Technical Data
No. MC68HC11A8/D
Evaluation Products brochure
No. BR292
Motorola Semiconductor Products Inc.
Sales and Product Information
P.O. Box 20912
Phoenix, AZ 85036
1-800-521-6274

Motorola Freeware BBS:
512-891-3733
300/1200/2,400 baud
eight bits/no parity/one stop bit

verter inputs and another that transfers a program from the evaluation board's user RAM to an EEPROM that you install in the socket provided. A limitation to BASIC11 is its lack of editing capabilities—if you mis-type a character, you have to re-type the entire line.

Final Comments

The MC68HC11 is a complicated chip, and there is a lot to know about it. The bright side is that there is a lot you can do with the chip once you are familiar with it. And the evaluation board is a good way to get acquainted with the chip's many features and capabilities.

If you need more capabilities than the evaluation board offers, Motorola also has an evaluation module (MC68HC11EVM, $500, discounts available) that includes extra features like an EEPROM programmer. Other evaluation boards are available for other Motorola microcontrollers.

I welcome your comments, suggestions and questions on topics that relate to designing, building and programming microcontrollers and other small, single-purpose computers. Send correspondence to me at *ComputerCraft*, 76 North Broadway, Hicksville, NY 11801. If you'd like a reply, please include a self-addressed, stamped envelope. Though I can't guarantee a personal response, I'll try to cover requested topics in future installments.

Next time, a look at memory ICs: EPROMs, EEPROMs and RAMs, including the new battery-backed RAMs that retain their data when power is removed. ■

Jan Axelson

 By Martin Meyer

Analog Circuits Operational-Amplifier Laboratory (Part 2)

More on building operational-amplifier circuits

Last month, we defined general operation and characteristics of an op amp. The goal was to present an organized overview on the use of these circuits so that even beginners could consider performing "hands-on" Lab experiments. This Month, we continue the Lab series with an op-amp lab exercise that further highlights information presented in data sheets and how the data relates to the basic operating characteristics of operational-amplifier designs. The lab exercise is presented using the Digital Storage Scope and Dual-Channel Function Generator presented in the January, February and March issues of *Modern Electronics*, now *ComputerCraft*.

Inverting Op-Amp Lab

Objectives: Learning how to use data in spec sheets will enable you to design your own circuits using any op amp. A spec sheet accompanies this article. What we'll explore here are how to verify, by actual measurement, the closed-loop gain equations; measure input impedance; measure maximum peak-to-peak output voltage as a function of frequency and load resistance; measure small-signal risetime; measure slew rate in two circuit configurations; and learn to understand and use the dynamic operating specifications that are provided graphically in the manufacturer's specification sheet.

Here's some support information you'll need to do these experiments. Design equations (from last month's article):

Open-loop dc gain	=	V_{out}/V_{in}
	=	R_{fb}/R_{in}
Input impedance	=	R_{in}
Output resistance	=	75 ohms (from spec sheet)

Wire together the circuit shown in Fig. 1 on any breadboard. We used the *Modern Electronics* Prototyping

PARTS LIST

1 μA741 or dual version μA747
1 4,700-ohm, ¼-watt resistor
3 47,000-ohm ¼-watt resistor
1 10,000-ohm ¼-watt resistor
1 2,000-ohm, ¼-watt resistor
1 200-ohm. ¼-watt resistor
2 0.1-μF disc capacitor
1 . 100-pF disc capacitor

Note: A kit of all above components plus specifications sheet and additional experiments is available for $9.95 plus $2 P&H from Netronics R&D Ltd., 333 Litchfield Rd., New Milford, CT 06776 (tel. 203-355-2659).

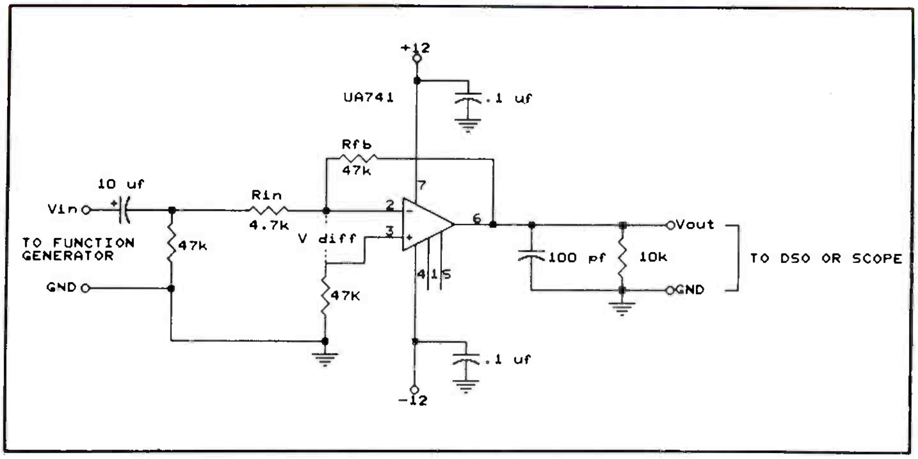

Fig. 1. Inverting amplifier with a gain of 10.

station that includes both solderless and Wire Wrap systems. See the Parts List for components required.

1. *Basic Calculations:* Calculate the closed-loop gain of this circuit:

(A) Rfb/Rin = __________

(B) Calculate input impedance. Remember that the voltage (Vdiff) is assumed to be 0__________

(C) Look up the output resistance in Fig. 2 and enter it here__________

2. *Measuring Gain:* Set the Function Generator for a 0.5-volt peak-to-peak (p-p) 1-kHz sine-wave output to use as input voltage Vin. Use your scope or DSO to verify signal frequency and level. (Set sensitivity to 0.1 volt/division and timebase to 0.1 ms/division.) Then connect the Function Generator to the input circuit and the DSO to the output.

(A) Measure p-p output voltage Vout. (Set DSO sensitivity to 1.0 volt/division.)

____

(B) Gain = Vout/Vin. Do your measurements agree with the calculated results?__________

3. *Measuring Input Resistance:* Connect a 4,700-ohm resistor in series with the output of the Function Generator, as shown in Fig. 3.

Use the same input signal as specified in measuring gain.

(A) Using the DSO, measure voltage V2 at the junction of the two 4,700-ohm resistors (set DSO sensitivity to 0.1 volt/division)__________

To calculate input resistance, solve

uA747M, uA747C
DUAL GENERAL-PURPOSE OPERATIONAL AMPLIFIERS

electrical characteristics at specified free-air temperature, V_{CC+} = 15 V, V_{CC-} = −15 V

PARAMETER		TEST CONDITIONS†		uA747M MIN	uA747M TYP	uA747M MAX	uA747C MIN	uA747C TYP	uA747C MAX	UNIT
V_{IO}	Input offset voltage	V_O = 0 V	25 °C		1	5		1	6	mV
			Full range			6			7.5	
$\Delta V_{IO(adj)}$	Offset voltage adjust range		25 °C		±15			±15		mV
I_{IO}	Input offset current		25 °C		20	200		20	200	nA
			Full range			500			300	
I_{IB}	Input bias current		25 °C		80	500		80	500	nA
			Full range			1500			800	
V_{ICR}	Common-mode input voltage range		25 °C	±12	±13		±12	±13		V
			Full range	±12			±12			
V_{OPP}	Maximum peak-to-peak output voltage swing	R_L = 10 kΩ	25 °C	24	28		24	28		V
		$R_L \geq$ 10 kΩ	Full range	24			24			
		R_L = 2 kΩ	25 °C	20	26		20	26		
		$R_L \geq$ 2 kΩ	Full range	20			20			
A_{VD}	Large-signal differential voltage amplification	$R_L \geq$ 2 kΩ, V_O = ±10 V	25 °C	50	200		25	200		V/mV
			Full range	25			15			
r_i	Input resistance		25 °C	0.3	2		0.3	2		MΩ
r_o	Output resistance	See Note 6	25 °C		75			75		Ω
C_i	Input capacitance		25 °C		1.4			1.4		pF
CMRR	Common-mode rejection ratio	$V_{IC} = V_{ICR}$	25 °C	70	90		70	90		dB
			Full range	70			70			
k_{SVS}	Supply voltage sensitivity ($\Delta V_{IO}/\Delta V_{CC}$)	V_{CC} = ±9 V to ±15 V	25 °C		30	150		30	150	μV/V
			Full range			150			150	
I_{OS}	Short-circuit output current		25 °C		±25	±40		±25	±40	mA
I_{CC}	Supply current (each amplifier)	No load	25 °C		1.7	2.8		1.7	2.8	mA
			Full range			3.3			3.3	
P_D	Power dissipation (each amplifier)	No load, V_O = 0 V	25 °C		50	85		50	85	mW
			Full range			100			100	
V_{o1}/V_{o2}	Channel separation		25 °C		120	0		120		dB

† All characteristics are measured under open-loop conditions with zero common-mode input voltage unless otherwise specified. Full range for uA747M is −55 °C to 125 °C and for uA747C is 0 °C to 70 °C.

NOTE 6: This typical value applies only at frequencies above a few hundred hertz because of the effects of drift and thermal feedback.

operating characteristics, V_{CC+} = 15 V, V_{CC-} = −15 V, T_A = 25 °C

PARAMETER		TEST CONDITIONS	uA747M MIN	uA747M TYP	uA747M MAX	uA747C MIN	uA747C TYP	uA747C MAX	UNIT
t_r	Rise time	V_I = 20 mV, R_L = 2 kΩ		0.3			0.3		μs
	Overshoot factor	C_L = 100 pF, See Figure 1		5%			5%		
SR	Slew rate at unity gain	V_I = 10 V, R_L = 2 kΩ, C_L = 100 pF, See Figure 1		0.5			0.5		V/μs

(Courtesy Texas Instruments)

Fig. 2. Typical specification sheet for a dual general-purpose op amp.

the following equation for Zin:

V2 = Vin [Zin/(Zin + R1)]
Zin = R1 × V2/(Vin − V2)

Using the results from above,

V1 = 0.5 volts p-p
V2 = 0.25 volts p-p

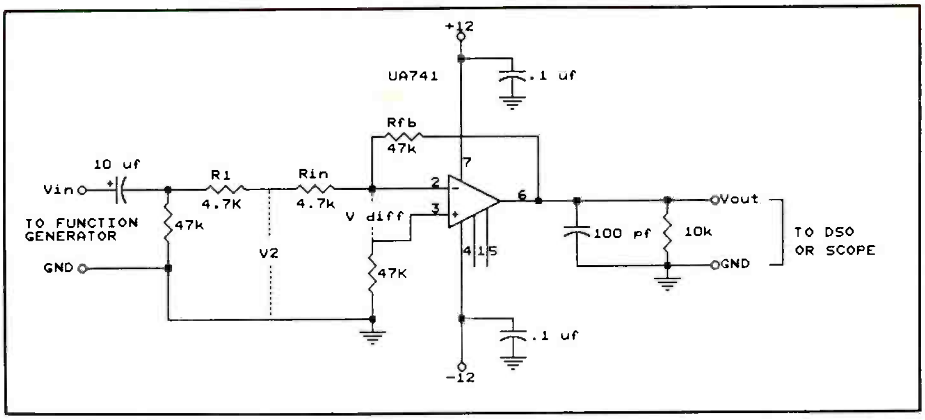

Fig. 3. Circuit arrangement to use for resistance test.

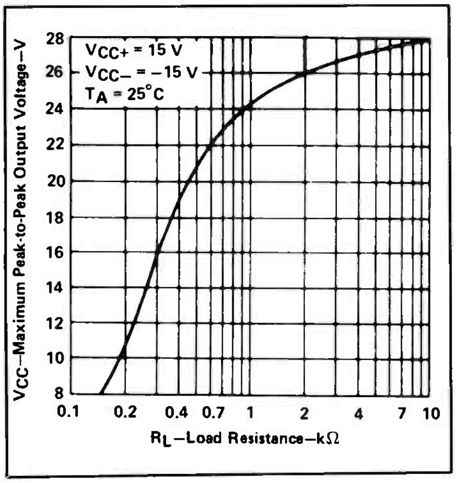

Fig. 4. Maximum peak-to-peak output voltage plotted against load resistance. (Courtesy Texas Instruments)

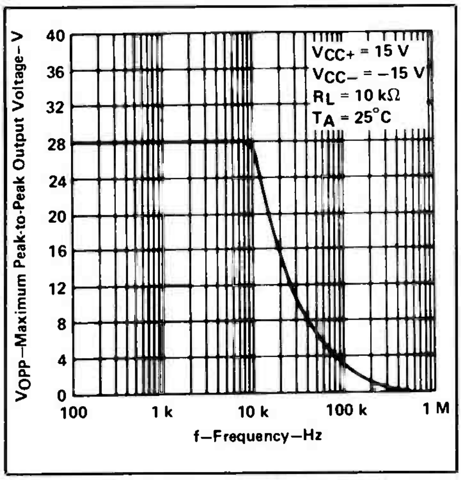

Fig. 5. Maximum peak-to-peak output voltage plotted against frequency. (Courtesy Texas Instruments)

R1 = 4,700 ohms
Zin = 4,700 ohms = Rin

This experiment verifies that the input resistance of an inverting amplifier is equal to the value of input resistor Rin, as derived earlier.

It's very important for you to know the amplifier input resistance because this resistance loads the driving amplifier.

4. *Measuring Undistorted Output Levels:* Reconnect the input as per Fig. 1. Connect the DSO to the output terminal (set sensitivity to 5 volts/division). You'll now measure the maximum undistorted p-p voltage before the waveform changes shape, relying on your eyes to detect distortion visually.

Increase the input until the output just begins to clip the top or bottom of the waveform.

(A) Measure the p-p output just below the clipping point_________

Compare the results with Fig. 4. Note that you're using a ±12-volt supply. This will reduce your maximum peak output to about 11 volts peak or 22 volts p-p.

5. *Measuring Output Vs. Load Resistance:* Referring to Fig. 1, change the value of the 10,000-ohm load resistor to 2,000 and then to 200 ohms. Measure maximum undistorted p-p output for all conditions.

Maximum voltage with:

(A) 10,000-ohm load resistor_______
(B) 2,000-ohm load resistor_______
(C) 200-ohm load resistor_______

Note that the value of the load resistor greatly affects the maximum output voltage swing.

6. *Measuring Output Vs. Frequency:* Now measure the maximum p-p output voltage as a function of frequency. Reconnect the 10,000-ohm load resistor to the output circuit. Increase input frequency and record the results (remember to decrease the timebase and increase sensitivity on your DSO as you increase the frequency).

(A) 1 kHz_______
(B) 10 kHz_______
(C) 50 kHz_______
(D) 100 kHz_______

(E) What happens to the distortion observed at frequencies beyond 10 kHz? _______

The triangular waveform produced when over-driving the output stage at higher frequencies reveals some of the idiosyncrasies of these seemingly simple but internally complicated circuits. This reinforces the need for you to bread board and test all new designs.

(F) Plot your results on a copy of Fig 5. and compare results.

Repeat this test by changing the value of the load resistor:

(G) You might also repeat these tests using a 200-ohm load resistor and plot the results. Can you guess what will occur? _______

7. *Measuring Transient Response:* Now measure the small-signal risetime of the circuit. Risetime and slew

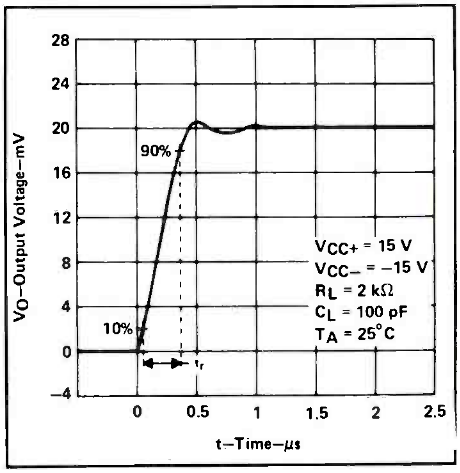

Fig. 6. Output voltage plotted against elapsed time. (Courtesy Texas Instruments)

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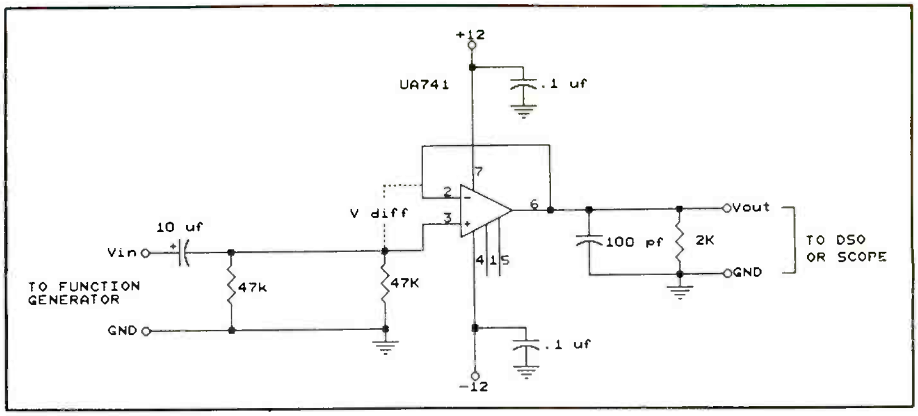


Fig. 7. A unity-gain voltage-follower.

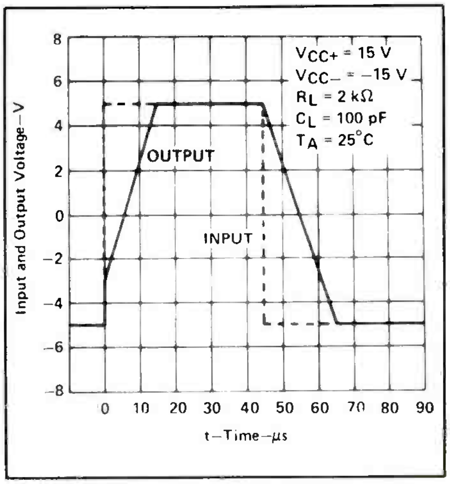


Fig. 8. Voltage-follower large-signal pulse response.
(Courtesy National Semiconductor)

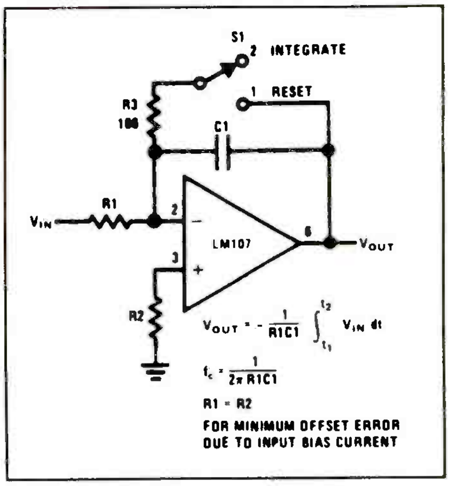


Fig. 9. An op-amp integrator circuit arrangement.
(Courtesy National Semiconductor)

rate are typically specified at unity gain. To change gain in the Fig. 1 circuit from 10 to unity (1), change the value of feedback resistor R_{fb} from 47,000 to 4,700 ohms.

(A) The new closed-loop gain = R_{fb}/R_{in} = ________

Set the Function Generator for a 100-kHz square-wave output. Adjust the input to obtain a 0.05-volt p-p signal at the output. (Set DSO sensitivity to 0.01 volt/division and timebase to 1.0 μs/division).

Measure the risetime (time it takes for the wave to go from a value 10% to 90% from the bottom). Reduce the input signal level and note that the risetime improves slightly.

(B) Measure risetime (microseconds) ________

Compare results to Fig 6. Note the slight overshoot is characteristic of this particular amplifier.

Change the value of R_{fb} back to 47,000 ohms and test the risetime again.

(C) Measure risetime (μs) ________

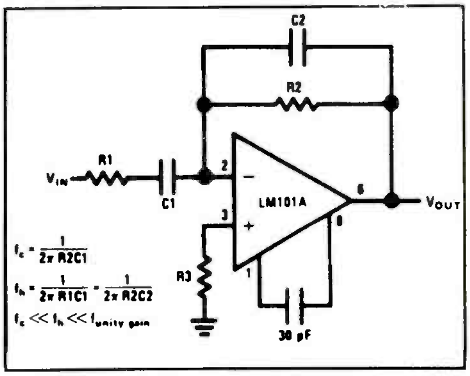
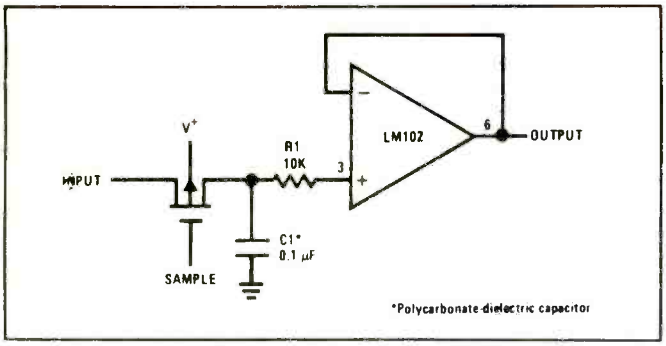
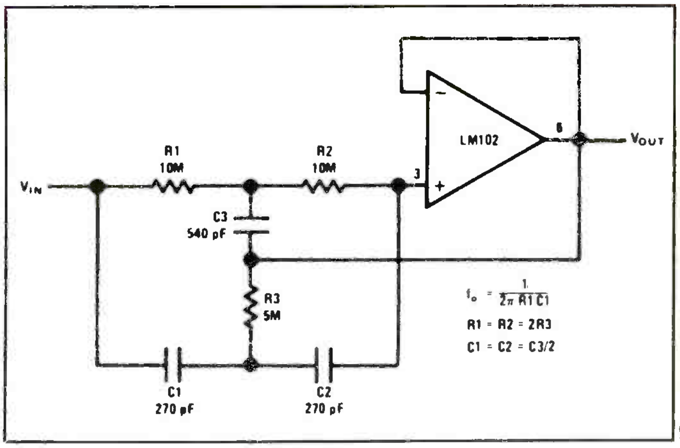


Fig. 10. An op-amp differential-input instrumentation amplifier circuit arrangement. (Courtesy National Semiconductor)



(Courtesy National Semiconductor)

Fig. 11. An op-amp sample-and-hold circuit arrangement.



(Courtesy National Semiconductor)

Fig. 12. A high-Q op-amp notch-filter circuit arrangement.

Risetime gets longer with greater gain because the frequency response, which amplifies all signals equally, is reduced as gain is increased.

8. *Measuring Slew Rate:* Using the Fig. 1 circuit, set the Function Generator to produce a 10-kHz square-wave signal. Set the sensitivity of your DSO to 5 volts/division and timebase to 20 μs/division. Increase the input to get the maximum p-p voltage at the output.

Slew rate is defined as the maximum rate of change of the output voltage per unit of time. You can determine slew rate by performing the following tests:

(A) Measure the change in output voltage__________

(B) Measure the time it took to produce the change__________

From these results, slew rate is obtained by dividing time in microseconds by output voltage (time/V_{out}).

(C) What is the slew rate of the amplifier with a gain of 10?__________

Note that the slew rate is very close to the 0.5 volt/microsecond specified in Fig. 2.

Now wire together the Fig. 7 circuit. This circuit is known as a voltage follower. Voltage gain is unity (1) because Vout is the same as V_{in} (assuming $V_{diff} = 0$). Use the same signals and DSO settings as above. Note the output waveform and compare it to that in Fig. 8.

(D) Slew rate (change in output voltage divided by time in microseconds, or ΔV/μs) of this circuit__________ (μs/ΔV)

Slew rate is less dependent on gain than risetime.

It should be obvious by now that test measurements must be made when designing and using op amps. The specification (data) sheet simply can't supply all the information needed to do a paper-only design. Therefore, you're encouraged to modify circuit component values as well as device types and redo the experiments. Recalculate gain and practice predicting results from the curves presented. Varying both and observing results, you'll be a pro in no time.

Other Uses

To encourage a continued interest in op-amp circuits, consider applications in Fig. 9 through Fig. 11 that appeared in a National Semiconductor *Linear Applications Handbook*. All circuits are wired using only op amps, resistors and capacitors.

To analyze the circuits, consider the impedance of capacitors as a function of frequency. Use the impedance of the combined circuits to estimate the gain and frequency response of the various sections of designs presented.

Integrator . . . Produces the mathematical process of integration (Fig. 9).
Differential input instrumentation amplifier . . . used to measure signals not referenced to ground (Fig. 10).
Sample-and-hold circuit . . . remembers what happened (Fig 11).
High-Q notch filter (Fig. 12).

You should now be able to analyze some of these circuits. You can build and test them, which is a great way to get to know them better, too.

(Answer Box on page 84)

Keyboard and Keystrokes
(Part 2)

More on a keystroke's trip to the screen of a video display monitor

Last month, I traced the first half of a keystroke's trip from your fingers to the screen. This month, I'll conclude by describing the rest of that journey. But first, a quick summary from last month's installment to bring newcomers up to speed.

When you press (or release) a key, the keyboard processor, a microprocessor inside the keyboard, senses the change in the status of keyboard switches. It sends a serial message to the keyboard controller, a dedicated microprocessor inside your computer. The keyboard controller compiles the serial signal into a byte and then signals a third microprocessor, the programmable interrupt controller. The interrupt controller waits until all hardware interrupts with greater priorities have been serviced and then forces your main microprocessor (the CPU) to perform a BIOS interrupt service routine, INT 09H.

The BIOS routine reads the byte received from the keyboard and, normally, translates the keystroke into its ASCII code. It places both the ASCII code and a key code into a type-ahead buffer. But before the codes are placed in the type-ahead buffer, several other things can happen. The BIOS interprets some codes as requests for internal services:

(1) Ctrl-Alt-Del (the "three-fingered salute") forces a warm reboot.

(2) Ctrl-Break (Ctrl-Scroll Lock on some systems) forces a break and a call to INT 23H.

(3) Pause (Ctrl-Num Lock on some systems) causes a pause.

(4) Shift-Print Screen calls INT 05H to print the data on the screen.

(5) SysReq makes a call to INT 15H, service 85H.

(6) The Shift, Caps Lock, Ctrl, Alt and Insert keys are used to update a shift-key table in memory instead of placing codes in the type-ahead buffer.

Also, INT 09H calls INT 15H, service 4F hex, the keyboard intercept, so that a user program can create an alternate keyboard layout or disable selected keys. I discussed some of the

Northgate is just one of many suppliers offering keyboards that are compatible with a wide variety of PC, XT, AT, 386 and 486 computers. This OmniKey/102 shows just one particular keyboard-layout arrangement. Others in the Northgate line offer different arrangements. (Courtesy Northgate Computer Systems).

intricacies of this keyboard intercept service last month.

When the INT 09 routine is ready to place a keystroke into the type-ahead buffer, it can't use the raw code it received from the keyboard. To keep the oldest PC and newest 486 as compatible as possible, the BIOS translates the scan codes for most keys to disguise the difference between keyboards. For example, the "A" key is key-number 30 on the original 83-key keyboard and key-number 31 on 84- and 101-key keyboards. In all cases, its code gets translated to 1E hex (30 decimal) when it's placed into the type-ahead buffer; so programs don't have to be concerned about which keyboard you are using.

INT 09 places two bytes in the type-ahead buffer for each keystroke: a scan code (possibly translated) and an ASCII code. A program can look at the scan code if it's interested in which key was pressed; it can look at the ASCII code if it's interested in the meaning of the key (to the human operator). The ASCII code is influenced by the state of the shift keys, but the scan code isn't.

An example will make this clearer (before it gets more confusing again). If you press an "A," a scan code of 1E hex is placed into the buffer. The ASCII code could be 41 hex (uppercase "A"), 61 hex (lower-case "a"), 01 hex (Ctrl-A) or 0 if you're holding down an Alt key. Most programs—like editors, database managers, spreadsheets, etc.—use the ASCII code and interpret "A" and "a" as different characters. A few programs, however, look at the scan code to see that you pressed the key in the second column of the third row on the keyboard. Also, whenever a program sees an ASCII value of 0, it knows that it must look at the scan code to decide whether you pressed a function key or Alt plus a letter or number.

Reading The Buffer

Keystrokes wait in the type-ahead buffer until DOS or a program asks for them. Virtually all key requests are made through BIOS interrupt INT 16H. If a program gets its input through a DOS service, DOS simply calls INT 16H. If the key has an ASCII value other than 0, DOS discards the scan code. Otherwise, it returns a 0

Table 1. Key Codes

```
/* This program displays the scan code and ASCII code for
 * every key you press.  It also shows the difference between
 * the codes returned by the enhanced and original keyboard
 * services.
 * Written for QuickC 2.5 but should be easy to convert to
 * other C compilers.
 */

#include <stdio.h>
#include <graph.h>
#include <bios.h>
#include <string.h>
#include <dos.h>

#ifndef TRUE
  #define TRUE 1
  #define FALSE 0
#endif

int support_101;

void check_support(void);

void main(void)
{
  unsigned kb_val;
  char v1[6], v2[6];

  check_support();                            /* Does BIOS support services */
                                              /* 0x10 & 0x11 of INT 0x16 ?  */
  _clearscreen(_GCLEARSCREEN);
  puts("Press ESC to end");
  puts("");
  puts("Keyboard Interrupt 16H Return Values");
  puts("");
  puts("Services      Services");
  puts("00h & 01h     10h & 11h");
  puts("");
  puts("Scan ASCII    Scan ASCII");
  puts("Code Code     Code Code");
  puts("---------     ---------");

  do {
     if (support_101)
        {
        do {
           kb_val = _bios_keybrd(_NKEYBRD_READY);    /* Wait for key          */
           } while (kb_val == 0);
        sprintf(v1,"%02x %02x",kb_val >> 8, kb_val & 0xff);
        kb_val = _bios_keybrd(_KEYBRD_READY);        /* Read via old serv.*/
        sprintf(v2,"%02x %02x",kb_val >> 8, kb_val & 0xff);
         if (kb_val)                                 /* Clear from buffer */
           kb_val = _bios_keybrd(_KEYBRD_READ);
        }
     else
        {
        strcpy(v1,"-- --");
        kb_val = _bios_keybrd(_KEYBRD_READ);
        sprintf(v2,"%02x %02x",kb_val >> 8, kb_val & 0xff);
        }
     printf("  %s         %s\n", v2, v1);
     } while ( (kb_val & 0xff) != 0x1b);             /* Loop until ESC    */
}

void check_support()
{
  union REGS regs;
  unsigned i;

  do {
     i = _bios_keybrd(_KEYBRD_READY);         /* Empty type-ahead buffer */
     if (i)
        i = _bios_keybrd(_KEYBRD_READ);
     } while (i);

  regs.h.ah = 5;                              /* Push dummy keystroke    */
  regs.x.cx = 0xffff;                         /* into buffer             */
  int86(0x16, &regs, &regs);

  if (regs.h.al != 0)                         /* Did push succeed?       */
     {
     support_101 = FALSE;                     /* No support available    */
     return;
     }

  if (_bios_keybrd(_NKEYBRD_READ) == 0xffff)
     support_101 = TRUE;                      /* Was our key there?      */
  else
     support_101 = FALSE;
}
```

and returns the scan code on the next keyboard request.

INT 16H provides eight services, but only half are relevant to this discussion. Service 0 reads the next keystroke in the type-ahead buffer. If no key code is in the buffer, it waits until one is ready. When it returns a keystroke, it removes it from the buffer. Service 1 looks to see if a key is waiting in the buffer. If it is, the key is returned. Service 1 doesn't remove the key code from the buffer; it simply peeks to see if a key code is waiting and, if so, reports what key code will be retrieved next. Both services return the ASCII code in the AL register and the (translated) scan code in the AH register.

Services 0 and 1 were available on the original PC and support both 83- and 84-key keyboards. Several older programs assume that they're running on such a computer and can crash if they receive a key code, such as that for F11 or F12, that wasn't available on those keyboards. So when services 0 and 1 are used with a 101-key keyboard, they make the computer look like it's connected to an 83-key keyboard. These services change the codes of keys on the cursor keypad to mimic the older numeric/cursor combined keypad. And they discard completely key codes like those for F11 and F12 that can't be mapped to the older keyboards.

Programs that want to see all of the keys on a 101-key keyboard use services 10 hex and 11 hex instead of 0 and 1. These are identical to the early services, but they don't hide special keys of the newer keyboard. They also permit programs to distinguish between keys that are duplicated on the newer keyboard.

There's a "gotcha" lurking in these two sets of services that can cause unwary programs to function erratically. DOS checks the keyboard during input/output services to see if the user has pressed Ctrl-C. Through version 3.x, DOS used keyboard services 0 and 1 to do the checking. A program could use services 10 hex and 11 hex but still not see an extended key code because an intervening DOS call to service 1 had erased it.

Also, if you use ANSI.SYS or one of its many clones to redefine the keyboard, you may find that you can't create definitions for the F11 and F12 keys under DOS 3.x or earlier. The reason is the same: calls to keyboard services 0 and 1 are effectively disabling those and other special keys.

Making a Correction

To see the effect of all this, and to enable extended keys for ANSI.SYS and all other programs, you have to write two small programs. The first, written in C, shows two values for each keystroke: the value available from services 0 and 1 (keyboard input and keyboard status) and the value available from services 10 hex and 11 hex (extended keyboard input and status). The program begins by checking your BIOS to see if your computer supports the extended services. If so, it reads each key code by calling service 11 hex first (to get the extended value) and then service 1 to get the standard value. If the standard service hasn't obliterated the waiting keystroke, the program ends each loop by making a call to service 0 to clear the keystroke from the type-ahead buffer.

The second program, written in assembly language, keeps DOS and other programs from clobbering extended keystrokes stored in the type-ahead buffer. It intercepts all calls to keyboard services 0 and 1 and replaces them with calls to services 10 hex and 11 hex.

The second program is written as a small, memory-resident utility. Once you run it, the first program will no longer show any differences between extended and normal services, since all normal-service calls will be translated to extended calls.

Almost all applications will get along with the second program without any problems, but be careful. If you decide to use it regularly—perhaps to use ANSI.SYS key definitions with F11 and F12—test your application programs thoroughly. Run each with dummy data and press the extended keys to see what happens. Most programs that don't accept F11 and F12, along with the Alt, Ctrl and

Table 2. 101-Key Support

```
comment |
   Memory-resident program that translates Int 16H keyboard
  request services 0 and 1 to 10h & 11h to provide support
  for 101-key keyboard in DOS and other programs.
   Warning!  This program may crash a few older applications.
  Test your applications with dummy data until you are sure
  that they are compatible with this program.

  Written for MASM 5.1 and the QuickC 2.5 assembler.
  Save as: KEY101.ASM
  Compile: MASM KEY101;
           LINK KEY101;  (ignore stack warning)
          EXE2BIN KEY101.EXE KEY101.COM
        |

cseg    segment
        assume cs:cseg, ds:nothing, es:nothing
        org 100h                        ;COM file format

start: jmp short install

old_16 = this   dword                   ;Old Int 16h address
old_off         dw      ?
old_seg         dw      ?

new_16:         pushf                           ;Save the flags
        cmp     ah,02h                  ;Call 0 or 1?
        jae     go_old                  ;No -- go
        or      ah,10h                  ;Translate call
go_old:         popf
        jmp     dword ptr cs:[old_16]   ;Jump to original Int 16h

                                        ;End of memory-resident program

        assume cs:cseg, ds:cseg, es:cseg
install:
  @@:   mov     ah,01                   ;Is key waiting?
        int     16h
        jz      @F                      ;Go if no key is waiting
        mov     ah,0                    ;Else get the key
        int     16h
        jmp     @B                      ;  and try again
```

```
@@:     mov     ah,05h                  ;Push dummy keystroke
        mov     cx,0ffffh               ;  of FFFF hex
        int     16h                     ;  into type-ahead buffer
        cmp     al,0                    ;Did function succeed?
        jne     no_support              ;No -- go
        mov     ah,10h                  ;Now read the dummy keystroke
        int     16h
        cmp     ax,0ffffh               ;Is it the same?
        jne     no_support              ;No -- go

        mov     ax,3516h                ;Get Int 16h vector
        int     21h                     ;  via DOS
        mov     old_off,bx              ;Save the address
        mov     old_seg,es
        mov     ax,2516h                ;Set new Int 16h vector
        mov     dx,offset new_16        ;DS:DX have new vector address
        int     21h                     ;Set new vector

        mov     ah,09h                  ;Display a string
        mov     dx,offset ok            ;DS:DX ==> message
        int     21h
        mov     dx,offset install       ;End of memory-resident code
        int     27h                     ;Exit but leave code in memory

no_support:
        mov     ah,09h                  ;Display a string
        mov     dx,offset nope          ;DS:DX ==> message
        int     21h
        mov     ax,4cffh                ;Exit with error code
        int     21h

ok      db      'Enhanced Keyboard Handler Succeessfully Installed$'
nope    db      'This computer does not support an enhanced keyboard',13,10
        db      'Program aborted.'


cseg    ends
        end start
```

Shift versions of each, simply ignore them; a few crash. You'll have to decide whether you can use this program safely on your computer.

Both programs show how to determine if a computer supports services 10 hex and 11 hex, along with service 5, which puts a keystroke into the keyboard buffer. The technique I've used is adapted from an algorithm suggested by Phoenix Technologies, makers of the Phoenix BIOS used in so many compatible computers.

The Last Step

Once a keystroke has been read from the type-ahead buffer, most programs echo it to the screen. There's no requirement that each keystroke appear on-screen, but most programs let the operator see and correct keystrokes.

The video adapter and its BIOS are as complicated as any other subsystem in the computer. We'll leave the inner workings of the various chips and modes for another time and look briefly at two common ways that programs use to display a character in text mode.

The easiest way, and the one that DOS uses to display each character that you type at the DOS prompt, is to delegate the job of displaying the character. DOS makes a call to the video BIOS through software interrupt 10 hex and passes it the character to display. The computer's built-in BIOS provides support for monochrome and CGA adapters; Hercules, EGA, VGA, 8514/a and more-advanced adapters substitute their own BIOSs, which typically provide many more services. The extended video BIOSs are tailored to manage the special features of each adapter.

Displaying characters through the BIOS is relatively slow in text modes and painfully slow in graphics modes. Virtually all modern commercial software ignores the BIOS and manipulates video memory directly. Most modern compilers, including Quick BASIC, Turbo Pascal, and popular C and C++ implementations, have built-in routines to print directly to the screen. Programs with pull-down menus, pop-up windows and other elements of modern user interfaces are almost forced to manipulate memory directly to keep from embarrassing slowness.

In text modes, each word (two bytes) of video memory contains one character plus its display attributes. The attributes determine the character's foreground and background colors, intensities and whether the character blinks. On some adapters, the attribute can also specify an underlined character and/or a character selected from an alternate font.

The attribute is stored in one byte; the other byte contains the character's ASCII value. Electronics on the video card translates the two bytes into the correct sequence of pixels several times each second and send the pixel information to the monitor.

Whether a program writes directly to video memory or uses video BIOS services, each time a character is displayed, one or more bytes of video memory is changed. The video electronics displays the entire screen 60 or more times per second. The next time the video electronics displays the altered screen position, a new character appears on-screen. The job of translating stored attribute and character codes to actual colored pixels is performed entirely by electronics on the video adapter card on all DOS machines; so the CPU can get on with other business.

Replacing a Keyboard

We've followed the path from keypress to character display and explored some of its quirks and intricacies. If you're faced with a balky or inoperative keyboard, you now should have some ideas of what to check and why. The most common failures occur in the keyboard itself, either because of bad or dirty switches or because of coffee or other liquid spilled into the keyboard electronics. If you find that you must replace the keyboard on a computer, I hope these two articles have given you the necessary background to ask the right questions before you buy.

Your first and most important choice is whether to buy an older

83-key (PC and XT) keyboard, 84-key (early ATs) or 101-key enhanced keyboard. Your choice is limited by what the computer can accept. Since the keyboard processor is different in all three, don't try to change from one model to another unless you're sure that your computer can handle the change.

Several companies offer replacement keyboards. You'll find two major differences between the ones available. First, the arrangement of keys is anything but standard. Some keyboards have a large Enter key, some have a small one. Unusual keys like the backslash, tilde, etc., seem to be scattered almost anywhere. Some 101-key keyboards have the function keys on the left instead of the top and some have an added F13 and F14 key.

Second, the type of key switches and, therefore, the "feel" of the keyboard changes from one manufacturer to another. The feel and amount of click is important to many touch typists. I can't suggest what brand or model you'll like best because each typist has personal preferences. I can only suggest that you find a dealer who'll let you type on several different keyboards until you find one that you really like.

Finally, some keyboards have extra features built into them. One manufacturer includes a simple four-function calculator in the numeric keypad; another has an optional trackball that can replace the cursor keypad. These special features often raise the cost of a replacement keyboard from a plain-vanilla price of $60 or $70 to well over $100. You can buy a lot of four-function calculators for the difference, and even glue them to your keyboard, if you want.

If you aren't sure what kind of keyboard a computer needs, you can find some that have a switch that makes them compatible with 83-key PCs and XTs or with 101-key ATs and 386s. And if you have a keyboard that doesn't work with your computer even though you think it should, look for such a switch on the bottom of the keyboard case or, occasionally, under the trademark label. When you buy a new keyboard, especially by phone or mail, make sure that the company will accept a return if, for some reason, the keyboard is incompatible with your computer.

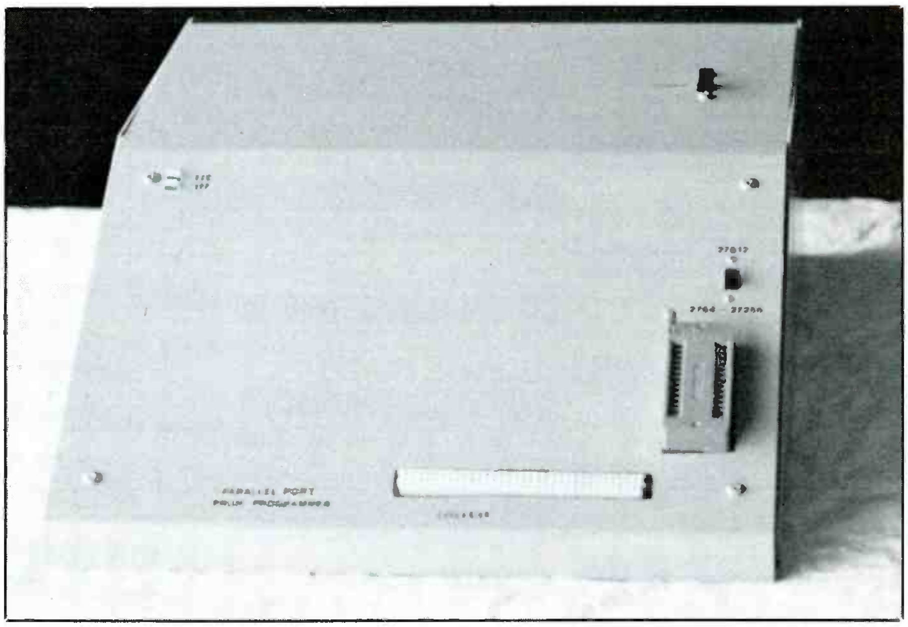
You should find that almost any manufacturer's keyboard will work with your computer if it follows the correct keyboard specifications (83-, 84- or 101-key) and has the correct plug. The few exceptions are unusual computers, like the old Tandy 1000 in my closet and some laptops that have external keyboard connectors. If you think your computer may fit into the "unusual" category, call the manufacturer and find our what kind of replacement you should buy.

To a fast touch-typist, the keyboard is the most important part of the computer. If the keys don't feel right and work reliably, a user may think the entire computer is misbehaving. This two-month keystroke tour of the computer should give you some insight into how the computer makes a complex process seem simple and intuitive, to both users and programmers. ■

A Parallel-Port EPROM Programmer

(Part 1)

Lets you program EPROMs through the parallel port of your computer without having to spend a bundle on hardware



Most commercial EPROM programmers are designed to plug into an RS-232 serial port on a computer. Because such programmers contain an embedded microprocessor, they are expensive. The build-it-yourself Parallel-Port EPROM Programmer to be described plugs into the Centronics-compatible parallel printer port of an IBM PC or compatible and uses the PC itself for the processor, which considerably reduces the cost of the hardware needed for programming EPROMs. With this project, all EPROM programming is controlled by the computer, and upgrading to new devices involves just a change to the driving program.

Our Parallel-Port EPROM Programmer can program 2764 through 27512 EPROMs. It has an expansion connector for connecting other programmable devices. The project verifies EPROMs after programming and can read an EPROM into a disk file. It reads binary, Intel Hex and extended hex files.

PROM Programming

An EPROM contains an array of transistors, each of which has a "floating" gate. Until an EPROM is programmed, the output of each transistor is a logic 1. To convert a transistor output to a 0, a charge is added to the gate. Then to convert the outputs back to 1s, the transistors must be exposed to ultraviolet light through a transparent window at the top of the EPROM. There is no way to program a 0 bit back to a 1 bit; 0s can be changed to 1s only by erasing the entire EPROM.

A problem with programming EPROMs is the time it takes to force the charge onto the transistors in the memory array. For older EPROMs, such as the 2716 (16K), programming required 50 milliseconds per byte (address), which results in a programming time of 102 seconds (2,048 bytes × 50 ms/byte). This is no problem for small EPROMs, but as device memory capacity becomes larger, programming time becomes excessive.

As an example of the foregoing, a 27512 EPROM would take almost an hour to program at 50 ms/byte (64K × 50 ms/byte). For this reason, PROM manufacturers have implemented faster programming algorithms for the larger devices. These algorithms involve applying a programming voltage to the EPROM, programming the location and then verifying the location. If the byte fails to program, another programming pulse is applied and another byte check is made. When the byte successfully programs, a longer "over-program" pulse is applied to the EPROM, after which the next location is programmed.

Different manufacturers vary the programming voltage, pulse width and over-program pulse. However, all manufacturers use basically the same method. Table 1 gives typical programming times for the Parallel Port Programmer.

Our Parallel Port PROM Pro-

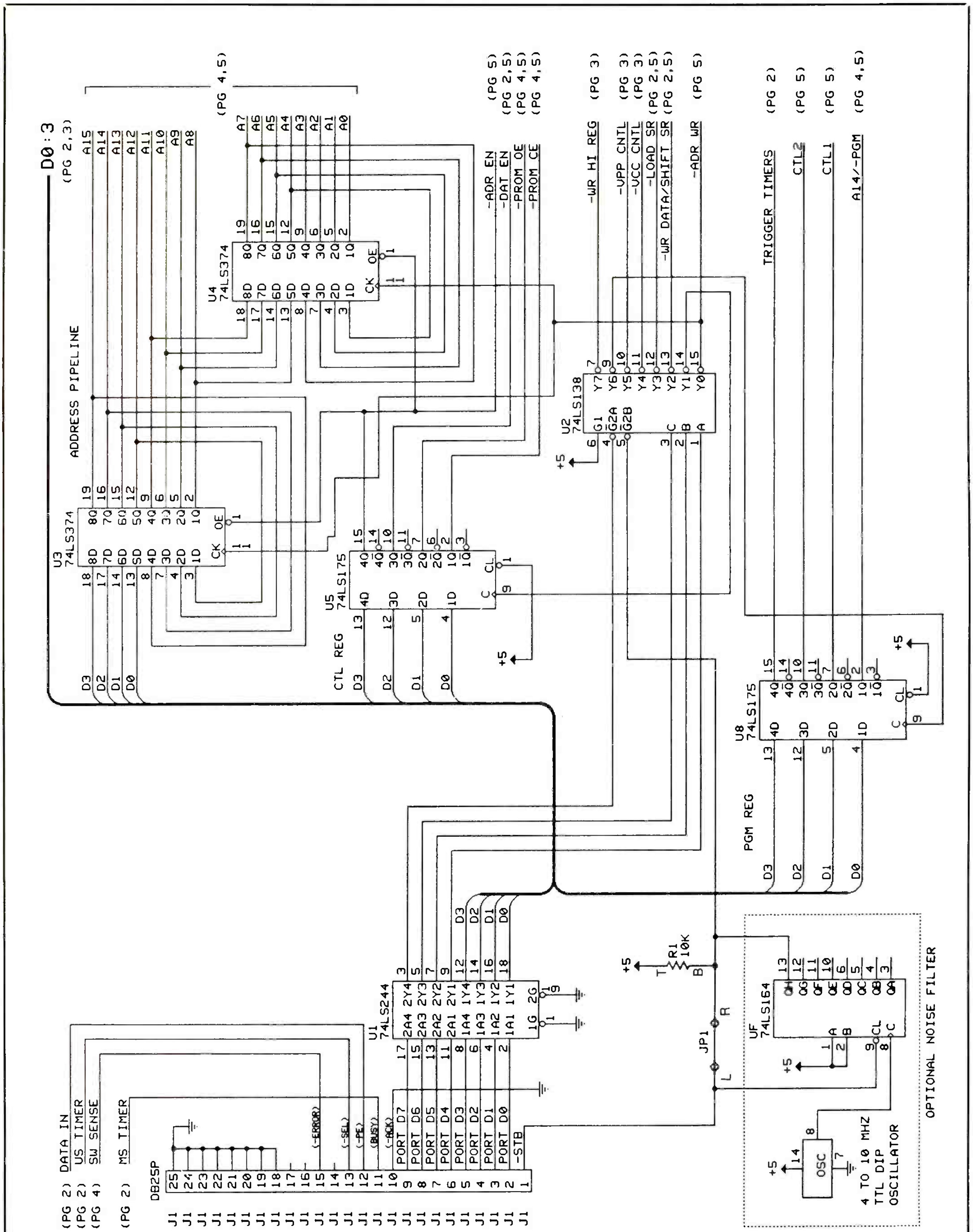
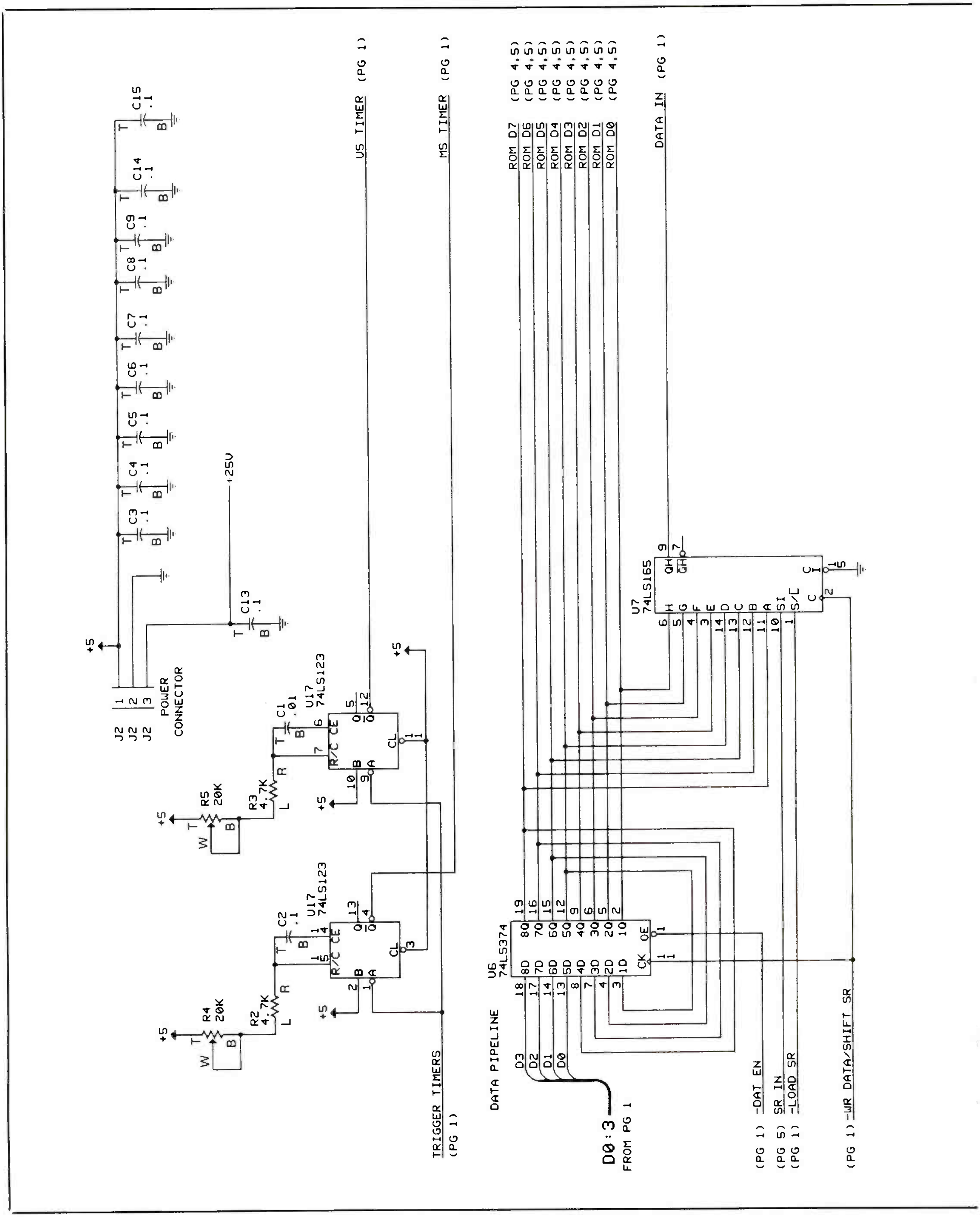


Fig. 1(A).

Fig. 1. The schematic diagram of the basic Parallel-Port EPROM Programmer is shown here in five parts.



US TIMER (PG 1)
MS TIMER (PG 1)
ROM D7 (PG 4,5)
ROM D6 (PG 4,5)
ROM D5 (PG 4,5)
ROM D4 (PG 4,5)
ROM D3 (PG 4,5)
ROM D2 (PG 4,5)
ROM D1 (PG 4,5)
ROM D0 (PG 4,5)
DATA IN (PG 1)
+25V
C13 .1
J2 J2 J2
POWER CONNECTOR
U7 74LS165
U17 74LS123
U6 74LS374
R5 20K
R3 4.7K
R4 20K
R2 4.7K
C1 .01
C2 .1
TRIGGER TIMERS (PG 1)
DATA PIPELINE
D0:3 FROM PG 1
(PG 1) -DAT EN
(PG 5) SR IN
(PG 1) -LOAD SR
(PG 1) -WR DATA/SHIFT SR

Fig. 1(B).

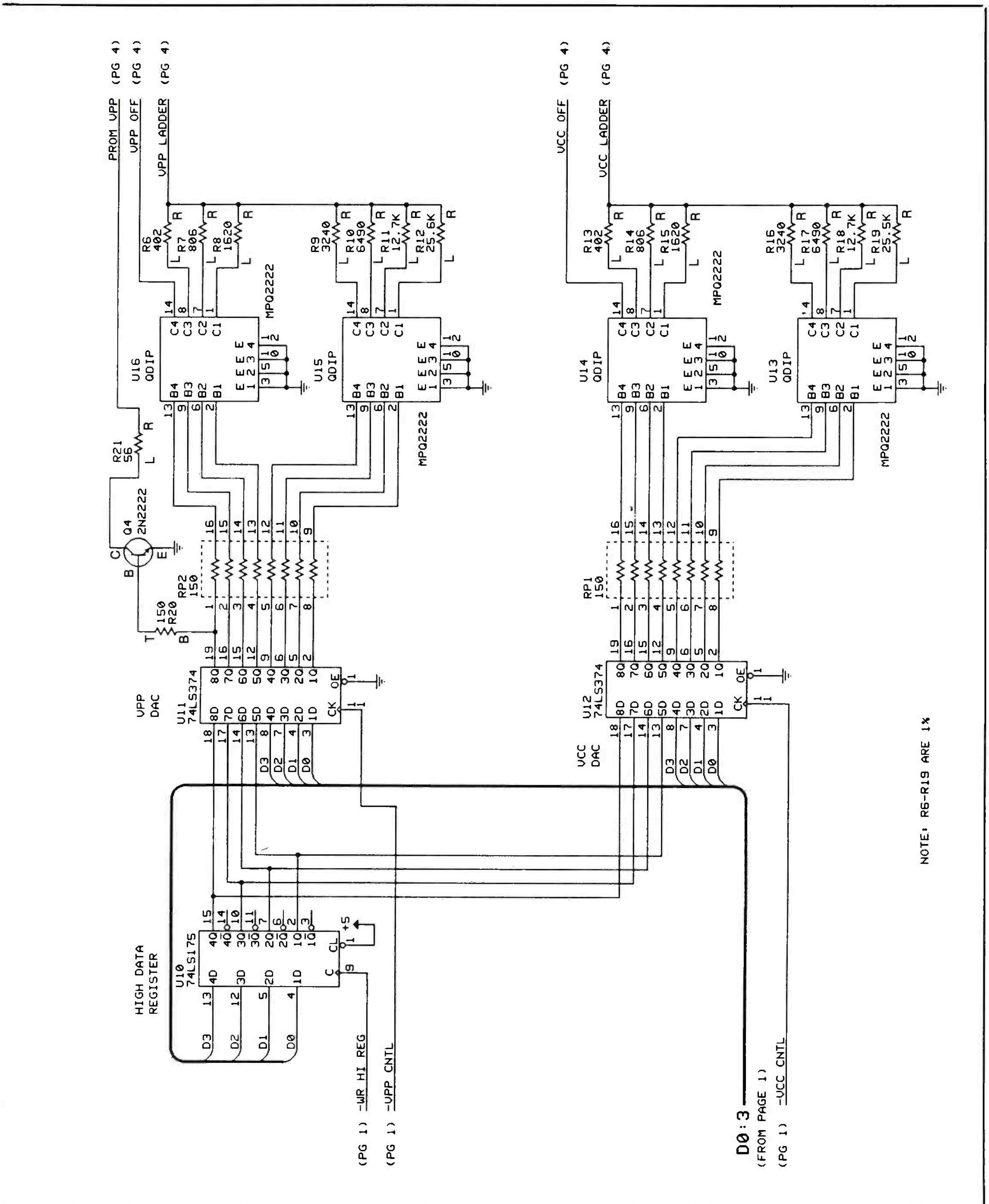
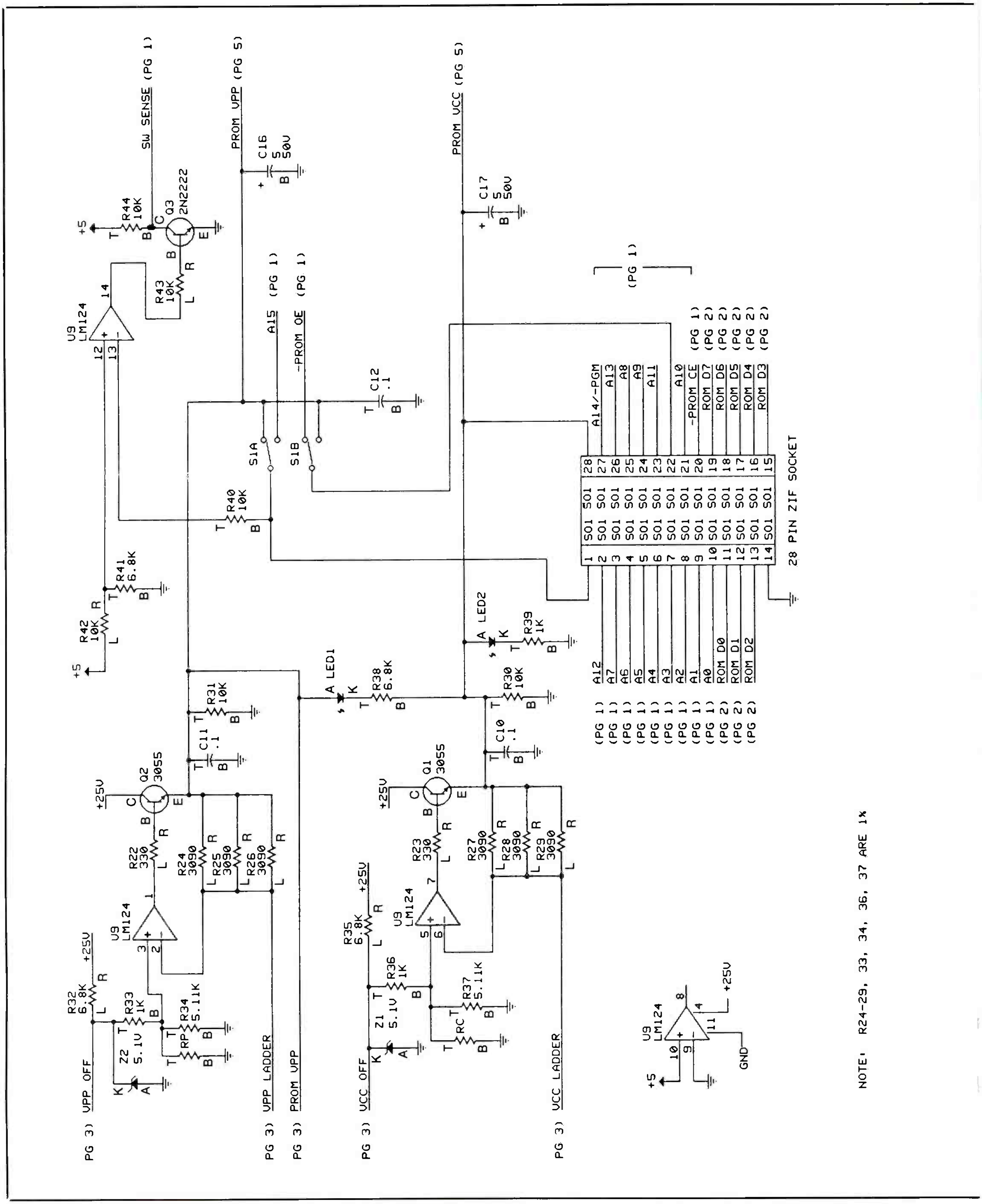

PROM VPP (PG 4)
VPP OFF (PG 4)
VPP LADDER (PG 4)
VCC OFF (PG 4)
VCC LADDER (PG 4)
R6 402
R7 806
R8 1620
R9 3240
R10 6490
R11 12.7K
R12 25.6K
R13 402
R14 806
R15 1620
R16 3240
R17 6490
R18 12.7K
R19 25.5K
U16 QDIP
U15 QDIP
U14 QDIP
U13 QDIP
MPQ2222
R21 56
Q4 2N2222
RP2 150
RP1 150
R20 150
VPP DAC
U11 74LS374
VCC DAC
U12 74LS374
HIGH DATA REGISTER
U10 74LS175
NOTE: R6-R19 ARE 1%
(PG 1) -WR HI REG
(PG 1) -VPP CNTL
D0:3
(FROM PAGE 1)
(PG 1) -VCC CNTL

Fig. 1(C).



SW SENSE (PG 1)
PROM UPP (PG 5)
PROM VCC (PG 5)
R44 10K
Q3 2N2222
U9 LM124
R43 10K
C16 5 50V
C17 5 50V
A15 (PG 1)
-PROM OE (PG 1)
C12 .1
S1A
S1B
R40 10K
R41 6.8K
R42 10K
LED1
LED2
R38 6.8K
R39 1K
R30 10K
R31 10K
C11 .1
C10 .1
Q2 3055
Q1 3055
+25V
R22 330
R23 330
R24 3090
R25 3090
R26 3090
R27 3090
R28 3090
R29 3090
R32 6.8K
R33 1K
R34 5.11K
R35 6.8K
R36 1K
R37 5.11K
Z1 5.1V
Z2 5.1V
RP
RC
PG 3) UPP OFF
PG 3) UPP LADDER
PG 3) PROM UPP
PG 3) VCC OFF
PG 3) VCC LADDER
28 PIN ZIF SOCKET
A14/-PGM
A13
A8
A9
A11
A10
-PROM CE (PG 1)
ROM D7 (PG 2)
ROM D6 (PG 2)
ROM D5 (PG 2)
ROM D4 (PG 2)
ROM D3 (PG 2)
(PG 1) A12
(PG 1) A7
(PG 1) A6
(PG 1) A5
(PG 1) A4
(PG 1) A3
(PG 1) A2
(PG 1) A1
(PG 1) A0
(PG 2) ROM D0
(PG 2) ROM D1
(PG 2) ROM D2
GND
+5
NOTE: R24-29, 33, 34, 36, 37 ARE 1%

Fig. 1(D).

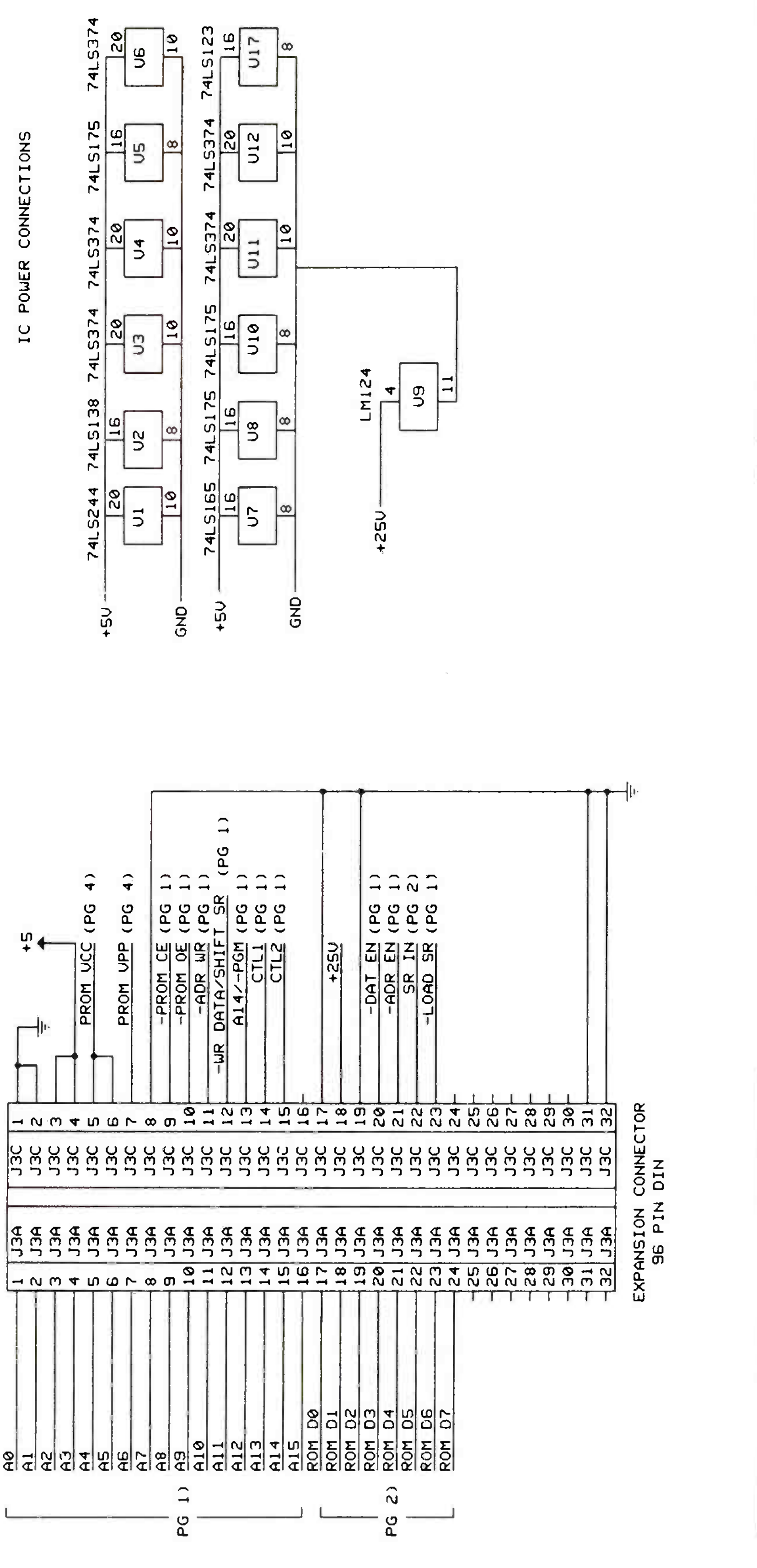


Fig. 1(E).

grammer programs 2764, 27256 and 27512 EPROMs, plus 8K NVRAMs. With the exception of two switches, all control of the Programmer is performed via the keyboard and display is via a PC. A 28-pin ZIF socket is provided for the EPROM to be programmed. A 64-pin expansion connector permits personality modules to be used for programming other devices, such as single-chip microprocessors and programmable logic devices. The control software for the project is structured for easy upgrades to other device types.

The normal parallel printer port interface on the PC includes eight data lines, a strobe, some control signals and some status lines. The Programmer requires a way to access 16 bits of address, eight bits of data, control for the programming and EPROM supply voltages, and several EPROM control lines. To do this, the normal printer port interface lines must be redefined by splitting the eight-bit data bus into four data bits and four address bits. The status and control lines are redefined to match the required functionality of the Programmer.

One problem with the PC printer port is that is intended to only output data. No provision is made for data input. However, the fast EPROM programming algorithms require that the EPROM data be read back for verification. Our Programmer accomplishes this by loading the data into a shift register and shifting it serially into one of the printer-port status lines. Table 2 lists the printer-port pins and how they are defined in the Programmer.

About the Circuit

The Parallel-Port EPROM Programmer circuitry consists of: a printer-port interface, PGM register, CTL register, address pipeline, data pipeline, data shift register, timers, V_{pp}/V_{cc} D/A and control, ZIF socket, expansion connector and a power supply. Its circuitry is shown schematically in Fig. 1.

The printer-port interface consists of *U1* and *U2*. Chip *U1* is a buffer for the four data and four address lines. Chip *U2* is a 74LS138 that decodes the address lines to generate eight control strobes for the various regis-

PARTS LIST

Semiconductors
LED1,LED2—Light-emitting diode
OSC—2- to 4-MHz TTL DIP oscillator (optional for noise filter—see text)
Q1,Q2—MJE3055 npn silicon power transistor
Q3,Q4,Q5—2N2222 general-purpose npn silicon transistor
U1—74LS244 tri-state octal line driver
U2—74LS138 expandable 3-to-8 decoder
U3,U4,U6,U11,U12—74LS374 tri-state octal D flip-flop
U5,U8—74LS175 quad D flip-flop
U7—74LS165 eight-bit parallel/in serial out shift register
U8,U10—74LS175 quad D flip-flop
U9—LM324 quad operational amplifier
U13 thru U16—MPQ2222 quad 2N2222 in DIP package
U17—74LS123 dual monostable multivibrator
UF—74LS164 eight-bit parallel out shift register (optional for noise filter —see text)
Z1,Z2—1N751 or similar 0.5-watt zener diode
Capacitors
C1—0.01-μF Mylar
C2—0.1-μF Mylar
C3 thru C11,C13,C14,C15—0.1-μF
C12—Not used
C16, C17—5-μF, 50-volt electrolytic
Resistors (¼-watt)
(5% tolerance)
R1,R40,R42,R43,R30,R31,R40,R42, R43,R44—10,000 ohms
R2,R3—4,700 ohms
R20—150 ohms
R21—56 ohms
R22,R23—330 ohms
R32,R35,R38,R41—6,800 ohms
R39—1,000 ohms
(1% tolerance)
R6,R13—402 ohms
R7,R14—806 ohms
R8,R15—1,620 ohms
R9,R16—3,240 ohms
R10,R17—6,490 ohms
R11,R18—12,700 ohms
R12,R19—25,500 ohms
R24 thru R29—3,090 ohms
R33,R36—1,000 ohms
R34,R37—5,110 ohms
R4,R5—20,000-ohm, 10-turn pc-mount trimmer potentiometer
RP1,RP2—150- to 1,000-ohm eight-position resistor network in DIP package (see text)
Miscellaneous
J1—DP-25P connector (consists of IDC DB-25P, 26-conductor ribbon cable, 26-pin IDC socket and 26-pin header)
J2—Three-pin MTA connector
J3—96-pin DIN connector (T&B Ansley No. FC096-031-3 or AMP No. B532504-1)
S1—Dpdt slide or toggle switch
SO1—28-pin ZIF DIP socket
Double-sided printed-circuit board or perforated board with holes on 0.1″ centers and suitable Wire Wrap or soldering hardware (see text and Note below); sockets for all DIP devices; heat sinks for Q1 and Q2 (see text); small-diameter heat-shrinkable tubing; suitable enclosure (see text); components for power supply (see Fig. 2); terminal strips; rubber grommet; spacers; machine hardware; hookup wire; solder; etc.

Note: The following items are available from Stuart R. Ball, 741 Okie Ridge, Yukon, OK 73099: ready-to-wire double-sided pc board with plated-through holes, $60; software on 5¼″ DSDD diskette, $11.50. Oklahoma residents, please add state sales tax. For copies of the etching-and-drilling guides for both sides of the printed-circuit board, send a SASE (25 cents postage) to: Modern Electronics, PC Guides, 76 N. Broadway, Hicksville, NY 11801.)

ters in the circuit. The four address lines are decoded as follows:

Address	Function
0000	Write data to address pipeline
0001	Write data to control register
0010	Write data to data pipeline
0011	Load data shift register
0100	Load V_{cc} control register
0101	Load V_{pp} control register
0110	Write data to control register
0111	Write data to V_{pp} and V_{cc} high nybble register
1XXX	Not used

PGM register *U8* controls the PGM bit on the ZIF socket into which the EPROM plugs. It also generates a control-line signal that triggers the timers.

CTL register *U5* controls the OE and CE pins on the ZIF socket and enables the tristate outputs of the address and data pipelines.

The address pipeline, made up of *U3* and *U4*, is a pair of 74LS374 octal D-type flip-flops. This pipeline is the mechanism that converts the four-bit data bus to the 16 bits required to address the EPROM. It is a four-stage shift register in which each stage is four bits wide.

Data written to the address pipeline appears at EPROM address bits A12 through A15, the four bits of which drive the inputs to A8 through A11. A second write causes the data on A12 through A15 to be shifted to A8 through A11, with the new data appearing at A12 through A15. Outputs A8 through A11 drive inputs A4 through A7, and outputs A4 through A7 drive inputs A0 through A3. After four writes, the original data is shifted to A0 through A3, and the subsequent data is shifted to the correct outputs.

Structuring the pipeline in this manner allows it to be expanded to as many bits as needed to address larger devices, by cascading additional address registers on lines A0 through A3. Note that the tristate outputs of the address pipeline registers must be enabled for the data to be shifted down.

Data pipeline *U6* is the same as the address pipeline. The least-significant four data bits are written first. Expansion to 16-bit EPROMs can be accomplished by cascading another pipeline register with the first.

Data shift register *U7* is a 74LS165 eight-bit shift register. Data is loaded into *U7* by one of the address decodes from *U2*. The shift register is shifted each time data is written to the data pipeline. The output of the shift register connects to one of the printer port status bits (–PE).

Two timers are used in this project. Each uses a half of *U17*, a 74LS123 dual one-shot multivibrator. The timers are triggered by a bit in the CTL register, and the outputs connect to two of the status bits on the printer port. At pin 12 of *U17* appears a 100-microsecond pulse when this timer is triggered, and pin 4 of *U17* provides a 1-millisecond pulse when the timer is triggered.

The V_{pp} and V_{cc} D/A and control provides the V_{cc} and V_{pp} voltages to

the ZIF socket. The D/A (digital-to-analog) converter uses a resistor network, switching transistors, an op amp and a pair of registers. Separate D/A converters are provided for the V_{PP} and V_{CC} voltages.

The V_{CC} control circuitry consists of *U12*, resistor pack *RP1*, *U14*, *U13*, *R13* through *R19* and the circuitry connected to pins 5, 6 and 7 of *U9* pins 5,6, and 7. A value written to 74LS374 *U12* turns on transistors in *U13* and *U14* (these two chips are quad 2N2222 transistors in a standard IC DIP package). The transistors drive 1-percent-tolerance resistors that are arranged in a voltage divider to control the gain of the *U9/Q1* combination.

If the most-significant bit of *U12* is written to a 1, it turns on a transistor that shorts voltage-reference zener diode *Z1* to ground. This turns off the V_{CC} output.

The D/A register requires eight bits to provide sufficient resolution. Since the data bus is only four bits wide, it must be expanded to eight bits. This is accomplished with the 74LS175 *U10* quad D-type flip-flop. The high four bits of D/A data are written to *U10*, and then the lower four bits are written to *U12*. D/A data is composed of four bits from *U10* and the four data bus bits.

The V_{PP} control circuitry functions the same way as the V_{CC} control circuitry, except that turning off the voltage also drives the V_{PP} output to ground. This is necessary because the 27512 EPROM shares the V_{PP} voltage pin with the OE output enable function.

The switching transistors of the V_{PP} and V_{CC} D/As each drive a resistor network. In turn, this controls the gain of the voltage control op amps. If all transistors are off (register value = 0), the output voltage will be the 4.2-volt reference potential. Each bit turned on adds an incremental voltage to the output. Table 3 lists the voltages each bit adds, while Table 4 lists the values that must be written to the D/A to generate typical EPROM programming voltages.

Activity of the V_{CC} and V_{PP} circuitry is indicated by a pair of light-emitting diodes. Turn-on of *LED1* indicates that the V_{PP} voltage is greater than the V_{CC} voltage. Turn-on of *LED2* indicates when V_{CC} is on.

Table 1. Typical EPROM Programming Times

EPROM Type	Capacity	Programming Time At 50 ms/Byte	Programming Time Fast Method
764	8K × 8	7 minutes	45 seconds
27256	32K × 8	27 minutes	3 minutes
27512	64K × 8	54 minutes	10 minutes

ZIF socket *SO1* has 28 pins for the PROM to be programmed or read. Dpdt switch *S1* permits switching between the EPROM types 2764 through 27256 and EPROM type 27512. This switch is needed because 2764 through 27256 EPROMs have V_{PP} on pin 1, while the 27512 shares V_{PP} with OE on pin 22. The *U9/Q3* combination is used by the control software to sense when the switch is in the correct position for the EPROM to be programmed.

The 96-pin DIN-type expansion connector identified as *J3* permits personality cards to be plugged into the project for programming devices that are not supported by the 28-pin ZIF socket. This connector provides signals to permit expansion of the address and data pipelines and the data shift register.

The Programmer power supply, shown schematically in Fig. 2, provides + 5 volts for the logic and + 25 volts for generating the V_{CC} and V_{PP} programming voltages.

Construction

The Programmer can be wired on a 6 × 9-inch double-sided printed-circuit board or perforated board that has holes on 0.1-inch centers, the latter using suitable Wire Wrap or soldering hardware. Though not recommended, you can can fabricate the required double-sided pc board using two actual-size etching-and-drilling guides that can be obtained from the source given in the Note at the end of the Parts List.

If you make your own board, take care to properly register the two sides and solder all component leads to the pads on *both* sides of the board. Be prepared to install more than 450 short wires to complete traces that alternate from one side of the board to the other. Instead of using IC and re-

Table 2. Use of Printer Port Signals

DB-25 Pin	Printer Port Function	Programmer Function	Comments
1	−STB	−STB	Data/Address strobe
2	D0	D0	Data Bit 0
3	D1	D1	Data Bit 1
4	D2	D2	Data Bit 2
5	D3	D3	Data Bit 3
6	D4	A0	Address Bit 0
7	D5	A1	Address Bit 1
8	D6	A2	Address Bit 2
9	D7	A3	Address Bit 3
10	ACK	Not Used	
11	BUSY	ms Timer	1-ms Timer
12	PE	SDAT	Serial Input Data
13	SEL IN	μs Timer	1-μs Timer
14	AF	Not Used	
15	ERROR	Switch	EPROM Type Switch Position
16	INIT	Not Used	
17	SEL	Not Used	
18-25	GND	GND	

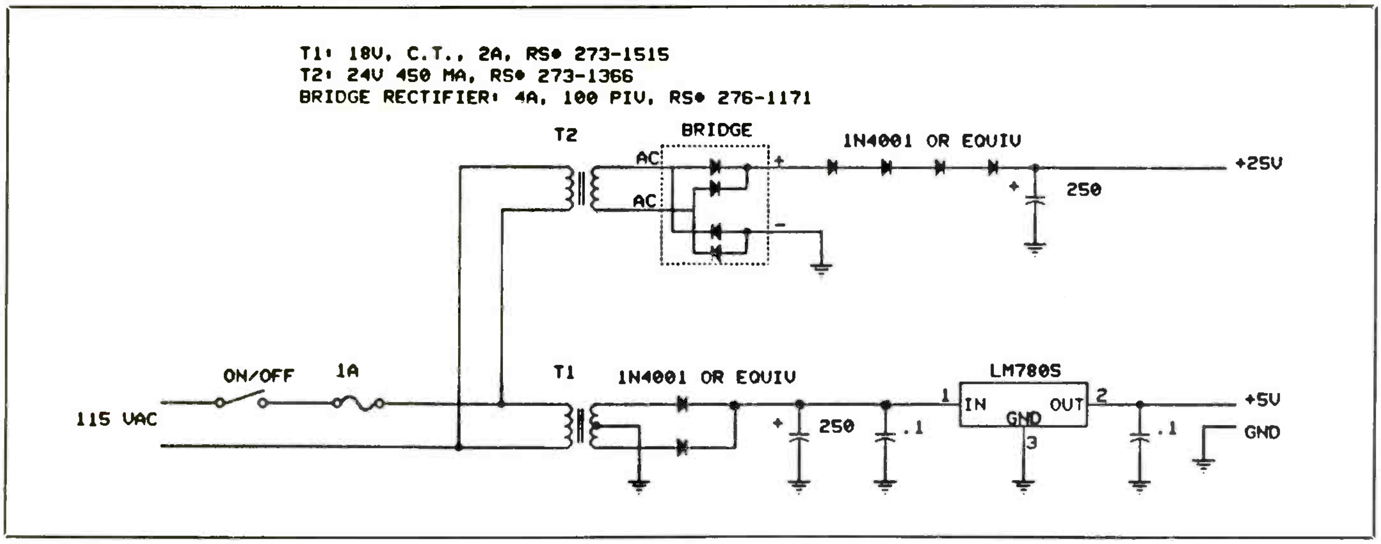


Fig. 2. Schematic diagram of a simple power-supply circuit that can be used to power the Programmer.

Bit	Volts
0	0.17
1	0.34
2	0.67
3	1.35
4	2.7
5	5.4
6	10.7
7	Turns Off Voltage

Table 3. D/A Voltage Control Values

sistor-pack sockets and the connectors specified for *SO2*, *J1* and *J3*, substitute Molex Soldercon® socket pins and a Wire Wrap-type ZIF socket that can be mounted above the surface of the board to obtain soldering access on both sides of the board.

By far the best way to go is to purchase a ready-to-wire board (see Note at end of Parts List) with plated-through holes that eliminate the need for jumper wires and permit use of standard IC sockets. Alternatively, wire the circuit on perforated board that has holes on 0.1-inch centers, using Wire Wrap or soldering hardware. Whichever way you go, though, use sockets for all DIP ICs.

Readers who wire the Programmer circuitry on perforated board should use the Master Wiring List given elsewhere in this article. As each wire run and component connection is made, it should be checked off on the List and traced with a red or other easily seen color marker on photocopies of the schematics.

If you are using a home-fabricated pc board, carefully determine where the short wire jumpers must be installed. Many are located under components and sockets, requiring that you install them *before* you install the components. Of particular concern is the area under the resistor banks. Use solid bare hookup wire and only enough solder to assure mechanically and electrically secure connections. If you wish, you can save installation of the jumpers not hidden under sockets or components for later.

Take note that the expansion connector, ZIF socket and PROM selector switch mount on and the wires to the LEDs connect to the bottom or solder side of the board. Save installation of these items for last. Also note that DB-25 connector *J1* mounts off the board and connects to it through a ribbon cable. Mount the 13 × 2 connector for this cable now. Then install and solder into place the resistors, capacitors and zener diodes. If you are using perforated board, refer to the Master Wire List shown elsewhere in this article for wiring details.

If you are wiring your project on perforated board, use the actual-size guide shown in Fig. 3 to place the various components for a compact layout. Regardless of the method of construction chosen, mount the IC and resistor-pack sockets first (heeding the above exception for home-fabricated pc boards). Do *not* plug the ICs into the sockets until construction is complete and you have conducted preliminary voltage checks to ascertain that your wiring is correct.

Once the sockets are in place, install the resistors, capacitors, zener diodes, transistors and trimmer controls in their respective locations. Make sure electrolytic capacitors *C16* and *C17* and zener diodes *Z1* and *Z2* are properly oriented before soldering their leads into place. Similarly, make sure all transistors are properly based before soldering their leads into place.

Capacitors *C1* and *C2* must be Mylar, polycarbonate, film or some other high-quality type. Do *not* substitute ceramic discs for them. Keep the leads of *C16* and *C17* as short as possible to prevent oscillation in the V_{PP} and V_{CC} regulators. Resistor packages *RP1* and *RP2* can contain any value resistor elements between 150 and 1,000 ohms. Of special im-

Table 4. Programming Voltages

Volts	Control Byte*
4.5	02
5	05
6	0B
12	2E
12.5	31
21	64

*In hex format

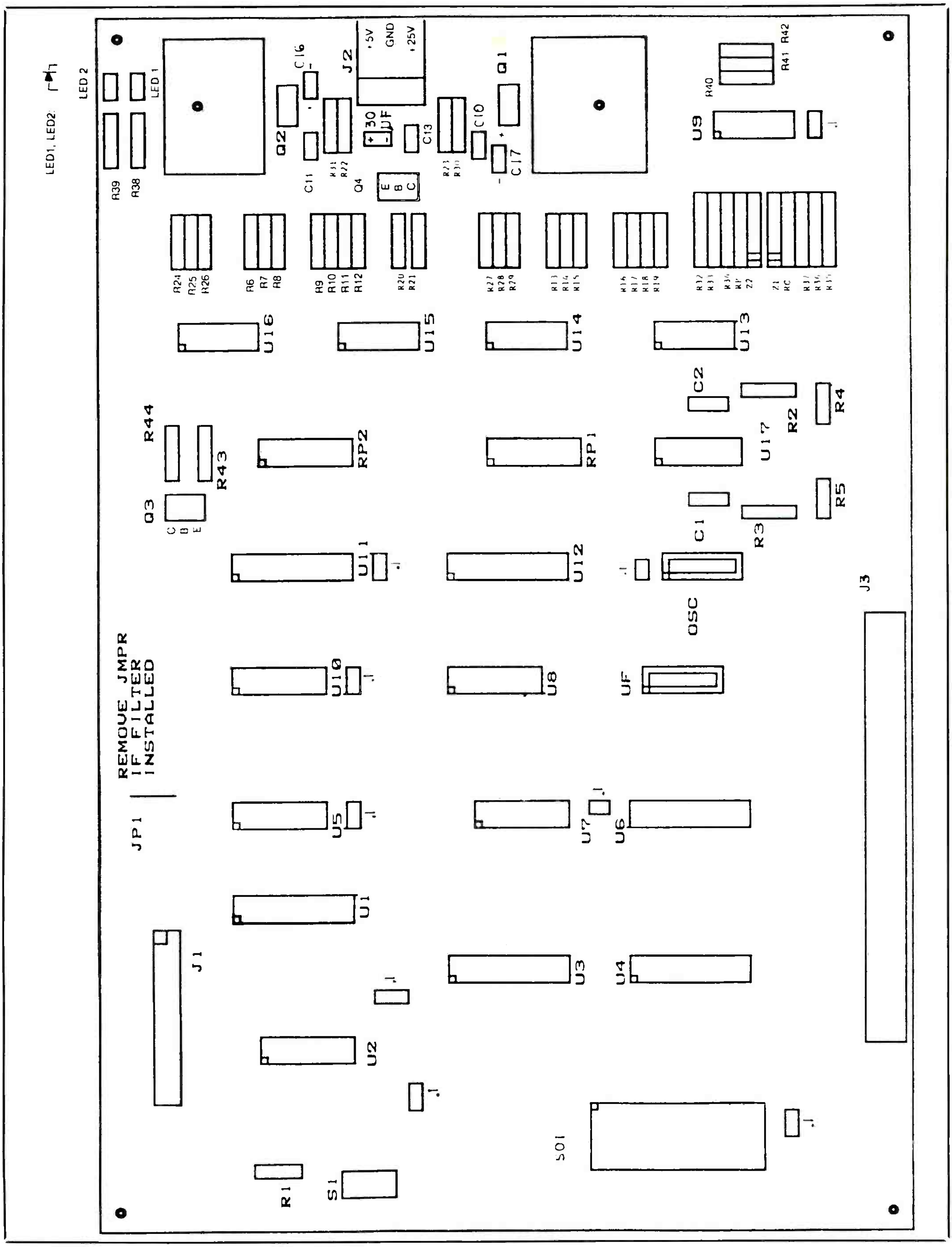
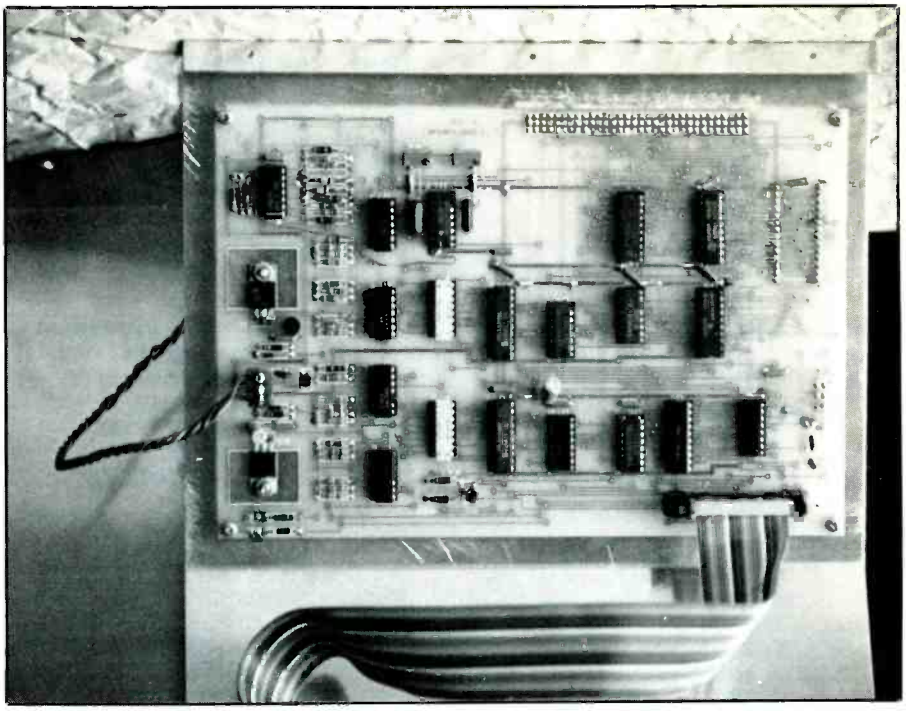


Fig. 3. Actual-size guide for placing and orienting components on pc or perforated board.

Master Wire List

From		To
U1 pin	1	U1(10),U1(19),GND
	2	J1(2)
	3	U2(4)
	4	J1(3)
	5	U2(3)
	6	J1(4)
	7	U2(2)
	8	J1(5)
	9	U2(1)
	11	J1(6)
	12	U3(18),U5(13),U6(18),U8(13), U10(13),U11(8),U12(8)
	13	J1(7)
	14	U3(17),U5(12),U6(17),U8(12), U10(12),U11(7),U12(7)
	15	J1(8)
	16	U3(14),U5(5),U6(14),U8(5), U10(5),U11(4),U12(4)
	17	J1(9)
	18	U3(13),U5(4),U613),U8(4), U10(4),U11(13),U12(13)
	20	+5V
U2 pin	5	R1(B),JP1(R),UF(13)
	6	U2(16), +5V
	7	U10(9)
	8	GND
	9	U8(9)
	10	U11(11)
	11	U12(11)
	12	U7(1),J3C(23)
	13	U6(11),U7(2),J3C(12)
	14	U5(9)
	15	U3(11),U4(11),J3C(11)
U3 pin	1	U4(1),U5(15),J3C(21)
	2	U4(13),J3A(9),SO1(25)
	3	U3(12),J3A(13),SO1(2)
	4	U3(15),J3A(14),SO1(26)
	5	U4(14),J3A(10),SO1(24)
	6	U4(17),J3A(11),SO1(21)
	7	U3(16),J3A(15),SO1(27)
	8	U3(19),J3A(16)
	9	U4(18),J3A(12),SO1(23)
	10	GND
	19	S1(3)
	20	+5V
U4 pin	2	J3A(1),SO1(10)
	3	U4(12),J3A(5),SO1(6)
	4	U4(15),J3A(6),SO1(5)
	5	J3A(2),SO1(9)
	6	J3A(3),SO1(8)
	7	U4(16),J3A(7),SO1(4)
	8	U4(19),J3A(8),SO1(3)
	9	J3A(4),SO1(7)
	10	GND
	20	+5V
U5 pin	1	U5(16), +5V
	2	J3C(9),SO1(20)
	7	J3C(10)
	8	GND
	10	U6(1),J3C(20)
U6 pin	2	U7(6),J3A(17),SO1(11)
	3	U6(12),U7(14),J3A(21), SO1(16)
	4	U6(15),U7(13),J3A(22), SO1(17)
	5	U7(5),J3A(18),SO1(12)
	6	U7(4),J3A(19),SO1(13)
	7	U6(16),U7(12),J3A(23), SO1(18)
	8	U6(19),U7(11),J3A(24), SO1(19)
	9	U7(3),J3A(20),SO1(15)
	10	GND
	20	+5V
U7 pin	8	U7(15),GND
	9	J1(12)
	10	J3C(22)
	16	+5V
U8 pin	1	U8(16), +5V
	2	J3C(13),SO1(27)
	7	J3C(14)
	8	GND
	10	J3C(15)
	15	U17(1),U17(9)
U9 pin	1	R22(L)
	2	R6(R) thru R12(R),R24(L), R25(L),R26(L)
	3	R33(B),R34(T),RP(T)
	4	U9(10), +25V
	5	R36(B),R37(T),RC(T)
	6	R13(R), thru R19(R), R27(L),R28(L),R29(L)
	7	R23(L)
	9	U9(11),GND
	12	R41(T),R42(R)
	13	R40(T)
	14	R43(L)
U10 pin	1	U10(16), +5V
	2	U11(13),U12(13)
	7	U11(14),U12(14)
	8	GND
	10	U11(17),U12(17)
	15	U11(18),U12(18)
U11 pin	1	U11(10),GND
	2	RP2(8)
	5	RP2(7)
	6	RP2(6)
	9	RP2(5)
	12	RP2(4)
	15	RP2(3)
	16	RP2(2)
	19	RP2(1),R20(B)
	20	+5V
U12 pin	1	U12(10),GND
	2	RP1(8)
	5	RP1(7)
	6	RP1(6)
	9	RP1(5)
	12	RP1(4)
	15	RP1(3)
	16	RP1(2)
	19	RP1(1)
	20	+5V
U13 pin	1	R19(L)
	2	RP1(9)
	3	U13(5),U13(10),U13(12), GND
	6	RP1(10)
	7	R18(L)
	8	R17(L)
	9	RP1(11)
	13	RP1(12)
	14	R16(L)
U14 pin	1	R15(L)
	2	RP1(13)
	3	U14(5),U14(10),U14(12), GND
	6	RP1(14)
	7	R14(L)
	8	R13(L)
	9	RP1(15)
	13	RP1(16)
	14	Z1(K),R35(L),R36(T)
U15 pin	1	R12(L)
	2	RP2(9)
	3	U15(5),U15(10),U15(12), GND
	6	RP2(10)
	7	R11(L)
	8	R10(L)
	9	RP2(11)
	13	RP2(12)
	14	R9(L)
U16 pin	1	R8(L)
	2	RP2(13)
	3	U16(5),U16(10),U16(12), GND
	6	RP2(14)
	7	R7(L)
	8	R6(L)
	9	RP2(15)
	13	RP2(16)
	14	Z2(K),R32(L),R33(T)
U17 pin	2	U17(3),U17(10),U17(11), U17(16), +5V
	4	J1(11)
	6	C1(B)
	7	C1(T),R3(R)
	8	GND
	12	J1(13)
	14	C2(B)
	15	C2(T),R2(R)
UF pin	1	UF(2), +5V
	8	OSC(8)
	9	JP1(L),J1(1)
OSC pin	7	GND
	14	+5V
J1 pin	10	J1(18 thru 25),GND
	15	Q3(C),R44(B)
Q1(C)		Q2(C),R32(R),R35(R), +25V
Q1(B)		R23(R)
Q1(E)		R27(R),R28(R),R29(R), C10(T),R30(T),LED2(A), R38(B),C17(+),J3C(5), J3C(6),SO1(28)
Q2(B)		R22(R)
Q2(E)		R24(R),R25(R),R26(R), C11(T),R31(T),LED1(A), R21(R),C16(+),J3C(7), S1(1),S1(6),C12(T)
Q3(B)		R43(R)
Q4(E)		R20(T)
Q4(C)		R21(L)
LED1(K)		R38(T)
LED2(K)		R39(T)
S1 lug	2	R40(B),SO1(1)
	5	SO1(22)
R4(W)		R4(B),R2(L)
R5(W)		R5(B),R3(L)
GND		C3 thru C17(B),R30(B), R31(B),R34(B),R37(B), R39(B),R41(B),RC(B), RP(B),J2(2),J3C(1,2,8,17, 19,31,32),Z1(A),Z2(A), Q3(E),Q4(E),SO1(14)
+5V		C3 thru C9(T),C14 thru C15(T),R1(T),R4(T),R5(T), R32(R),R42(L),R44(T), J2(1),J3C(3,4)
+25V		J3C(18)

1) IC pins to which no connections are made are not listed. 2) Numbers in parentheses identify IC, oscilator and switch pin numbers. 3) Except for transistors, letters in parentheses are decoded as follows: A = anode, B = bottom, K = cathode, L = left, R = right and W = wiper. All directional references are with schematics in "normal" orientation. 4) Letters in parentheses for transistors decode as follows: B = base, C = Collector and E = emitter.



Interior view shows main circuit-board assembly mounted to front panel, power-supply circuit wired on terminal strips on floor of enclosure.

portance are the values for *R6* through *R19*, which make up the V_{PP} and V_{CC} ladders. These must be 1% precision resistors.

Power transistors *Q1* and *Q2* must mount on heat sinks and lie flat on the board. Prepare their leads by bending the two outer ones toward the rear to form a 90° angle to the cases. Do the same with the center leads but make the distance from the cases about 1/16″ longer than for the outer leads. Use 1 × 3/4-inch aluminum heat sinks where *Q1* and *Q2* mount.

Before mounting them, liberally coat the the metal rears of the transistors with heat-transfer paste. Then carefully match the transistor pins with the holes for them in the board and push *Q1* and *Q2* into place until the cases are resting on the heat sinks. Use 4-40 × 1/4-inch machine screws, lockwashers and nuts to secure the transistors and heat sinks to the board. Only after mechanically mounting the transistors should you solder their pins into place.

Finish wiring the board by installing and soldering into place the ZIF socket, expansion connector and switch. Then strip 1/4 inch of insulation from both ends of two red-insulated and two black-insulated hookup wires. Make these wires about 12 inches long. If you are using stranded wire, tightly twist together the fine conductors at all ends and sparingly tin with solder. Loosely twist together one red- and one black-insulated wire. Do the same for the remaining two wires.

Connect and solder one end of one twisted-pair wire cable into the holes for *LED1*, black-insulated wire to the anode connection point and red-insulated wire to the cathode (K) point. Do the same for the other twisted-pair cable and the *LED2* holes. Remember to connect these cables to the *solder* side of the circuit-board assembly.

When you are done, carefully inspect all wiring and soldering on the circuit-board assembly. Correct any wiring errors you find now. If you missed a connection, solder it now. If any connection appears suspicious, reflow the solder on it and add solder if needed. If you locate any solder bridges, especially between closely spaced IC socket pads, clear them with a vacuum-type desoldering tool or desoldering braid. Set the circuit-board assembly aside for now.

The enclosure you select to house

the Programmer must be large enough to accommodate the circuit-board assembly and any optional power supply you might decide to use. A good choice is the metal "instrument-type" enclosure pictured in the lead photo.

Begin machining the enclosure by drilling mounting holes for the circuit-board assembly, power transformers and two terminal strips on which to mount and wire together the power-supply components. Also drill a mounting hole for the fuse holder, an entry hole for the ac line cord, a mounting hole for the POWER switch and mounting holes for the LEDs. Finish up by cutting the slots for the on-board ZIF socket, expansion connector and switch in the front panel and a slot in which to mount DB-25 connector *J1* in the rear panel. Deburr all holes to remove sharp edges, and line the ac-cord hole with a rubber grommet.

As can be seen in Fig. 2, the power-supply circuitry is fairly simple. It can be wired by point-to-point means on a pair of multiple-lug terminal strips. Mount the two power transformers and the terminal strips in place. Then mount the various components that make up the power supply on the terminal strips and make connections from the secondaries of the transformers to the appropriate points. Solder all connections. Make sure you do not mistake the primary leads of the transformers for the secondary leads.

Mount the fuse block near the power supply and the POWER switch on the top of the enclosure. If you are using a bayonet-type fuse holder, mount it on the rear panel. Pass the unprepared end of the ac line cord through its grommet-lined hole and tie a strain-relieving knot in it about 8 inches from the unprepared end inside the enclosure. Tightly twist together the fine wires in each conductor and sparingly tin with solder.

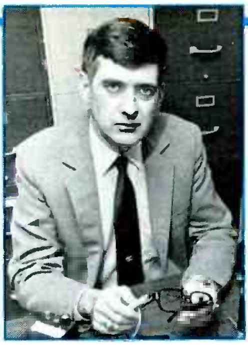
Crimp and solder one conductor of the line cord to one lug of the POWER switch. Crimp and solder one primary lead of both transformers to one lug of the fuse holder. Tightly twist together the exposed wires of the other two transformer primary leads. Slip over the pair a 2-inch length of small-diameter heat-shrinkable tubing, twist these wires together with the other line-cord conductor and solder the connection. Slide the tubing over the connection to completely insulate it and shrink solidly into place. If you wish, you can eliminate the tubing by using a wire nut over the unsoldered connection.

Strip ¼ inch of insulation from the conductors at both ends of a 12-inch-long three-conductor cable. Tightly twist together the fine exposed wires and sparingly tin with solder. Crimp and solder the conductors at one end of the cable to the appropriate points in the power supply and terminate the opposite end of the cable in a connector that mates with *J2* on the circuit-board assembly.

Trim the cathode leads of the LEDs to ½ inch long and form a small hook in each lead stub. Slide a 1 inch length of small-diameter heat-shrinkable tubing over the free ends of all LED wires coming from the circuit-board assembly. Crimp and solder the cathode (K) wires to the shortened cathode leads of the LEDs. Similarly prepare the anode leads of the LEDs and crimp and solder the anode wires coming from the board to them. Slide the tubing up over the connections until it is flush against the bottoms of the LED cases and shrink into place.

Next month, we conclude with voltage measurements and adjustments and discuss how to put the Programmer into use. ■

Forrest M. Mims III



A Primer on Fiber Optics

Telecommunications has become by far the most important application for fiber optics. If you've recently used a telephone in a major city or placed a long distance telephone call, chances are that at least part of your conversation was transformed into flashes of laser radiation that were carried through optical fibers.

This year, AT&T plans to place into service its second transatlantic optical-fiber link. Each fiber will carry 560 megabits (that's *millions* of bits!) of data per second. Periodically, the optical signals will be received by repeaters on the ocean floor, where they're amplified and used to drive laser diodes that generate a fresh signal containing the same data. In Fig. 1, an AT&T engineer examines a surface-mount laser-diode driver circuit designed for this new transatlantic link.

Even though telecommunications is the best known application, optical fibers have many other uses as well, including serial data links for computers, local-area networks (LANs) and dozens of kinds of sensors. This time around, I'll cover the optical fiber fundamentals that experimenters, hackers and engineers should know about. Next month, I'll detail experiments using some optical-fiber sensors and a homemade optical-fiber microphone that uses no wires or electricity to operate.

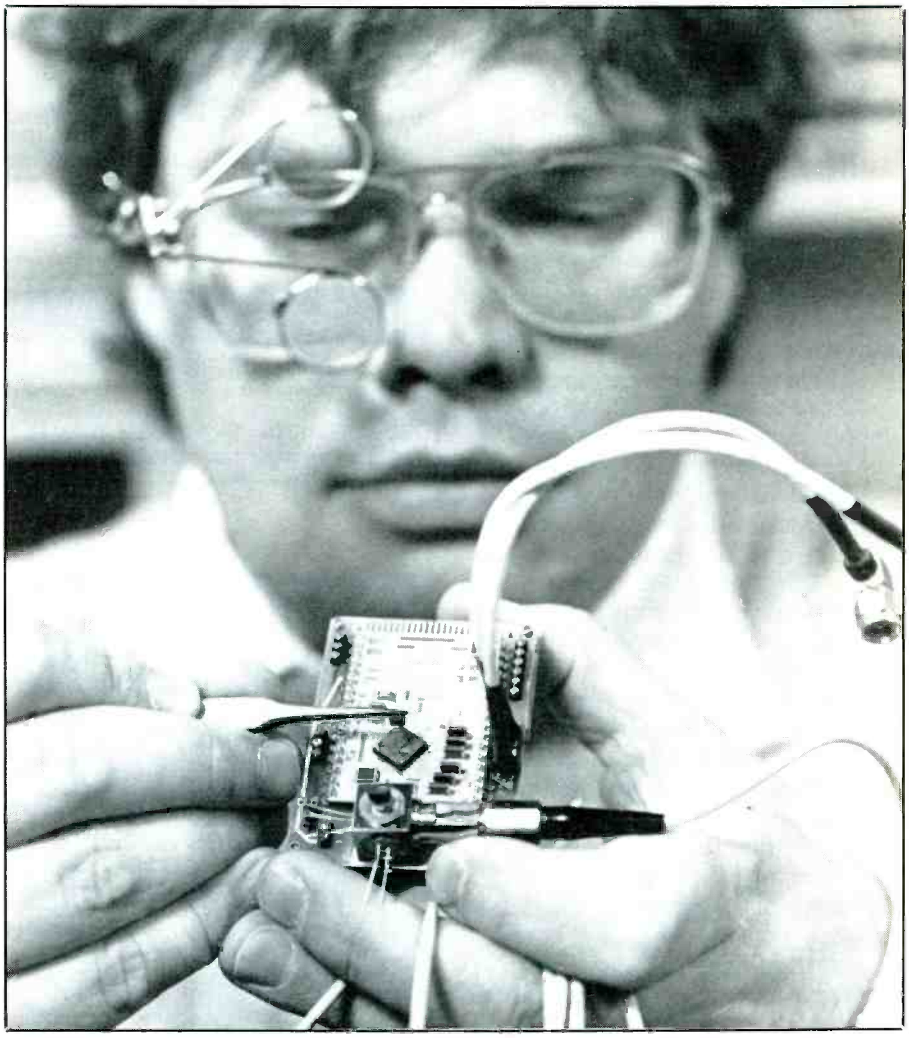


Fig. 1. AT&T engineer Stephen Granlund inspects a laser diode transmitter circuit that forms part of a repeater system for a transatlantic lightwave cable. (Courtesy AT&T)

Optical Fibers

An optical fiber is a strand of silica, glass, plastic or other material through which light or infrared radiation can be transmitted. The radiation travels through a central region known as the core. The core is surrounded by the cladding, a material usually made from the same material as the core.

The radiation stays inside the core because its index of refraction is higher than that of the cladding that surrounds it. One way the difference in the index of refraction is achieved is to use different kinds of glass for the core and cladding. Another is to add a tiny percentage of contaminants to the core to increase its index of refraction.

The difference in refractive index between core and cladding causes the interface between the two to appear like a mirror to light rays traveling within the core. When a ray strikes the core/cladding interface at a glancing angle, it's reflected back into the core. A fiber made like this is called a step-index fiber. Figure 2(A) is an outline drawing of a step-index fiber.

That some rays are reflected from the core-cladding interface more times than others in a step-index fiber means these rays travel a longer distance than is the case for others. This phenomenon is known as modal dispersion.

Modal dispersion causes a narrow pulse of light injected into one end of a step-index fiber to become stretched as it passes through the fiber. This limits the maximum data rate in high-speed telecommunication and data transmission systems. If the maximum allowable data rate is exceeded, closely spaced pulses injected into one end of a fiber will be merged into a continuous pulse by the time they reach the other end. This effect, which is directly related to the length of the fiber, is shown in Fig. 2(B).

There are two ways to reduce the pulse stretching caused by modal dispersion. One is to make the core so tiny that only a single mode of light can pass through it. This kind of fiber is known as a single-mode or monomode fiber. The principal disadvantage of a single-mode fiber is that the tiny size of the core (perhaps 1 micrometer in diameter) limits the amount of radiation that can be injected into the fiber.

Another way to improve the bandwidth of an optical fiber is to blur the sharp boundary between the core and cladding to give a gradual change in the index of refraction between the two. The resulting fiber is called a graded-index fiber. A light ray that enters the refractive index transition region in a graded-index fiber is gradually bent back toward the core. Since light traveling through the region of lower refractive index near the cladding travels faster than the light traveling in the region of higher refractive index near the core, pulse broadening is minimized. Figure 2(C) is an outline of a graded-index fiber.

Depending on spectral width of the optical source, the material from which a fiber is made can also cause a pulse of light to be stretched. This phenomenon, known as material dispersion or wavelength dispersion, is caused by the effect on the speed of light by the index of refraction through which the light passes. Index of refraction is a function of wavelength and the speed of light is reduced as the refractive index is increased. The combined effect of these two principles is that a light pulse composed of a band of wavelengths travels at different velocities through the same fiber. The longer wavelength portions of the pulse give a longer refractive index and a faster propagation speed. The shorter wavelength portions of the pulse give a slower propagation speed. The result is a stretched pulse that limits the maximum bandwidth of a fiber.

Wavelength dispersion occurs in both step- and graded-index fibers. The easiest way to solve the wavelength dispersion problem is to use a laser diode as an optical source. Since the spectral width of the radiation from a laser is very narrow (around 1 nanometer or so; much less for single-mode lasers), wavelength dispersion is minimal. LEDs are much simpler to work with, but their spectral width is typically 30 to 40 nanometers. So they cause much more wavelength dispersion.

Fortunately, wavelength dispersion disappears at a certain point known as the zero-dispersion wavelength. By tailoring LEDs to emit at the zero-dispersion wavelength for a specific fiber, high-performance links can be achieved without having to use more expensive laser diodes.

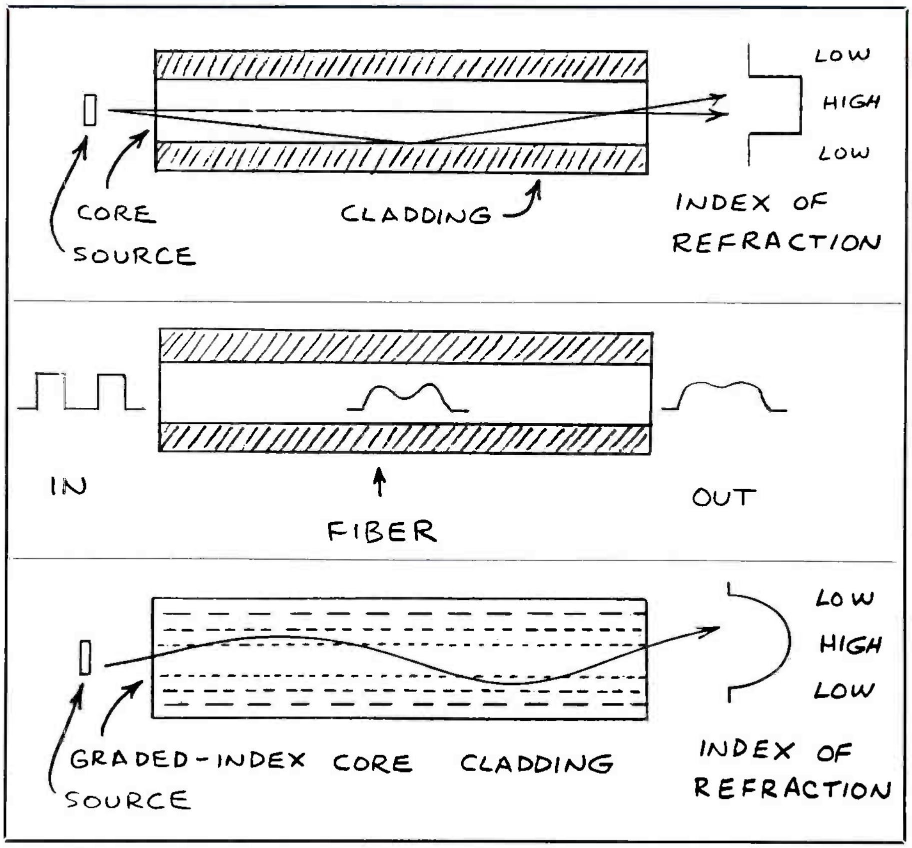


Fig. 2. Shown here are: (A) a step-index optical fiber, (B) how modal dispersion in a step-index fiber leads to pulse stretching and (C) a graded-index optical fiber.

Keep in mind that many applications don't require the high level of performance necessary for wide-bandwidth telecommunication links. Straightforward voice and intercom links as well as most computer modem and serial links work fine over distances of 1 kilometer or less with readily available step-index plastic or silica fiber and inexpensive light-emitting diode sources.

Advantages

When compared to conventional transmission methods, optical fibers—especially those made from glass or silica—offer many important advantages. Communications grade fiber attenuates a signal much less than a copper wire. A single fiber can have a potential transmission capacity of 100 gigahertz per kilometer. Operational systems have exhibited transmission rates in excess of 100 megabits per second.

An optical fiber is smaller in diameter, lighter in weight and less costly than a conventional metal cable that has the same bandwidth. The small diameter of optical-fiber cables means they can often be threaded through the spaces between cables and pipes in existing telecommunication ducts.

Optical fibers have continued to function properly during and after fires that have damaged wire communication links. Since the insulation on a conventional wire is destroyed during a fire, the conductive wires within a cable may short together and may even melt. Optical fibers also have protective coatings, but their destruction doesn't cause a short circuit. Also, the melting point of silica and glass is considerably higher than that of copper.

Since optical fibers don't conduct electricity, they can't be short-circuited. Additionally, they pose no shock hazard. Unless they're bundled with conductors, they pose absolutely no hazard from lightning strikes. They aren't affected by electromagnetic pulse effects from lightning or nuclear explosions nor are they affected by electromagnetic fields generated by motors, relays and electrical circuits. They don't create sparks in an explosive environment. They provide total electrical isolation between the opposite sides of a link. They generate no electromagnetic field, and they aren't subject to crosstalk from adjacent fibers. Finally, for these and other reasons, optical fibers provide a more secure communications link than conventional wire links.

Disadvantages

From a purely practical perspective, the greatest drawback to optical fibers is the fact that an electrical signal must first be transformed into a light signal and then, at the opposite end of the link, back again to an electrical signal. This is much less convenient than simply connecting the exposed end of a wire cable to terminals at either end of a link.

Another drawback is that because fibers carry no electricity it isn't possible to power one side of a link with power from the other. This can be alleviated by transforming some of the light injected into the fiber into electricity. More than 5 years ago, Bell Laboratories demonstrated an optical-fiber telephone powered in just this fashion. But this method isn't nearly as efficient as supplying power with copper wires.

Yet another drawback of optical fibers is that individual fibers are more difficult to handle and splice than copper wires. Fortunately, simplified and improved splicing techniques and kits are now available, but it's still more difficult to splice optical fibers than copper wires.

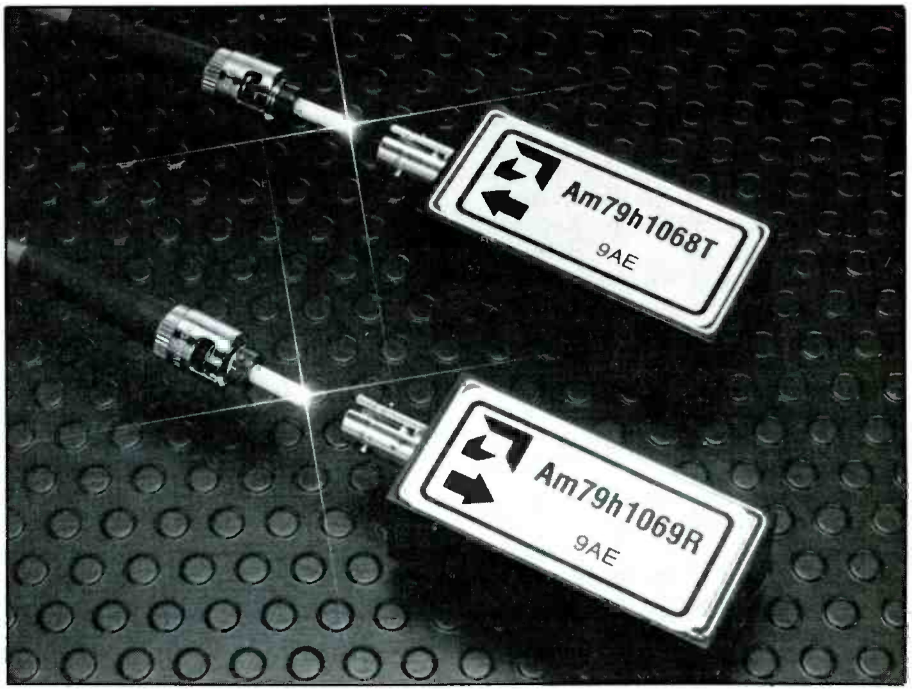


Fig. 3. The optical-fiber transmitter module shown at top can send data to the receiver module below it at 125 MHz. (Courtesy Advanced Micro Devices, Inc.)

Comparing Materials

Glass and silica fibers offer superior performance for high data rate links and telecommunications. But this kind of capability is usually overkill for simple links of less than 100 meters between offices or a couple of nearby buildings. In the latter case, an inexpensive link using plastic fiber is often a better alternative.

Near-infrared-emitting diodes and lasers are used with silica and glass fibers. The preferred optical source for plastic fiber links, however, is a light-emitting diode (LED) that emits red light at a wavelength of around 660 nanometers. Not long ago, such LEDs were far less powerful than their near-infrared cousins. Now red-emitting LEDs can emit nearly as much power (several milliwatts or more) as near-infrared emitters. Moreover, the advent of visible-light laser diodes that emit at wavelengths as low as 660 nanometers means a considerable fraction of the light emitted by the source can be injected into a plastic fiber.

Data Links

Several companies manufacture optical-fiber serial links for personal computers. Since they add perhaps $100 or more (sometimes much more) to the cost of a conventional cable link, why would you even want to consider such a link?

Offices, laboratories and manufacturing areas that have lots of electromagnetic interference (emi) are perfect choices for optical-fiber serial links. Since emi can't zap bits passing through an optical fiber, data integrity is preserved.

Security is another good reason for selecting an optical-fiber serial link. While a serial link that uses a wire cable can be easily tapped, it's much more difficult to tap an optical-fiber link. This means sensitive data can be exchanged between computers located in separate rooms or even buildings.

I'm thinking of using an optical-fiber serial link for a data-acquisition system that will link some meteorological instruments in a nearby field with a computer in my office. Since I want the system to operate during electrical storms, an optical fiber link will protect the computer in the event lightning strikes the remote instruments in the field.

Many different optical data links are available, some of which are designed specifically as RS-232 serial links. These systems are modular in design and easy to use. RS-232 fiber systems, for example, plug directly into a serial-port socket just like an ordinary cable connector. In some cases, power for the electronics and the LED is derived from the serial port; so no external wiring is required. Others require a compact external power supply.

If you want to build up your own optical data link, you can select from a wide variety of transmitter and receiver modules. Some of these systems are very sophisticated and operate at very high data rates. Figure 3, for example, shows a pair of American Micro Devices, Inc. 125-MHz optical-fiber transmitter and receiver modules.

Hewlett-Packard, which sells calculators that access a portable printer by means of a near-infrared beam, makes many kinds of optical fiber systems. This company's optical-fiber technology is part of its recently announced Ether-Twist LAN family.

HP's HFBR-1001 transmitter includes a 700-nanometer LED that can be pulsed at 10 megabits per second and is designed for links of 1 kilometer in length. This and various other HP lightwave transmitters and receivers are modular devices fitted with connectors that make them very easy to use. All you have to do is provide a power supply and the necessary input signal. The link between transmitter and receiver modules is made by a fiber cable terminated at each end with an appropriate connector.

For information about the entire family of HP optical-fiber modules and accessories, contact a local HP representative or write to Hewlett-Packard, P.O. Box 10301, Palo Alto, CA 94303).

Edmund Scientific (101 E. Gloucester Pike, Barrington, NJ 08007) sells an RS-232 link that sends serial data along a 100-foot-long optical-fiber cable. At $540, this system is far too expensive for home use, but it may be worth it to those

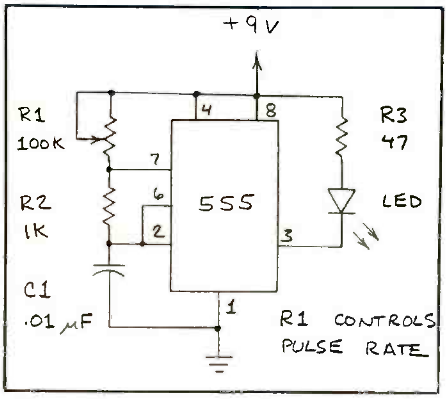


Fig. 4. Circuit details of a simple LED transmitter for use as optical-fiber continuity tester.

who must establish a computer-to-computer communication link across an electrically noisy environment.

Edmund also sells an optical-fiber video transmission system. The system is specifically designed to provide a transmission link totally immune to water, emi, lightning, ground loops and other hazards. Cost for this system and 1,500 feet of optical-fiber cable is $1,094.

For those of you on a limited budget, Edmund also sells several economical fiber-optic communication kits and various kinds of fibers. The communication kits can be used as learning tools and projects as well as in functional systems.

Digi-Key (P.O. Box 677, Thief River Falls, MN 56701) sells several very economical optical-fiber data-link kits. It also sells splice kits for plastic fiber and AMP Optimate fiber-optic connectors.

If you prefer the challenge of building your own electronic systems without using a kit, you might want to consider the new CS8123 and CS8124 24-pin modem integrated circuits known as Optimodems. A pair of CS8123s can communicate over a distance of up to 1 kilometer of optical fiber in an asynchronous mode at up to 38.4 kilobits per second. A pair of CS8124 can operate in a synchronous mode at up to 256 kilobits per second.

Each of these chips is connected to a single LED that doubles as both emitter and detector of light, a method well known to experimenters. After one chip sends its signal to the other, the function of the LEDs is automatically switched and communication takes place in the opposite direction.

The CS8123 sells for $25.20, the CS-8124 for $30.20, in single-unit quantity. For more information on these devices, contact Crystal Semiconductor Corp. (P.O. Box 17847, Austin, TX 78760).

Another option for build-it-yourselfers is Signetics' High Performance Fiber Interface (HiFi) 100A and 100B chip sets. The transmitter in these sets consists of a LED driver and a LED. The receiver consists of a PIN photodiode, which is followed by transimpedance amplifier and postamplifier stages.

The HiFi100A can transmit up to 100 megabits per second and is designed for long-distance applications. It includes an NE5211 transimpedance amplifier, NE-5214 amplifier and 74F5300 LED driver. The HiFi100B is designed for short-distance links and includes an NE5210 transimpedance amplifier, NE5217 amplifier and the same LED driver as the HiFi-100A. The 74F5300 LED driver converts TTL input pulses into current pulses that are delivered to a LED.

Performance of both chip sets can be tailored for different applications with external components. For additional information, contact a Signetics representative or write to the company at P.O. Box 9052, Sunnyvale, CA 94086.

Manufacturers and suppliers listed here are only some of the many sources for optical-fiber data links and fibers. For additional suppliers, visit the technical library at an engineering college or university and look for trade directories

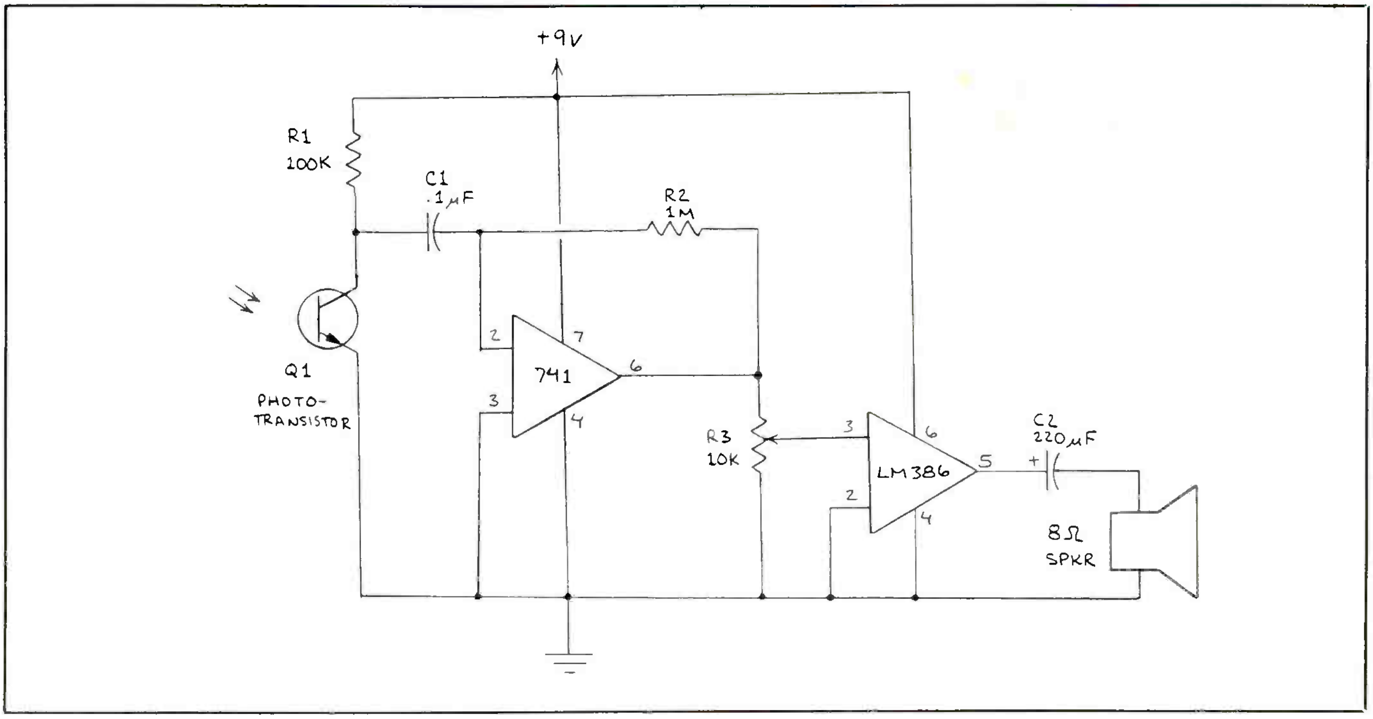


Fig. 5. Circuit details for a simple optical-fiber receiver.

like those published by *Photonics Spectra* and *Laser Focus World*. Also, some of the mail-order distributors that advertise in *ComputerCraft* and various electronics magazines sell surplus optical fibers and components at discounted prices.

A Continuity Tester

It's important to be able to test the continuity of an optical fiber. This way, you can quickly determine if a problem is in the electronics or due to a broken fiber.

The simplest way to test a fiber is to inject visible light into one end and see if it emerges from the other end. I've used super-bright red LEDs, visible-light laser diodes and helium-neon lasers for this purpose. Lasers work best because they inject more light into the fiber. But you must always exercise caution when using lasers to avoid pointing the end of the fiber directly at your or anyone else's eyes.

Shown in Fig. 4 is a simple LED transmitter circuit that can function as an optical-fiber continuity tester when used with the receiver shown in Fig. 5. These two circuits can also form a simple data link demonstrator. The transmitter pulse modulates a LED. The receiver transforms the pulsating light into an audio-frequency tone that you can easily hear. If you connect the input probe of an oscilloscope to pin 6 of the 741 in the receiver circuit, you can compare the attenuations obtained for different lengths and different kinds of optical fiber.

Safety Notes

The radiation that passes through an optical fiber can be hazardous to your eyes if it's of sufficient intensity. Therefore, it's important that you always exercise caution when working with active fibers. Fortunately, the radiation emerging from the end of an exposed fiber ordinarily diverges outward in a relatively broad cone, thereby greatly reducing the hazard.

Another hazard is physical injury that can result from cutting and placing optical fibers. I'm not aware of any such hazards associated with using or working with plastic fibers, unless you use solvents or bonding agents to polish or bond the fibers. Glass and silica fibers are another matter. You must be *very* careful when working with glass and silica fiber cables that aren't terminated and when cleaving them! These fibers may have a diameter of 100 micrometers or less. While a length of such fiber is very flexible, shorter stiff pieces can become very sharp, almost invisible splinters.

When cleaving glass and silica fibers, always wear eye protection. And be sure to pick up and dispose of fiber splinters immediately afterwards. Otherwise, one may end up stuck in your elbow the next time you sit down to work. I usually dispose of such splinters by picking them up with the sticky side of a piece of masking tape and folding the tape over them. ■

Ted Needleman

A technology can be around for years, making little inroads for general use. Then, all of a sudden, it's the hottest thing around! This is pretty much what's happened with facsimile. Though techniques for transmitting a copy of a page were originally developed in the early 1950s, fax pretty much languished until fairly recently, being used primarily by wire services, law-enforcement agencies, and very large companies. To some extent, this is because fax technology remained fairly primitive, relying on special aluminized paper where the image was literally burned onto the paper with a spark (and smelling up any office in which the fax machine was used). Poor resolution, slow page-transfer speed and high cost of the equipment and paper are all additional factors that slowed widespread acceptance of fax systems.

In the past few years, though, several developments and refinements in facsimile technology took place, which brought down the price, improved the quality and made fax the "must-have" that it has quickly become. Solid-state scanning technology, fax modems contained on a single chip, the use of thermal printers and fax modems as a peripheral card for PCs all combined to bring the use of fax to the critical mass it needed to be accepted as a common business and personal tool. And one of the newest, and most feature-filled, of these fax boards is the SatisFAXtion board from Intel.

Intel's SatisFAXtion Board.

Intel's SatisFAXtion Board

Intel Corp. is, of course, best known for its microprocessors. Chances are that at least one of the PCs you own or use contains an 8088, 8086, 80286, 386SX or 386 CPU. In addition to microprocessors, Intel makes a variety of other products that are somewhat less known. The company is, for example, a major producer of PC motherboards; many clones, in fact, contain not only an Intel CPU, but an Intel motherboard as well. An entirely different division, Intel PCEO (Personal Computer Enhancement Products) sells printer-enhancement products like the Visual Edge board (which increases resolution and gray scales on H-P LaserJet Series II printers), networking products, modems and the SatisFAXtion card.

SatisFAXtion is a refinement of the Connection Coprocessor, Intel's earlier fax card. Most of the fax cards used on PCs have very similar features. It's how the features are implemented that largely distinguishes between the offerings. SatisFAXtion is your standard full-length card and can be used in any open eight-bit (or 16-bit) expansion slot. It is Group 3-compatible (can transmit and receive at 9,600 baud), offers standard (204 by 102) or fine (204 by 204) resolution and, like many fax cards these days, includes an on-board standard modem that works at 2,400 baud. This second "standard" 2,400-baud modem is necessary, by the way, to communicate with other computer systems and bulletin-board systems. Both fax and standard modems work on the same principle, but they use different frequency pairs.

The SatisFAXtion board does offer some features that other fax cards lack. One major one is high-speed file transfer when communicating with another SatisFAXtion card or Intel's earlier Connection Coprocessor. These file transfers use a proprietary Intel transfer method, and can take place at the fax modem's speed (9,600 baud), rather than at the 2,400-baud limit of the included "standard" modem for computer communication.

Furthermore, most fax boards require that such system parameters as I/O ports be set with DIP switches or jumpers on the board. Intel's card lets these parameters be set (or changed if necessary) by software during installation. In most cases, the software is able to automatically configure the installation, and requires little, if any, operator input. I was able to install the board, copy the software to my hard disk, perform the software setup and send my first fax within 15 minutes of opening the PC's system-unit case; one of the simplest installations of a peripheral I've run across.

Another place where the SatisFAXtion board differs from the rest of the crowd is in the variety of fax software it provides. Most cards come with one fax package. the Intel card, in contrast, comes with three. All include common features, such as a phone book and the ability to create a group of numbers to which the same fax can be sent (this feature is often called broadcasting). All also allow a fax transmission to be scheduled for a later time, and all work in the background, allowing you to transmit and receive faxes while working on some other application.

The FAX program is the stand-alone package provided. This menu-driven program is accessed from DOS level. It lets you perform either faxing or, when you're connected to another Intel card, high-speed file transfers. It can handle files in .PCX (PC Paintbrush) format,

.DCX (Intel's own fax format) and ASCII text. The .PCX and ASCII formats are converted to Intel's .DCX fax format before being transmitted.

A second program, *FAXPOP*, is a TSR (Terminate and Stay Resident) program that allows you to fax from within your applications. To use *FAXPOP*, you install an Epson FX printer driver in your applications and direct printer output to port LPT3, assuming you have this port. When you give the command to print from within an application, the output is directed to the fax capture port and is converted into fax format. You're then presented with a screen that lets you either select a fax destination from your phone book or enter the recipient's name and fax number.

In addition to a fairly hefty SatisFAXtion Board manual, Intel provides a booklet that explains how to set up a variety of word processors, spreadsheets and other programs to work efficiently with the *FAXPOP* software.

The third package, and the one I use most often, is *FAXit* for Windows, developed by Alien Software. This lets you install the fax as an output port in *Windows* 3.0, and you can fax from within any *Windows* application by just choosing *FAXit* as the target printer. I generally create my faxes using either Microsoft's *Word for Windows* word processor or Aldus' *PageMaker*, and transmit them directly from within the application used to create the fax. I did notice one minor bug that creeps in occasionally with *FAXit*. After you select the destination and either hit RETURN or click on the OK button, you're brought to a fax cover sheet screen, which allows you to enter a short message to be included on the transmission's cover sheet.

I recently had to fax a survey to about 150 different locations. As this was a one-time occurrence, I didn't bother adding all of the phone numbers to the phone book, but did it for each transmission separately. Occasionally, the program skipped the cover sheet screen, going directly from the screen where you specify the recipient's name and phone number to the conversion-to-fax format. This hasn't happened since, and I haven't followed up with Intel's excellent customer support as to the cause.

Other than this slight glitch, the SatisFAXtion (and *FAXit*) have worked great. The internal 2,400-baud modem operates fine with the latest version of *Procomm Plus* 2.0, though Intel doesn't include a code program for the modem. This is a little odd, considering that the company gives you three packages for the fax side of the board.

At $499, the Intel board isn't the least-expensive fax card you can put in your PC, but with all that it offers, it's one of the better ones.

The Complete FAX/Portable

The Intel SatisFAXtion card is fine if you have a desktop PC with an open slot. Sometimes, though, you don't. I need the capability of sending and receiving faxes while on the road with a portable PC that doesn't have an empty slot, for example. Whenever possible, I try to determine if the hotel I'm staying at offers fax service, and if so, what this service costs.

Many hotels are set up to offer fax service to their guests, but I've also run across a number of them who charge $3 per page for an incoming or outgoing fax. If I think I may just need to fax (or receive) a page or two in an emergency, I can easily live with being gouged a bit. Sometimes, however, I know that I'll have to examine a 10-or 15- page document while traveling and quite possibly make some changes and fax these back to the office. To do this, I usually rely on a notebook PC and a product called the Complete FAX/Portable from The Complete PC.

The Complete FAX/Portable is an implementation of the Complete FAX that's been optimized for on-the-road use. It's a true Group 3-compatible FAX, operating at 9,600 baud and offering 1" thickness and weighing about ½ pound, it's not much trouble to carrying around. It's powered either by a standard 9-volt battery for completely portable use or by plugging in the included typical power-cube-style ac adapter.

The unit has a nine-pin DB connector and two RJ-11 type modular phone plugs on its top edge. These two RJ plugs are for connecting the unit between the wall plug and the modem. The Complete FAX/Portable comes with a short cable, one end of which plugs into a nine-pin DB connector on the FAX/Portable, the other into a serial port on your PC. There's also a 9-to-25-pin adapter if your PC uses the older DB-25 connectors for its COM ports. Accompanied by the same software that comes with The Complete FAX for internal PC installation, the FAX/Portable lists for $499.

If you're going to use the FAX/Portable on the road, (or a portable modem for that matter), better plan on spending a bit more cash for one of the many accessory kits that let you connect a modem to a non-modular telephone. These kits, available from companies like CP+ and Traveling Software, have special adapters that let you tie your modem or fax into phone sets never intended to accommodate computer communications. This can actually be a big problem when traveling. Some of the hotels I've stayed at recently have phones with a "data port" on the side of the instrument; you just plug the LINE OUT cord from the modem/fax into this port, and you're pretty much on your way. More common, however,

The Complete PC's The Complete FAX/Portable package.

are hotel-room phones whose cords disappear into the wall on one side and into the instrument on the other.

I've recently taken to traveling with The Road Warrior from CP+, which provides several clever work-arounds to this problem. One is a box that connects between the instrument and handset (assuming the handset cord is of the modular type). You then plug the modem/fax into this small box. If this isn't possible, The Road Warrior kit has a universal acoustic coupler, capable of operating at 2,400 baud. You just plug the LINE OUT from your modem or fax into this coupler, and you're in communication with the rest of the computer world. Of course, at 2,400 baud, faxing in or out takes quite a bit longer (the standard Group 3 rate is 9,600 baud), but it's a lot better than not being able to use the phone in your room at all.

The Complete FAX/Portable's software has both similarities and differences from that which comes with the Intel SatisFAXtion card. As with the Intel card, you can operate the fax in the background (though you probably wouldn't most of the time with the FAX/Portable), schedule faxes to be sent at a later time, maintain a phone book of frequently used fax numbers and include in your faxed documents graphic images created with *Dr. HALO* (.CUT files), *PC Paintbrush* (.PCX files), Microsoft *Windows Paint* (.MSP files) and any application that creates standard .TIF files. The *CFAX/P* software also lets you create cover sheets that can precede your faxed documents.

What the *CFAX/P* can also do is directly support the Complete PC's family of hand scanners and several compatible page scanners. Of course, the usefulness of this feature depends on whether your portable PC has an expansion slot for the scanner's interface card. The Epson Equity 386-LT I used for a while had this slot, while the notebook PCs I've been favoring lately don't.

When traveling with a notebook PC and the Complete FAX/Portable a lot, I generally have *PC Paintbrush* installed on my PC so that if I have to make changes on a received layout, I can do so by converting the received fax into .PCX format, make the change in *PC Paintbrush*, then convert the file back to fax format and transmit it to my office. This sounds somewhat convoluted, but since the *CFAX/P* software makes the outgoing conversion automatically when I include the .PCX file as part of my outgoing document, it's really a lot easier than it might seem at first.

The one thing the Intel card offers that I wish the Complete FAX/Portable did is Alien Computing's *FAXit*. I've pretty much switched over to Microsoft's terrific *Word for Windows*, and *FAXit* lets me fax directly from this application. With *CFAX/P*, I have to save the document in ASCII first or use one of the non-*Windows* applications that *CFAX* software supports. On the plus side, though, I can use the *CFAX/P* on both my portable and desktop PCs just by unplugging the serial cable. As none of my current portables has an expansion slot, the Intel card is, naturally, desk-bound.

The Complete FAX/Portable requires a hard disk with at least 3M free, 640K of RAM, MS-DOS 3.1 or later and an 80-column display with CGA, EGA, VGA or Hercules graphics capability. If your laptop or notebook uses battery-conservation techniques, like shutting down the hard-disk drive after a few seconds of inactivity, you'll want to change this timing parameter to avoid losing fax data while the drive is brought back up to speed. ■

Products Mentioned

Intel SatisFAXtion ($499)
Intel PCEO
5200 N.E. Elam Young Pkwy.
Hillsboro, OR 97124
800-538-3373

The Complete FAX/Portable ($499)
The Complete PC
1983 Concourse Dr.
San Jose, CA 95131
408-434-0145

Joseph Desposito

Flash Memory Programming Adapters, a New NEC Microcontroller, Dual-port RAMs and a Battery Back-Up IC

This month, I'll tell you where you can obtain an adapter if you want to program Intel's flash memory chips. Then I'll discuss a new 16-MHz microcontroller, nine-bit-wide dual-port RAMs and an IC for battery back-up control.

Flash Memory Programming Adapters

Programming adapters for Intel's recently released TSOP (Thin Small Outline Package) flash memory chips can be obtained from Emulation Technology (2344 Walsh Ave., Bldg. F, Santa Clara, CA 95051). They're the latest addition to the company's Adapt-A-Socket product line. With these adapters, engineers who design with TSOP flash memory chips can now program these chips with DIP programmers.

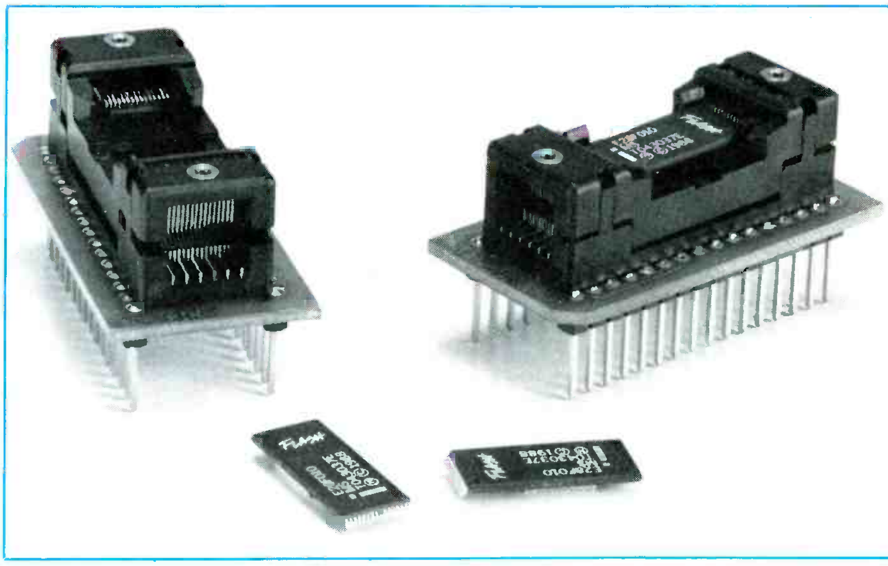
Available in 1- and 2-megabit densities, the TSOP is the latest generation of plastic surface-mount memory packaging from Intel. It provides an unprecedented level of nonvolatile memory bits for space-constrained applications. The TSOP flash memory chip measures only 20 × 8 × 1.2 mm and has 32 pins on only two sides of the package. The high-density, compact packaging of this high-performance chip increases the need for a quick and reliable socket adapter.

Emulation Technology has designed the new socket adapters to fit all DIP programmers currently being manufactured, since more programmers are designed to accept DIP packages than any other package type. A user plugs the Adapt-A-Socket into a DIP socket and inserts the TSOP chip into the adapter.

Intel's TSOP, introduced last June, supports the electronics industry's trend towards miniaturization of components and systems, using a third to a half the volume of other surface-mount packages, according to Intel.

Flash memory is an inherently nonvolatile, read/write semiconductor memory device. In a TSOP package, it's particularly advantageous in such size-critical applications as memory cards, laptop and notebook PCs, hand-held instruments, disk-drive controllers, cellular telephones and laser printers.

Adapt-A-Sockets for TSOP flash memory are available for $96.50 in both standard and reverse pinouts.



Emulation Technology's new programming adapters for Intel flash memory in TSOP.

New Microcontroller

Like its predecessor, the eight-bit K2, the new K3 16-bit internal/eight-bit external microcontroller from NEC Electronics (401 Ellis St., P.O. Box 7241, Mountain View, CA 94039) features enhanced Peripheral Management Unit (PMU) technology. PMU permits the device to service most types of interrupts while maximizing host processor speed.

The PMU technology makes K-Series products good choices for embedded applications. The 12-MHz K2 microcontrollers offer multiple data-transfer capabilities through the PMU. These controllers are useful for such applications as office automation, security systems and motor control. In comparison, the 16-MHz speed of the K3 microcontrollers pushes the PMU to provide CPU-type functions while handling the data as it's transferred to or from the peripherals. This leaves the CPU even less burdened for more complex high-end applications, including anti-skid braking, hard-disk drives, engine control and other embedded applications.

K3 microcontrollers incorporate 16-bit CPUs, 10-bit A/D converters, real-time pulse units and real-time output ports on a single chip. Features include a minimum command-execution time of 250 ns with an operating clock frequency of 16 MHz, up to 32K of ROM, 1K of RAM and 64K of external address space.

The real-time pulse unit consists of three sets of 16- and 18-bit timers and counters and 16 auxiliary registers for comparing or capturing operations with the timer or counter. This enables pulse widths and frequencies of input signal pulses to be measured in high frequencies while controlling timer output.

Designers can assign three types of interrupt functions with the K3 family: vector interrupt, context switching and PMU intervention. The PMU method can offer up to five times performance improvement over vector interrupt.

Development tools for the K3 include an in-circuit emulator, evaluation board, relocatable assembler, structured assembler and C-compiler.

K3 microcontrollers are available in 64- to 94-pin PLCC and quad flat packages, depending on the product. All are supported by EPROM parts. The K3 is priced at $15 each in 10,000 quantity.

Dual-Port RAMS

Integrated Device Technology (IDT, 3236 Scott Blvd., P.O. Box 58015, Santa Clara, CA 95052) has new nine-bit-wide dual-port RAMs. The first two members of this new family are available in configurations of 1K × 9 (IDT70101, IDT7010 and IDT70105) and 2K × 9 (IDT70121, IDT7012 and IDT70125) with access times as low as 25 ns. They're useful in multi-processor systems, especially in telecommunications, DSP (digital-signal processing), radar/sonar and imaging applications.

The ×9 configuration of these devices permits designers to use the extra bit as a parity bit. Typically used in telecommunications applications, the parity bit enables systems to employ error checking that helps ensure the validity of data transmission. Normally, extra hardware is required to accomplish this. In addition, these are true dual-port memories that include on-board arbitration logic. This means that data can be accessed from both ports simultaneously by multiple processors, with no risk of data corruption. Designing a multiple processor system no longer means that extra external hardware and software are necessary to access data in RAM.

Another benefit of IDT's ×9 dual-port RAMs is that its access time of 25 ns permits 0-wait-state operation. Overall system performance improves because processors can obtain needed information from the RAM in one cycle. Slower devices require processors to go into a wait-state mode for one cycle before retrieving the data.

These devices are offered in 48-pin DIP, LCC (leadless chip carrier), side-brazed 52-pin LCC and PLCC (plastic leadless chip carrier) packages with speeds ranging from 25 to 55 ns. The IDT7010525P is priced at $21.65 in quantities of 100.

Battery Back-Up

Fujitsu Microelectronics' (Integrated Circuits Div., 3545 N. First St., San Jose, CA 95134) new MB3780A battery back-up IC bipolar linear technology. It provides all functions needed for battery back-up control on a single chip. Designed specifically for use with SRAMs, ROMs and logic IC devices, this IC automatically switches to two alternate power sources—either non-rechargeable primary battery or rechargeable secondary battery—during dc power losses or disturbances. With battery back-up control, systems are protected from destructive fault conditions, maintaining system data integrity.

The IC features a low 1.0-mA standby current and a 200-mA output drive current (drive current can be increased with an external power transistor). In addition, it offers a low input-to-output differential of just 230 mV for greater efficiency. The device also provides an input loss detection level of 4.2-volt + 2.5% for higher accuracy and has an on-chip secondary 2.8-volt rechargeable battery.

Applications for the MB3780A include mini-, mainframe- and network-server systems in the medical, airline and banking industries.

Fujitsu's battery back-up IC is available in a 16-pin plastic DIP and 16- and 20-pin plastic FPTs (flatpacks). DIP-packaged devices are priced at $1.15, while flatpack devices are priced at $1.50, both in 1,000-piece quantities.

Analog Circuits Op-Amp Lab Answer Box

(from page 49)

1. (A) 10
   (B) 75 ohms
2. (A) 5.0 volts p-p
   (B) 10
3. (A) V2 = 0.25 volt p-p
4. (A) 22 volts p-p
5. (A) 22 volts p-p
   (B) 18 volts p-p
   (C) 10 volts p-p
6. (A) 22 volts p-p
   (B) 21 volts p-p
   (C) 4 volts p-p
   (D) 3 volts p-p
   (E) Distortion changes from clipped to triangular wave shape
   (F) Readings are a bit lower than shown in Fig. 8 because supply is only ±12 volts.
   (G) Lower load resistances lower maximum p-p output voltages at all frequencies.
7. (A) 1
   (B) 0.4 μs
   (C) 5.0 μs
8. (A) 22 volts
   (B) 15 μs
   (C) 0.68 V/μs
   (D) 0.6 V/μs

Coming In July

- Turn On Your Computer By Phone
- Using Non-Volatile Memory ICs
- Upgrade an AT to a 386
- Make a Parallel-Port EPROM Programmer, Pt. 2
- New Schematic & PC Layout Programs
- Working with Assemblers
- Heath's New Computer Kit and more

Software Review *(from page 90)*

Bird's Eye View

EZCosmos ($69.95)
Future Trends Software
1601 Osprey Dr., Ste. 102
DeSoto, TX 78764
Tel.: 800-869-EASY

Requirements:

Computers	IBM & Compatibles, 512K RAM
Graphics	VGA, EGA, CGA, Hercules

Evaluation

Documentation	Good
Graphics	Excellent
Learning Curve	Short
Complexity	Easy
Play Length	N/A
Playability	N/A
In Brief:	Ideal for indoor stargazing. Can be used as a potent learning tool. May well be the best astronomy software for the personal computer

terms. It offers brief comments on the meaning of sidereal time, right ascension and declination. The comments and definitions will be greatly appreciated by novice astronomers.

An extra feature is seen in beautiful graphic pictures. Many of the more intriguing sky objects are stored in 256-color GIF files. They include M13: a globular cluster in the constellation Hercules; M27, a planetary nebula located in the constellation Vulpecula; and even such more-familiar objects as the Andromeda Galaxy and the Orion Nebula. There are 40 such pictures included with this version. More pictures become available as they're digitized.

EZCosmos is a superb program that can serve anyone's interest in astronomy. It's accuracy, animation and user features make it a most complete astronomy program. It is ideal for indoor stargazing and it can be used as a potent learning tool. It may well be the best astronomy software for the personal computer.

For a review of *Astronomy Lab for the IBM PC*, see page 85.

CIRCLE NO. 151 ON FREE INFORMATION CARD

Letters . . . *from page 7*

disks for *PCBoards*, *PCRoute* and *SuperCAD* are available for $10, a very low price. I wish more software program companies would offer demos.

Mike Giamportone
Yale, MI

•At last, a computer magazine with the hobbyist in mind. Although I use a computer regularly at work, it's also my hobby and I pursue it avidly. I own a 386-25 tower with a Myltisync 3-D at home, along with a laptop. I also run a computer BBS system for our club, the Anderson Computer User Group.

Most computer magazines evidently believe that their readership consists entirely of MIS directors, top executives and secretaries. These magazines are choked with redundant information about astronomically expensive software packages and overpriced hardware.

I and others like me have been starved for information about hardware tweaks and software shortcuts for the average person who doesn't spend $6,000 for a computer he can buy for $2,500. We've been longing for insights into ways we can improve our systems without dumping them every year to buy the "latest, greatest and fastest."

For instance, I was a charter subscriber to *PC/Resource* until it was absorbed into *PC World* magazine. Now, the excellent technical articles are relegated to the smallest space possible, while the majority of the magazine is devoted to discussion of whether Microsoft will merge with Lotus and other inane subjects.

Roy J. Winkler
Anderson, IN

Computers, Never!

• Please excuse this hand-written letter. I do not own a computer, nor do I plan to own one in the near future. Cancel my subscription.

W.V. Shuford
Winder, GA

We welcome your input. If you have comments or suggestions to make about any article, column or department, address your correspondenc to Computer-Craft, *Letters Department, 76 North Broadway, Hicksville, NY 11801.*

Astronomy Lab for the IBM PC: View the Stars and Planets on Your PC

By Joseph Desposito

If you're interested in astronomy or want to learn about this interesting field, you should investigate *Astronomy Lab for the IBM PC* from Personal MicroCosmos. This program's likeness of the heavens includes such features as movies that simulate a host of astronomical events, charts that illustrate fundamental concepts of astronomy and reports that contain predictions of important astronomical events. All movies, charts and reports are customized to the user's location and time zone.

The software maker recommends that you use an IBM AT or more powerful model computer with at least 512K of RAM, MS-DOS 3.0 or later, a hard disk (or high-density 3½" or 5¼" floppy drive) and EGA (256K) or VGA graphics. *Astronomy Lab* will use a math coprocessor if one is installed. An Epson PostScript-compatible printer is required to print charts and other graphical images. *Astronomy Lab*, which includes a single 720K 3½" floppy disk, two 360K 5¼" disks and a 153-page plastic-spiral-bound manual, sells for $59.95.

About the Program

Astronomy Lab produces movies, charts and reports that are customized for the user's locale: latitude, longitude, time zone and elevation above sea level.

An *Astronomy Lab* movie is a simulation on-screen of an astronomical event. There are several kinds of movies, including the night sky movie and the day/night movie. The night sky movie is a representation of an astronomical event visible from the Earth. These events include solar and lunar eclipses, transit of Mercury and Venus, lunar occultations (eclipses) of stars and planets, mutual planetary occultations and planetary occultations of stars. A night sky movie looks like the display shown in Fig. 1.

The symbols or "glyphs" on the display are used to locate the sun, moon and planets. (The manual has a chart that shows which planets correspond to which glyphs.) Basically, the day/night movies show circles, diamonds and dots moving with respect to one another and are not photo-quality images of the planets.

The day/night movie shows sunlit regions of the Earth. Figure 2 shows a frame from a day/night movie on August 1, 1990. Among other things, the frame displays the North Pole illuminated by the midnight sun.

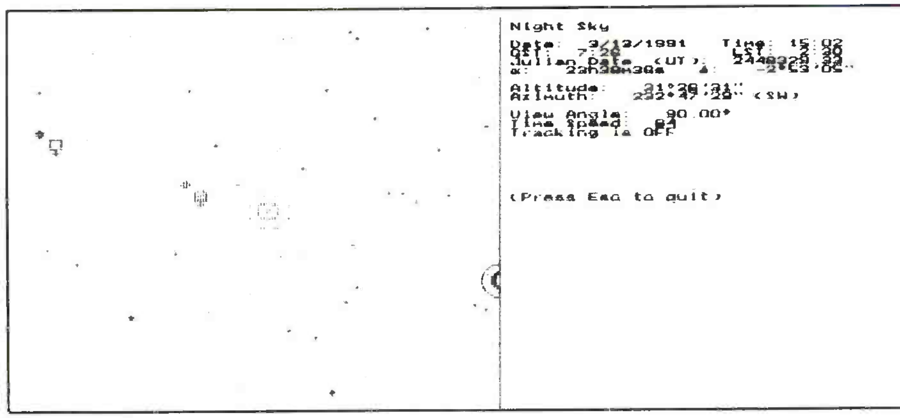


Fig. 1. A typical frame from a night-sky movie.

Other movies included with the program illustrate planet orbits from above the ecliptic, a side view of planet orbits, orbits of Jupiter's moons viewed from the Earth and orbits of Jupiter's moons viewed from above the planet.

The charts produced by *Astronomy Lab* illustrate fundamental concepts of astronomy. All charts can be generated for any date between 1000 CE and 3000 CE. The program can produce 12 different types of charts, including planet orbits, Jupiter moons orbits, angle of the sun at noon for one year, azimuth of sunrise for one year and other charts. A jupiter moons orbit chart is shown in Fig. 3.

The reports produced by *Astronomy Lab* contain predictions of important astronomical events, including calendar, solar eclipses, lunar eclipses, planet apsides and more.

Installation & Use

To install *Astronomy Lab*, you need only create a directory on the hard disk and then copy the files from the included floppy disk(s) to the hard disk. To start the program, you type AL at the DOS prompt for *Astronomy Lab*'s directory.

Astronomy Lab uses a horizontal menu bar with eight choices. You select a choice by typing its initial letter. (Curiously enough, the first choice is Quit.) A drop-down menu with further choices then appears, as in Fig. 4.

Since *Astronomy Lab* is a customized program, as cited, you must enter latitude, longitude, time zone and elevation information. You do this by selecting the Set Location choice on the menu bar. The manual includes location information for many U.S., Canadian and other cities around the world. Rather than having to look up this information in the manual and enter it into the program, I would have preferred to select a city from a list supplied by the program and have the data entered automatically.

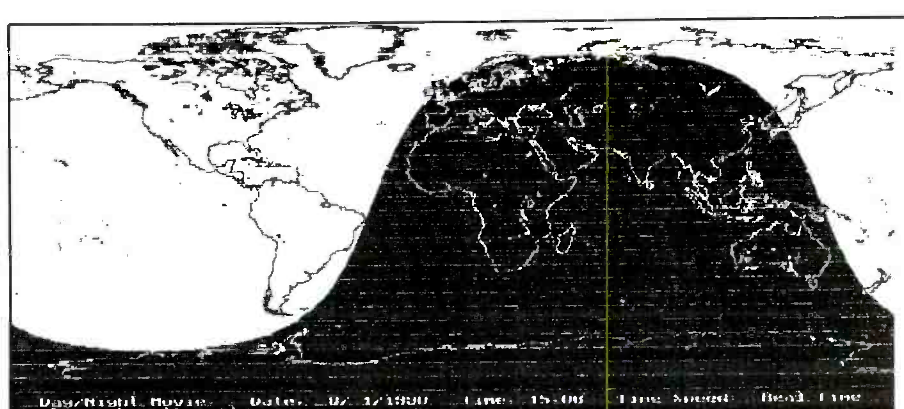


Fig. 2. A frame from a day/night movie of August 1, 1990.

To run a movie, you select Movies from the horizontal menu bar and then choose the movie you want to watch from the menu shown in Fig. 4. When you choose a movie, a dialog box appears, where you enter the date and time of the movie you want to watch. A movie, such as a night-sky movie, shows movement of stars and planets in relation to each other. You can either speed up or slow down a movie and make it progress in time or retreat in time. If events are happening slowly, there is a turbo mode that lets you speed things up by a factor of 1,000.

Charts and reports are also generated through choices on the main menu bar. When you choose Charts or Reports, a drop-down menu appears with a list of choices. Once you choose the type of report or chart you want to create, dialog boxes appear in which you enter such pertinent information as dates and which celestial bodies to include.

Charts and reports can be generated either on-screen or on a printer, or they can be saved to a disk file. Movie frames can be printed or saved to disk. If you press F5 during a movie or when a chart is displayed on-screen, a snapshot is taken of the screen. After taking a snapshot, you select Display from the menu bar and then choose Screen Dump from the drop-down menu. You then have the choice of sending the image to the printer or a file for later printing.

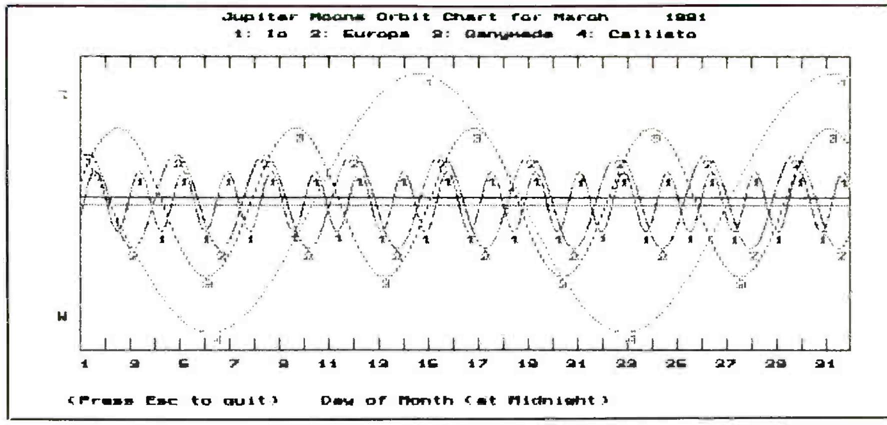


Fig. 3. A Jupiter moons orbit chart.

Documentation

The 153-page manual that accompanies the *Astronomy Lab* software is both a guide to using the program and a tutorial on astronomy. The manual is well-written and well-illustrated and includes activities to do with *Astronomy Lab*. The manual also includes tips for using the program in conjunction with your favorite spreadsheet. For those who get bitten by the astronomy bug after using this program, there is a comprehensive list of books and magazines listed in the manual to help broaden the user's knowledge of astronomy.

Conclusions

Astronomy Lab is a thoughtful program that provides solid information for anyone interested in learning about astronomy. Although appropriate for novice users who want to use it as an educational tool, the program can also be used by seasoned astronomers to calculate when astronomical events will occur and where in the sky they will be found.

With its movies, charts and reports, *Astronomy Lab* gives you plenty to work with. However, if you are interested in photos of the universe, such as those taken by *Voyager 2*, to show to a class or group, you have to look elsewhere.

To sum up, *Astronomy Lab* is an excellent choice for anyone looking for a program that teaches the fundamentals of astronomy. If you already know about astronomy and need a program to help you make the best use of your observing time, *Astronomy Lab* can fill the bill for you.

For a review of the *EZCosmos* program, see page 90.

In Brief	
Astronomy Lab for the IBM PC ($59.95)	
Personal Microcosmos	
Computers	IBM/compatibles, 512K RAM
Video	VGA, EGA (256K)

Evaluation	
Documentation	Very good
Graphics	Good
Learning curve	Short
Complexity	Easy

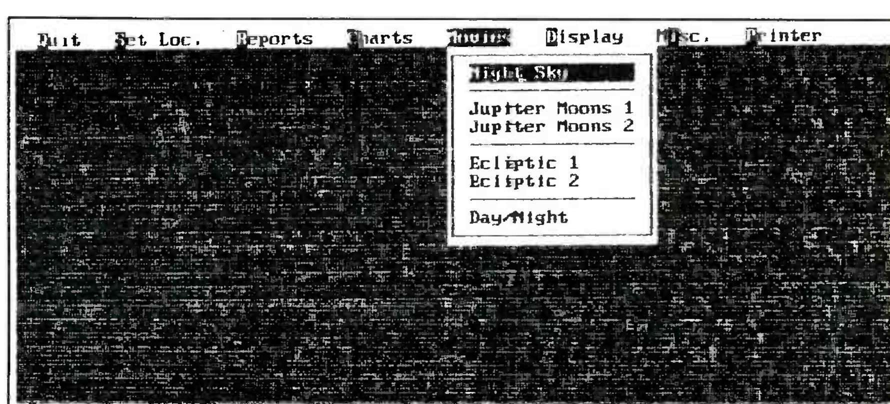


Fig. 4. Astronomy Lab's main menu.

ComputerCraft Mart

Classified Commercial Rates: $1 per word, 15-word minimum ($15.00) prepaid. (Word count includes name and address; ZIP code and abbreviation each count as one word; P.O. Box number and telephone number count as two words each.) Indicate free category heading (**Computers, Communications, Electronics, Video** or **Miscellaneous**). A special heading is available for a $6 surcharge. First word only is set boldface caps at no charge. Add 20% for additional boldface words.
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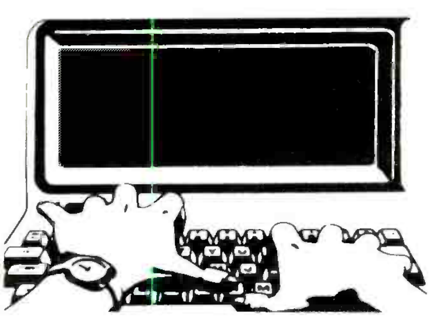

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Two Astronomy Programs:

EZCosmos: Revealing The Entire Celestial Sphere

By SF Sparrow

Astronomy for the personal computer seems to have lagged behind other leisure software development. Future Trends Software remedies the situation with *EZCosmos*, an astronomy program that's in a class by itself.

The first impressive feature of this package is its visual presentation. The night sky is drawn on the computer screen in brilliant 16-color resolution for computer owners who have this capability. All types of celestial objects appear, including stars, planets, clusters, galaxies and nebulae. Constellations are clearly marked as if strung with silken thread. Besides appearing in varying colors, the stars and other objects are painted in accurate relation to one another, easing close study of the constellations.

Ease of use makes *EZCosmos* more enjoyable as both a toy for casual stargazers and as a tool for the serious amateur. Experts, too, will find some useful features. Viewing the sky for any time and any place is a simple matter of entering required information on the Status screen. Geographical position can be entered by city name. That's a quick way to get going with some stargazing that places familiar star groupings overhead. Approximately 500 major cities are supported.

For those who like to be more detailed about matters, *EZCosmos* just as readily accepts longitude and latitude coordinates. Accordingly, star watchers can accurately see the sky from literally any place on the Earth. Other configurable items on the Status screen are toggles that let one define his own viewing environment before the sky is actually plotted. Constellations and NGC objects can be turned on and off. So can planetary display and text labels. Users can have either a view that's aesthetically pristine or one that's filled with helpful information.

On command, positions of the planets are calculated and a section of the sky is splendidly displayed. The display can be advanced or regressed in time so that any constellation can be brought overhead. In addition, the angle of view can be decreased to as little as 1°. These controls are all accessible from a pop-up menu. The smaller angles of view are perfect for zooming in on particular objects. In addition, the overhead view can be widened to a full 270° horizon-to-horizon panorama. This affords an opportunity to see the sky in a manner that's impossible by conventional means.

Such flexibility in manipulation is a powerful tool for astronomical study. But it can be easy to become overwhelmed by a full screen of piercing stars and other celestial objects. To counter this, the software's Magnitude Filter lets you adjust the sky plot to display only those objects discernible with the unaided eye. With a few adjustments of angle, magnitude and a couple of Status screen toggles, you can duplicate the sky close enough so that a look outside at the real thing appears uncannily like the computer screen's display.

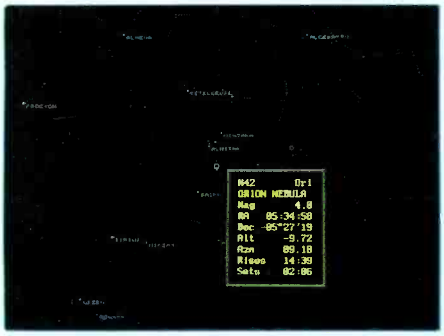
One of the more outstanding features this package contains is its animation capability. Users can watch the magical movement of planets as they dance across the computer screen. The animation time slice can be set in hours or days. This function lets you watch the full cycles of the moon in relation to the other planets, for example.

Animation is particularly useful in conjunction with the program's ability to track time. Users can enter the time of any day or night, from as far back as 4000 BCE, all the way forward to 10,000 CE and have it shown. As a result, celestial activity can be displaced by many years, past or future. How did the sky look when Christ was born? How will it look during the next solar eclipse? Each event can be replayed after the fact or preplayed before it happens.

Perhaps the most effective feature of *EZCosmos* is that it allows astronomy buffs to do serious star watching during daytime or when the weather is too cold or viewing conditions are too poor for natural viewing. Having the heavens at one's command helps to integrate the theory of astronomy with computer simulation. Astronomy students and other interested parties can actually see the apparent path of the sun and planets through the constellations. Furthermore, the often-difficult concepts of precession and retrograde motion can be witnessed and understood in a different light. These features make *EZCosmos* an effective teaching and learning aid.

The documentation, too, is quite helpful. *EZCosmos* has an on-disk manual that's complete and informative. It has a list of all the constellations and explains some of the more esoteric astronomy

(Continued on page 84)



A narrow view of the Orion nebula and its neighbors.

A view of NGC2024, the Horsehead nebula.

A full-screen view of the night sky as seen in Dallas, Texas.

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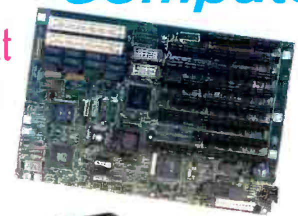

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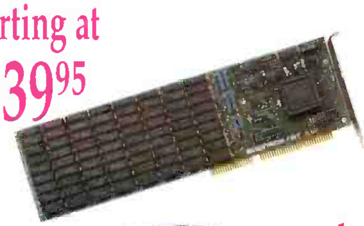

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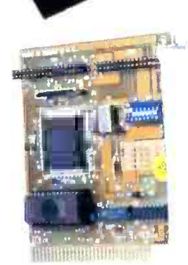

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