YOUR ONE-STOP SOURCE OF ELECTRONICS INFORMATION

ICD 08559

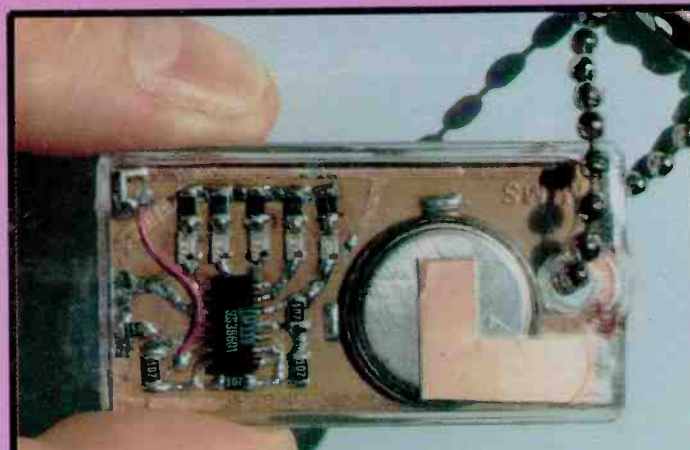
MODERN ELECTRONICS™

MARCH 1987 $1.95
CANADA $2.50

THE MAGAZINE FOR ELECTRONICS & COMPUTER ENTHUSIASTS

- **A DISTRIBUTION AMP PROJECT FOR CLEAN AUDIO & VIDEO**
- **USING AN OSCILLOSCOPE TO MAKE DIGITAL LOGIC MEASUREMENTS**
- **HOW TO ADD A HARD-DISK [...]OR CARD TO [...]ONAL COMPUTER**

Plus
- U[...]he EPROM Programmer t[...]4K and 128K EPROMs
- A[...]te Telephone Bell R[...]t/Stand-Alone Annunciator



Keychain Electronic Projects (p. 68)

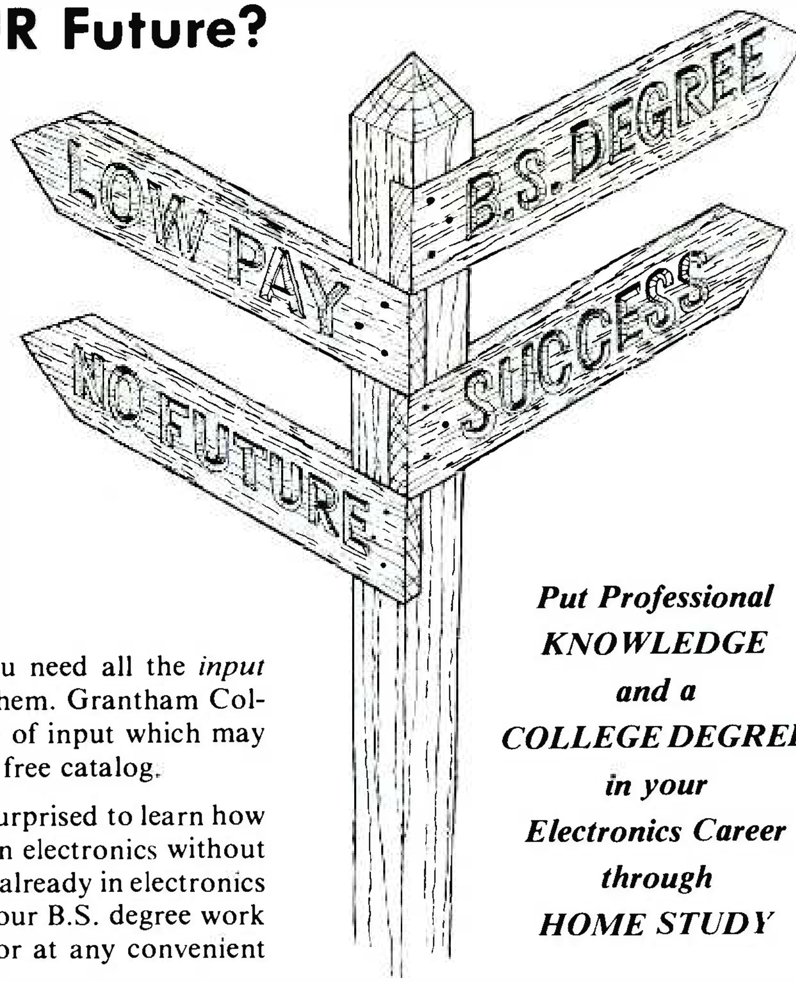
Solid-State Phone Bell Replacement/Annunciator (p. 48)

Adding A Hard-Disk Drive to a Personal Computer (p.26)

Bulk Rate
Permit No. 79
U.S. Postage Paid
Gordonsville, VA 22942

Also: Forrest Mims' Keychain Electronic Projects Using SMTs • Eric Grevstad's First Impressions of the Tandy 3000HL and Words & Figures • Don Lancaster on Genlocking Video Images, V/F Converters, & an Easy Printed-Circuit Process, etc. • Desktop Publishing Power with MacPublisher • Electronic & Computer News . . . and more.

Which Way To YOUR Future?



Are you at a crossroads in your career? Have you really thought about it? Are you *planning* for your future, or perhaps refusing to face the subject? Which way will you go — down the same old road? Or are you ready for something else?

In electronics you can't stand still. If you are not moving ahead, then you're falling behind. At the crossroads of your career, various choices are available — and, yes, *decisions* have to be made.

Which road will you take — one that doesn't go where you want to be, or one that leads to hard work *but also* to the better life? Ah, decisions, decisions!

Career decisions are so important that you need all the *input* you can get before locking-in on one of them. Grantham College of Engineering offers you *one* source of input which may help you in making that decision. It's our free catalog.

Ask for our free catalog and you may be surprised to learn how it is easily possible to earn a B.S. degree in electronics without attending traditional classes. Since you are already in electronics (you are, aren't you?), you can complete your B.S. degree work with Grantham while studying at home or at any convenient place.

But don't expect to earn that degree without hard work. Any degree that's worth your effort can't be had without giving effort to the task. And of course it is what you learn in the process, as much as the degree itself, that makes you stand out above the crowd — that places you in an enviable position, prestige-wise and financially.

Put Professional KNOWLEDGE and a COLLEGE DEGREE in your Electronics Career through HOME STUDY

Grantham offers this program, complete but without laboratory, to electronics technicians whose objectives are to upgrade their level of technical employment.

Recognition and Quality Assurance

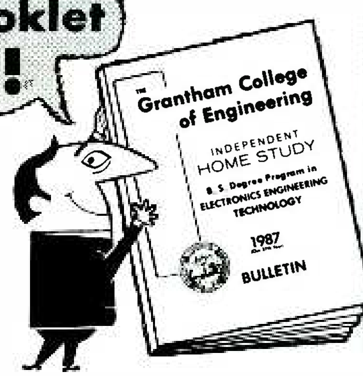
Grantham College of Engineering is accredited by the Accrediting Commission of the National Home Study Council, as a degree-granting institution.

•

All lessons and other study materials, as well as communications between the college and students, are in the English language. However, we have students in many foreign countries; about 80% of our students live in the United States of America.

Grantham College of Engineering
10570 Humbolt Street
Los Alamitos, California, 90720

This booklet FREE!



This free booklet explains the Grantham B.S. Degree Program, offered by independent study to those who work in electronics.

for FREE Booklet CLIP COUPON and mail in envelope or paste on postal card.

Grantham College of Engineering M-3-87
10570 Humbolt Street, Los Alamitos, CA 90720

Please mail me your free catalog which explains your B.S. Degree independent-study program.

Name____________________ Age______

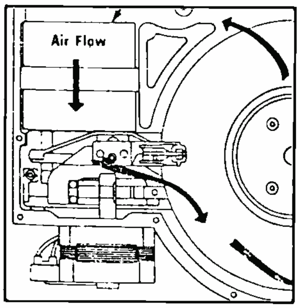
Address__________________________

City__________ State________ Zip______

MODERN ELECTRONICS

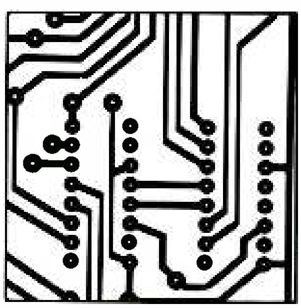
THE MAGAZINE FOR ELECTRONICS & COMPUTER ENTHUSIASTS

MARCH 1987 **VOLUME 4, NUMBER 3**

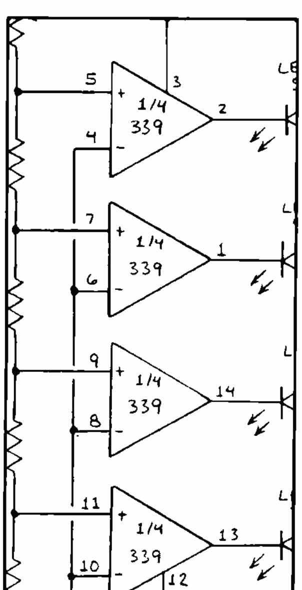


26

34



44



68

FEATURES

COLUMNS

DEPARTMENTS

Offices: 76 North Broadway, Hicksville, NY 11801. Telephone: (516) 681-2922. Modern Electronics (ISSN 0748-9889) is published monthly by Modern Electronics, Inc. Application to mail at second class rates pending at Hicksville, NY and other points. Subscription prices (payable in US Dollars only): Domestic—one year $17.97, two years $33.00, three years $48.00; Canada/Mexico—one year $20.00, two years $37.00, three years $54.00; Foreign—one year $22.00, two years $41.00, three years $60.00. Foreign Air Mail—one year $75.00, two years $147.00, three years $219.00.

Postmaster: Please send change of address notice to Modern Electronics, Inc., 76 North Broadway, Hicksville, NY 11801.

CABLE-TV

LOWEST PRICES ANYWHERE

SCIENTIFIC ATLANTA UNITS

BONANZA!

ITEM	SINGLE UNIT PRICE	DEALER 10-UNIT PRICE
RCA 36 CHANNEL CONVERTER (CH. 3 OUTPUT ONLY)	29.95	18.00 ea.
PIONEER WIRELESS CONVERTER (OUR BEST BUY)	88.95	72.00 ea.
LCC-58 WIRELESS CONVERTER	92.95	76.00 ea.
JERROLD 450 WIRELESS CONVERTER (CH. 3 OUTPUT ONLY)	105.95	90.00 ea.
SB ADD-ON UNIT	109.95	58.00 ea.
BRAND NEW — UNITS FOR SCIENTIFIC ATLANTA	*Call for specifics*	
MINICODE (N-12)	109.95	58.00 ea.
MINICODE (N-12) VARISYNC	119.95	62.00 ea.
MINICODE VARISYNC W/AUTO ON-OFF	179.95	115.00 ea.
M-35 B (CH. 3 OUTPUT ONLY)	139.95	70.00 ea.
M-35 B W/AUTO ON-OFF (CALL FOR AVAILABILITY)	199.95	125.00 ea.
MLD-1200-3 (CALL IF CH. 2 OUTPUT)	109.95	58.00 ea.
INTERFERENCE FILTERS — CH. 3	24.95	14.00 ea.
JERROLD 400 OR 450 REMOTE CONTROLLER	29.95	18.00 ea.
ZENITH SSAVI CABLE READY (DEALER PRICE BASED ON 5 UNITS)	225.00	185.00 ea.
SPECIFY CHANNEL 2 or 3 OUTPUT	***Other products available — Please Call***	

Quantity	Item	Output Channel	Price Each	TOTAL PRICE
			SUBTOTAL	
			Shipping Add $3.00 per unit	
			COD & Credit Cards — Add 5%	
			TOTAL	

California Penal Code #593-D forbids us from shipping any cable descrambling unit to anyone residing in the state of California.

Prices subject to change without notice.

PLEASE PRINT

Name ______________________

Address ______________________ City ______________________

State ____________ Zip ____________ Phone Number ( ) ____________

☐ Cashier's Check ☐ Money Order ☐ COD ☐ Visa ☐ Mastercard

Acct # ______________________ Exp Date ____________

Signature ______________________

FOR OUR RECORDS:

DECLARATION OF AUTHORIZED USE — I, the undersigned, do hereby declare under penalty of perjury that all products purchased, now and in the future, will only be used on cable TV systems with proper authorization from local officials or cable company officials in accordance with all applicable federal and state laws.

Dated: ____________ Signed: ______________________

SCIENTIFIC ATLANTA UNITS

LOWEST PRICES ANYWHERE

Pacific Cable Company, Inc.

7325½ RESEDA BLVD., DEPT. # 20 • RESEDA, CA 91335

(818) 716-5914 • *No Collect Calls* • (818) 716-5140

IMPORTANT: WHEN CALLING FOR INFORMATION
Please have the make and model # of the equipment used in your area. *Thank You*

EDITORIAL

Consumer Rights & Wrongs

We have a lot of consumer rights, some of which have constitutional support. But that doesn't mean you can do everything you wish to, even when it might seem that it's legal. For example, it's illegal to yell "Fire!" in a crowded auditorium when there is no fire, so don't look to First Amendment Rights here (and rightly so!)

In the electronics and computer areas, there are a host of "You shall nots" that consumers should (but don't always) obey. Some of these laws change, of course, while others come to the forefront by being newly introduced.

On the former, the Communications Privacy Act is now public law 99-508, which is effective January 19, 1987. It has enough ambiguities to drive a Mack truck through it, though. It needs a good definition/interpretation of the word, "surreptitious," for example. The way it's worded, any secret listening might be construed to be a violation, even if it isn't specifically prohibited. Would listening to someone else's marine radiotelephone conversations be illegal under this new law? I'd say no, even though it is surreptitious listening. But the law doesn't spell it out.

Concerning newly introduced technology, the people at General Instrument Corp., which recently purchased M/A-Com's Video Cipher Division, appear to be worried about pirate satellite TV descramblers that are claimed to break security of its VC II descrambler box. GI claims that their investigations show that many decoders with "fixes" are frauds, while other modifications have been anticipated and can be controlled through multiple levels of security measures that make the pirate descramblers useless.

The company notes that the Cable Communications Policy Act of 1984 makes violators who make or sell products designed to receive encrypted signals without authorization subject to a fine of $50,000 and up to two years in jail, while recipients of these signals without authorization can be fined up to $1,000 and jailed for up to six months.

Nonetheless, "stealing" signals from HBO, Showtime, etc., must be concerning GI in light of its press-release warning. Interestingly, an underground, widely circulated newsletter gives insights to how to give a VC II a "fix." It talks about coded chip-cloning methods, with the ins and outs of modifications, costs for getting a serial-numbered ROM and replicating it, etc. Bad business!

There are other consumer-rights activities churning that relates to electronics. Outstanding among them concerns the new generation of digital audio tape recorders (DATs).

Audio recording companies are seeking agreement from equipment manufacturers to incorporate a VLSI chip in their DAT equipment that would prevent consumers from recording the copyrighted music it contains (and, consequently, raise the price the consumer has to pay for the equipment). Happily, the Electronic Industries Association of Japan, representing hardware makers, rejected this anti-copying circuitry that the music industry's representatives are pushing.

EIAJ members said they will not accept the International Federation of Phonogram and Videogram Producers' (IFPI) posture of placing consumers and commercial pirates in the same position. Nor does the EIJA agree that home taping suppresses sales of records and tapes, as charged by the IFPI.

The DAT equipment manufacturers have already established a special playback mode and does not have any digital-to-digital recording capability. Furthermore, DAT's digitization sampling frequency differs from that of CD recordings (48 kHz vs. 44.1 kHz).

Along the lines of what the music industry is trying to do to squeeze out money on top of the large royalties they already receive from records and prerecorded tapes, the motion-picture industry is also striving to get anti-copy ICs into VCR equipment, which the U.S. Congress will soon be addressing as a result of an appeal from motion-picture companies.

Everyone agrees that commercial pirates are blatant thieves and that steps should be taken to prevent them from pursuing their illegal activities. But this should not come at the expense of the consumer.

(Continued on page 80)

Reader Feedback

• One of the greatest applications of a dual-trace scope was not even mentioned in "Understanding and Using Dual-Trace Oscilloscopes" (October 1986)—the viewing of signals on balanced lines (telephone, audio, etc.) using the invert and add mode. Also, the need for an isolation or ×10 probe came about to prevent loading caused by the scope's input resistance and capacitance. The isolation probe should be used at all times except when the scope (or its feed cable) is of desired ideal terminating impedance, terminated to eliminate circuit impedance-changing effects.

In the "Programmable Ni-Cd Recycler" (same issue), by the time the battery is discharged to where an assumed 1 volt per cell is reached, I'll bet 99% batteries in the field will have one or more cells at 0 volt or are already in reverse-charge. A 1-volt per cell discharge is *too* low. Ideally, the weakest cell should not go below 1.0 volt (unless you are deliberately trying to give it a complete discharge test, which is not normally desirable).

Your team of Forrest M. Mims and Don Lancaster make *Modern Electronics* a requirement for the modern electronics person!

Franklin Swan
Oak Forest, IL

Accelerator Update

• The $30 PC Speed-up Board article I wrote in ME's February 1987 issue was based on installing the device in Zenith PC compatibles. I discovered too late that a true-blue IBM PC's 8284 chip, mounted on its motherboard, doesn't leave enough room to plug in the Accelerator. You need a right-angle 18-pin socket or another board. We'll send another board at no charge to those with an IBM machine who ordered and received it. Anyone else ordering the PCA board should request it as PCA-IBM. Sorry.

Bill Owen
NRG Electronics

Also, readers should note that an original IBM PC, which has only 64K-maximum motherboard RAM, has its 8284 clock IC soldered in, so it's necessary to desolder it and mount a socket in its place in order to install the PCA.—Ed.

• I always purchased "hard to find" parts first so I wouldn't be stuck with a lot of other parts when the critical ones can't be found. My mistake was believing the author of the "Ocean Box" in your Feb. 1986 issue when he said the IC (National Semiconductor's MM5837) that is the heart of the device is readily available. Also two 2.2-megohm potentiometers are needed.

I do not live in a thinly populated area and have been to several major electronics supply houses that are fairly close. Without exception, they all claimed total ignorance of the existence of such a chip. One asked if I had transposed the num-

(Continued on page 80)

OPEN MAC. Open-architecture Apple Macintosh computer versions are soon to debut. Took them three years to recognize the positive aspects of this, which would open the gates for third-party developers to create and produce products to give users greater operating and expansion flexibility. Room for 8088, 8086 and 80286 co-processor boards is reportedly in the works for the upcoming Macs so that IBM compatibility would also be an option.

WHERE DO BATTERIES GO? It seems as if all those small batteries are devoured as if they were fast-food burgers. Where do they go? According to Eastman Kodak's Ultra Technologies subsidiary, just about everywhere there's a need for reliable portable devices: calculators, audio tape equipment, toys, smoke alarms, clocks and watches, briefcase computers, pocket pagers, 35-mm cameras, power hand tools, etc. As an example of the wild number of batteries used, consider that 1985 sales of battery-powered watches alone amounted to 123-million units, each of which comes with a battery that has to be replaced yearly. Today, the average household buys about 27 batteries each year for a variety of portable devices.

CUSTOMER-SERVICE ELECTRONIC BULLETIN BOARD. Motorola's Microcomputer Operation developed an electronic bulletin board that's available free to the public 24 hours a day, seven days a week. It features the latest MCU literature, new product information, technical updates, custom ROM information, MCU selector guides, a Motorola sales and distributor directory, etc. You can catch it on a modem by dialing 512-440-2725.

EUROPE EMBRACES "SMART" CARDS. Whereas the typical magnetic-strip credit or bank card holds only a few hundred data bits, France's same-size CP8 card stores 8 kilobytes. This capacity allows French university students to keep their academic records on "smart" cards that they carry around with them, providing greater confidentiality than keeping them in central files. Some 16-million such cards will be distributed soon to people in France for electronic shopping, identification, and personal database purposes. About 30-million such cards are already employed for credit phone calls. Other countries, including Norway and Luxembourg, have taken to the new technology. The U.S.'s MasterCard is experimenting with the system, too, and it's expected that a 16K version will be offered in about a year.

KING KONG vs. DONKEY KONG. Universal City Studios must be whipping its management and lawyers as a result of the company's lawsuit filed against Japanese video game maker, Nintendo. The suit claimed that Nintendo's Donkey Kong was infringing on Universal's King Kong trademark. In a countersuit recently upheld by the United States Supreme Court, Nintendo of America Inc. was awarded $1.6-million lawyer's fees and damages from Universal for interfering with Nintendo's sales of the hugely successful Donkey Kong game, said to be the largest sanction awarded in history. The Nintendo Entertainment System™ holds a 95% share of the home video game market, producing about 400,000 units a month to keep up with Japanese demands. The company's Super Mario Bros.™ video game cartridge is so popular, that more than 600,000 book copies on tips to play the game have been sold in Japan. Now marketing its products in the U.S., it has awakened new interest in video games here.

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

Shirt-Pocket DMM

Beckman's new Model DM78 digital multimeter is small enough to fit into a shirt pocket, yet it offers autoranging measurement of ac and dc voltage and resistance. The latest DMM to be added to the company's Circuitmate instrument line, the Model DM78 measures only 4.25" × 2.13" × 0.4" and weighs a mere 3.5 ozs. It comes in a billfold-like carrying case that has room inside for storage of the testleads.

All measurements appear in a 3½-digit liquid-crystal display window, along with function selected. Dc and ac voltage ranges are to 2, 20, 200 and 450 volts full-scale, while resistance ranges are 2k, 20k, 200k and 2000k full-scale. Rated accuracy is 0.7 percent. Bandwidth is 40 to 500 Hz, and overload protection is to 650 volts dc or peak ac. $29.95.

CIRCLE 1 ON FREE INFORMATION CARD

Symbolic-Math Calculator

Believed to be the first calculator capable of doing symbolic mathematics, Hewlett-Packard's HP-28C goes beyond numeric calculations to use symbols or variables so that algebra and calculus operations can be performed with just a few keystrokes. Complex numbers, matrices, vectors, lists, algebraic expressions and other types of data can be viewed, edited and used in calculations as easily as ordinary numbers.

An enhanced operating system allows direct entry of algebraic expressions to be mixed with RPN (reverse Polish notation) logic operations. Equations can be entered and stored in the user's own terms with the calculation-solver capability. The calculator then solves an equation for any unknown variable anywhere in the equation. On-screen menus and soft keys give keystroke access to hundreds of functions without the need for programming.

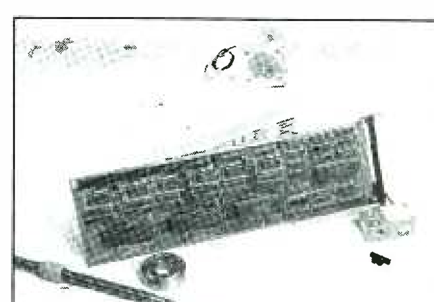
Any single-value functions can be graphically depicted and statistical data can be plotted. Once an expression is plotted in the display, the user can locate an approximate root, press a key to record the coordinates, and use the equation solver to calculate the root with 12-digit accuracy. The calculator contains a system for converting values between unit systems. The values of 120 units are built in.

Separate alphabetic and numeric keypads are provided. When open, the calculator measures 7.5"W × 6.25"H × 0.5"D and weighs just 8 ozs. $235; $135 for optional compact printer that communicates with the HP-28C by infrared beam.

CIRCLE 2 ON FREE INFORMATION CARD

Industrial/Scientific Computer I/O Board

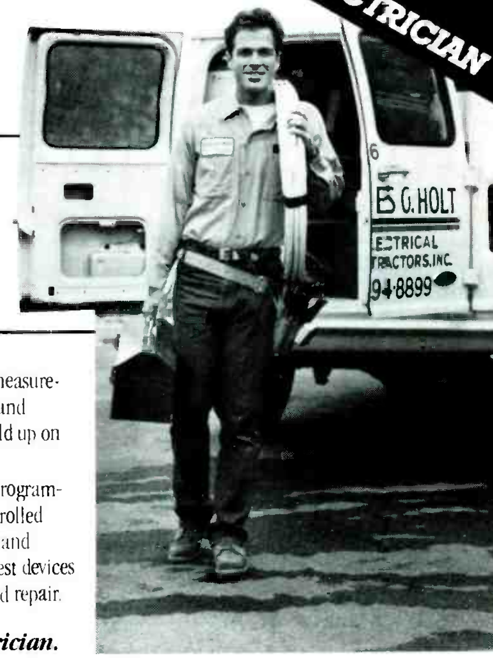
Step Control Ltd. (Santa Barbara, CA) announced availability of its PC-XIO board for industrial and scientific applications. The board comes with documentation and software that allows users to set up and use an IBM PC or compatible computer to control/communicate with electrical devices and electronic instruments. It can interface up to 72 discrete inputs or outputs and offers



up to eight latchable interrupts to provide direct local control of test equipment, assembly or inspection devices, robotics, process controls,

NEW!
BECOME TODAY'S
ELECTRONIC-AGE ELECTRICIAN

Only NRI Gives You the Latest Need-to-Know Skills for a Top-Paying Career as an Electrician



Few other jobs offer you the money, the stability, and the opportunities that can be yours as an electrician

Each year, the demand for skilled construction, maintenance, commercial and utility electricians continues to grow. The U.S. Department of Labor estimates that close to 100,000 new jobs will open up in the next 10 years — a *conservative* estimate compared to industry and union projections.

And few can match the money-making potential of the qualified electrician. You can earn from $25,000 up to $40,000 a year, even more with overtime! Of course, the sky could be the limit with your own electrical contracting business.

The best training you can get... and right in your own home.

With NRI, the leader in technical training, you train right in your own home at *your* convenience. No night school. No need to quit your job while you learn. Through NRI's unique "Discovery Learning Method," you learn fast no matter how little you know about electricity now. NRI's 72 years of training more people for good jobs backs you up all the way.

Hands-on equipment you keep brings theory to life.

Practical, job-oriented training sets NRI apart from any other training you'll find — anywhere. Here are just some of the ways you master practical skills with the equipment, test instruments, and training materials included in your course:

- You duplicate actual on-the-job wiring procedures with your complete NRI Residential Wiring Practice Lab.
- You learn professional troubleshooting and measurement techniques, using your volt ohmmeter and clamp-on ammeter to test the circuits you build up on your NRI Circuit Demonstrator.
- And, by installing and testing an electronic programmable thermostat and a microprocessor-controlled remote power control, you'll come to understand electronics principles as they apply to the latest devices today's electricians are called on to install and repair.

Get the expert skills you need on the job as you work with all this hands-on training equipment... complete NRI Residential Wiring Practice Lab, NRI Circuit Demonstrator, volt ohmmeter, clamp-on ammeter, home security simulator, electronic programmable thermostat, microprocessor-based remote power control, and more!

Training for the new breed of electrician.

NRI knows that you need to understand more than the principles of electricity and wiring to become a top electrician today. That's why NRI is the only school to also give you a solid foundation in basic electronics. With NRI training, you'll be able to say "No problem" to jobs like these: installing and repairing electronic controls on air conditioning and heating systems... wiring and servicing electronic security and alarm systems... even running appropriate lines to accommodate computer equipment and today's increasingly used fiber optic communications systems.

Step by step, you move from the simplest fundamentals of electricity, through professional wiring and troubleshooting techniques, all the way up to the latest need-to-know skills essential to become today's "electronic-age" electrician.

Your NRI instructors — like having a master electrician at your side.

Soon after you enroll, you'll discover that your NRI instructors have a personal interest in you, your progress, and your success. They're trained professionals whose experience and helpful advice come to you on a one-on-one basis. You can count on receiving from your instructors the same level of expertise, guidance, and understanding you'd expect from working side by side with a master electrician.

Send for free catalog — no obligation.

Act now to get started on the road to good pay and security. Send for your complete catalog that tells all about the opportunities for good, steady jobs or a contracting business of your own... get the details about each step-by-step lesson... and see how the practical training equipment included in the course builds the confidence that comes only from NRI hands-on experience. Become a skilled electrician the NRI way! If the coupon has been removed, write to NRI Schools, 3939 Wisconsin Ave., Washington, D.C. 20016.

SEND COUPON TODAY FOR FREE NRI CATALOG!

NRI SCHOOLS
McGraw-Hill Continuing Education Center
3939 Wisconsin Avenue, NW, Washington, DC 20016
We'll give you tomorrow.

For Career courses approved under GI bill
☐ check for details.

CHECK ONE FREE CATALOG ONLY

☐ Electrician	☐ Automotive Servicing	☐ Data Communications
☐ Air Conditioning, Heating, & Refrigeration	☐ Bookkeeping & Accounting	☐ Industrial Electronics
☐ Small Engine Repair	☐ Photography	☐ Communication Electronics
☐ Appliance Servicing	☐ Computer Electronics	☐ Electronic Design Technology
☐ Locksmithing & Electronic Security	☐ TV/Audio/Video Servicing	☐ Telephone Servicing
☐ Building Construction	☐ Satellite Electronics	☐ Digital Electronics Servicing
	☐ Robotics & Industrial Controls	☐ Basic Electronics

Name ______________________ Age ______

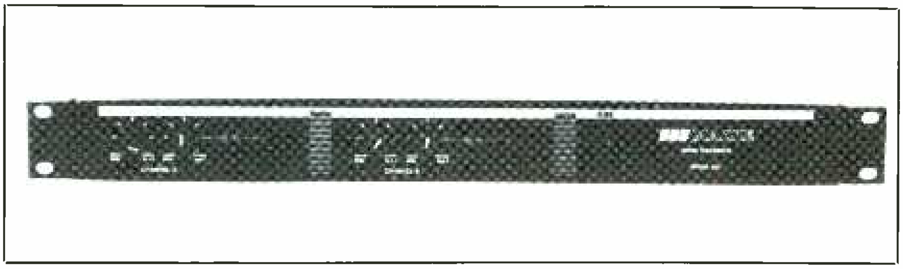
Street ______________________

City/State/Zip ______________________

Accredited by the National Home Study Council 4-037 etc. Jumper selection of inputs and outputs in groups of four provides for maximum configuring flexibility.

Software and documentation are provided for using the board with Microsoft BASIC, Turbo Pascal, Lattice C and/or 8088 assembly code. Included in the software are concise examples of how the system is used and test programs. A 5-ft. ribbon cable is also included for connecting any I/O module to the board. $445.

CIRCLE 3 ON FREE INFORMATION CARD

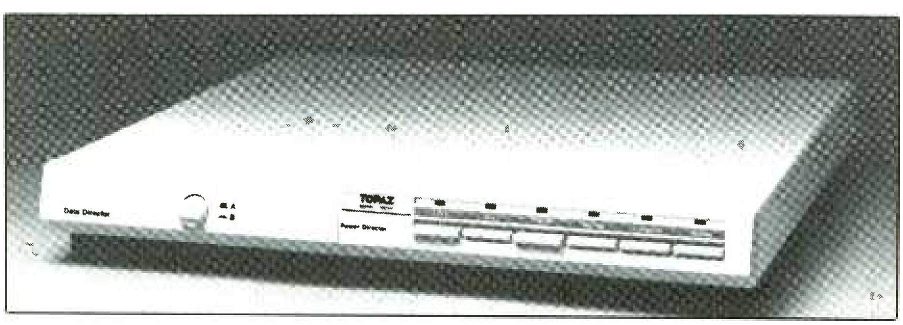


Sonic Maximizer

Barcus-Berry Electronics' (Huntington Beach, CA) new BBE 402 ''Maxie'' sonic maximizer is designed for use in both home recording studios and small musical groups or small club sound systems. The semiprofessional accessory is a multi-band, program-controlled signal processor that can add brightness and presence without introducing the undesirable stridency that often characterizes equalized sound. It is said to increase voice intelligibility by eliminating frequency band masking when important sibilant and consonant elements are present in the program signal. It is also claimed to dramatically improve the overall sonic quality of sound regardless of speaker quality.

Housed in a 17" single-slot rack-mountable cabinet, the accessory is 5" deep and weighs 5.5 lbs. $229.

CIRCLE 4 ON FREE INFORMATION CARD



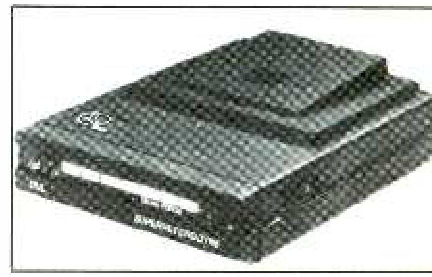
Power Control Center

Data Director is the latest addition to Topaz's line of Power Directors for PCs. A new feature is the ability to switch between any two parallel peripherals connected to it via DB-25 connectors located on the rear panel. A data transfer switch enables the user to access either peripheral simply by pushing a button on the front panel, without powering down equipment. This multiple-outlet power control center protects a PC and up to four peripherals from damage and loss of data due to voltage spikes of up to 6,000 volts, power surges, and emi and rfi. It has a low silhouette that allows it to fit between system unit and video monitor. Five power outlets on the rear panel are individually controlled by front-panel power switches. Additionally, a master switch simultaneously powers up/down all components plugged into the unit. All front-panel switches are labeled pushbutton types. $325.95.

CIRCLE 5 ON FREE INFORMATION CARD

Deluxe Radar Detector

Topping GUL Industries' line of radar detectors is the Model G-300S, which is designed to provide optimum sensitivity to police radar without sensitivity loss needed to avoid random falsing. The claimed perfor-



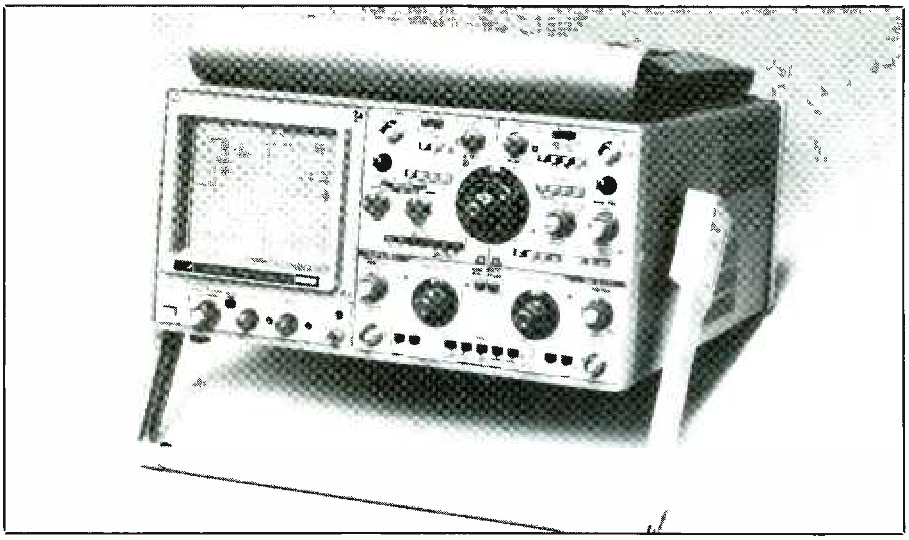
mance is said to be due to microprocessor-based superheterodyne circuitry and a gallium-arsenide diode mixer. Features built into this new radar detector include: a Radar Interference Defeat (R.I.D.) computer circuit that analyzes incoming signals and eliminates false alerts; an Autocorrelator Digital Counter that singles out fixed-frequency rate police radar signals from random background interference; and city/highway and computerized signal recognition circuits.

Other features include: computer-generated audio alert that adjusts so that even drivers with impaired hearing can be alerted to the presence of police radar; a separate manual volume control; different audio alerts for X- and K-band radar signals; audio alert shutoff after four beeps; and visible alert lights that flash faster and faster as the vehicle approaches the source of the radar signal. The detector measures 4.5"D × 3.25"W × 1.0"H. $260.

CIRCLE 8 ON FREE INFORMATION CARD

60-MHz Portable Oscilloscope

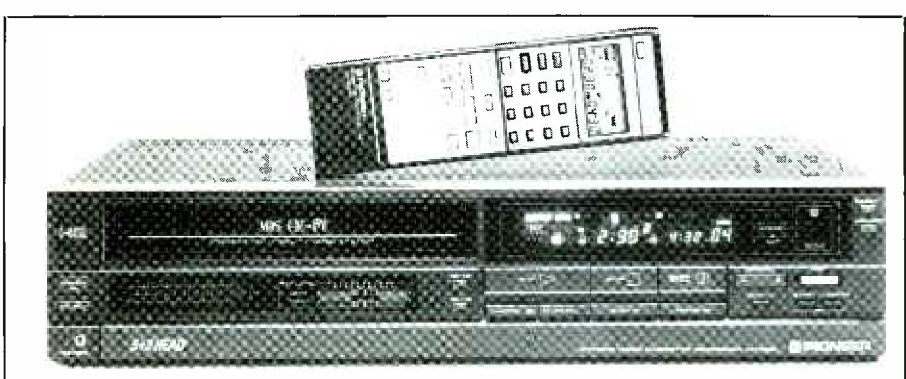
Iwatsu's Model SS-6611 60-MHz portable, ac-powered oscilloscope offers versatile CRT readout in a 6" rectangular display area, four inputs, eight-trace capability, and measurement by cursors. A unique



four-cursor display feature comes with two-speed movement. The vertical and horizontal cursors automatically track to 10% to 90% for easier waveform rise/fall-time measurement. The vertical cursors track for rms measurements, while the horizontal cursors track for ratio duty-cycle measurement.

An internal six-digit reciprocal counter with an accuracy of 0.0003% extends the capability to measure test parameters. Each of the four input channels automatically corrects the vertical scale factor when standard SS-0012R probes are used. Other features include: 80 characters of on-screen comments (battery backed up) for displaying measurement setup, title and operator name; a date/time display on the CRT screen; voltage-ratio and phase-difference measurement using reference functions; simultaneous time-difference and frequency display; independent A and B trigger; low-noise design; and attached carrying handle that doubles as a tilt stand on the bench. Dimensions are 12⅝"W × 15¾"D × 6⅜"H, and it weighs 24.2 lbs. $1,795.

CIRCLE 6 ON FREE INFORMATION CARD



VHS 7-Head VCR

A seven-head recording transport and HQ video circuits are the major features of Pioneer's new top-of-the-line Model VH-900 VHS Hi-Fi videocassette recorder. Five heads are used for video and two heads are used for audio recording. A white clip circuit in the HQ section increases brightness and edge definition. Additionally, a luminance signal noise reduction circuit improves S/N ratio, a detail enhancer circuit increases clarity during recording, a line-type comb filter enhances resolution and automatic gain control assures tight focus.

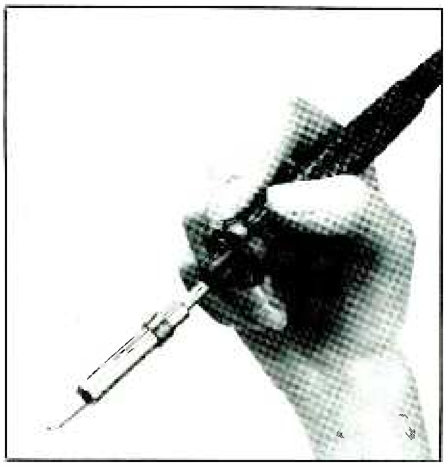
Audio is processed with a dynamic range of greater than 80 dB. Frequency response is 20 to 20,000 Hz, and wow and flutter are specified at less than 0.005%.

Recordings of up to 8 hours duration are possible with the VCR, which includes SP, LP and EP speeds. Also included are, 14-day/4-event timer as well as a quick timer that can be set for one-button recording in 30-minute intervals. Built in are an MTS (stereo) decoder and a 119-channel cable-ready tuner. The VCR is "SR" compatible, making it compatible with all Pioneer remote systems. A 35-function wireless remote controller, included with the VCR, has an LCD screen that displays the selected channel, day of week and program start and stop times in succession. The VCR measures 18⅛"W × 13⅛"D × 3¾"H and weighs 17 lbs. 10 ozs. $999.95.

CIRCLE 7 ON FREE INFORMATION CARD

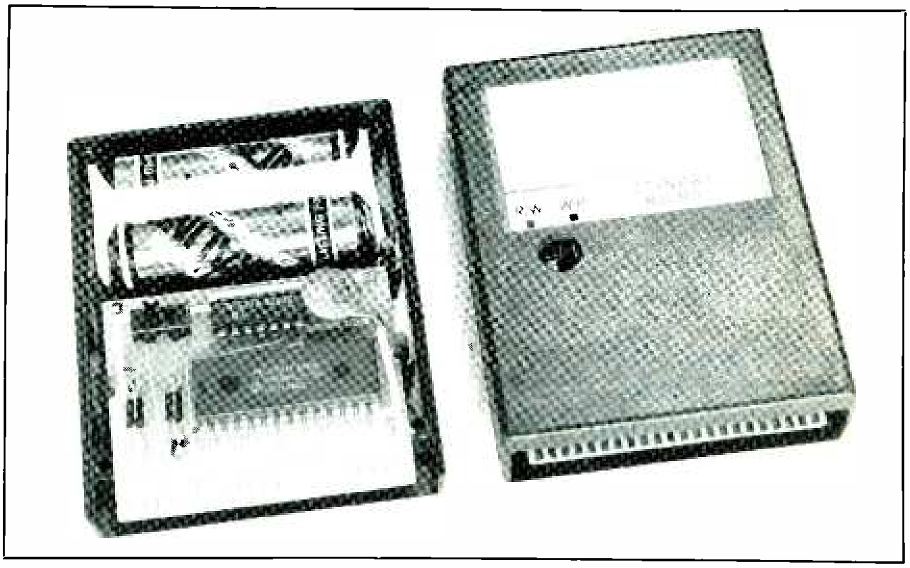
High-Efficiency Soldering Iron

A general-purpose soldering iron that has the heating element directly under its tip for high thermal efficiency is available from M.M. Newman (Marblehead, MA). The Antex Model X-25 soldering iron is said to heat up to 750° F in just 45 seconds. Equivalent to conventional 40-watt irons, this 25-watt iron uses slide-on iron-plated tips that cannot freeze or stick.



Available with 3/32", 1/8" and 3/16" diameter tips, the X-25 has a thermoset plastic handle that is claimed not to melt if touched by another hot soldering iron. It comes with a 6-ft. cord with three-prong, positively grounded plug. $19.95.

CIRCLE 9 ON FREE INFORMATION CARD



Nonvolatile Memory For Commodore-64 Computers

A new nonvolatile memory cartridge from Scinort Micro (Austin, TX) for the Commodore 64 computer eliminates the tedium of manually loading frequently used utility programs, function key settings, screen configurations, etc. on power-up. Unlike EPROM cartridges, changing the contents of the new nonvolatile memory cartridge is quick and easy to do. The loader program provided can set the user's program (BASIC or machine language) to autoload and run on power-up. Or it can be made available by making a SYS jump to the cartridge.

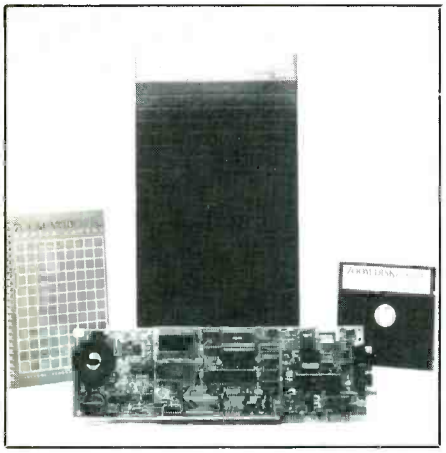
Batteries, included with the unit, preserve stored data for more than a year. A write-protect switch guards against accidental write access to the memory. Spare labels are provided for noting contents. $24.95 plus $2.50 P&H.

CIRCLE 10 ON FREE INFORMATION CARD

2400-Baud Modem

ZOOM Telephonics is now offering the Zoom/Modem PC2400, a high-speed 2400-baud modem designed for use in IBM PC, XT, AT and compatible computers. It is built around the Rockwell 2400 bps chip set that provides adaptive equalization when connecting at 2400 baud. The modem supports Bell and CCITT full-duplex standards, which makes it compatible with 2400-, 1200- and 300-bps standards.

Featured are: call-progress tone detection, Demon dialing of busy numbers, audio input and output ports, support for four COM ports and a high-speed 16450 UART to assure compatibility with high-speed AT and compatible computers. Optionally available is the XL model, which includes Touch Tone decoding, Touch Tone password security, and 8K (upgradeable to 32K) electronic mail buffer with battery back-up and a real-time system clock/calendar. At $499, the PC2400 includes

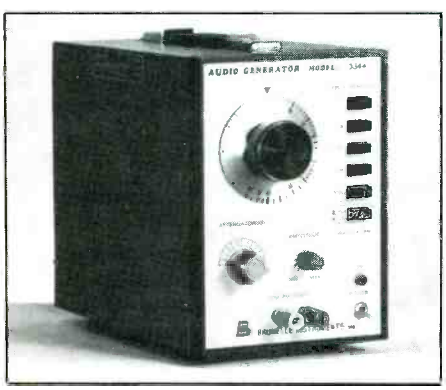


Zoom/Disk software, that interfaces with the modem's "Demon Dialing" machine. For $100 more, Crosstalk XVI is included; the XL model is an added $50.

CIRCLE 13 ON FREE INFORMATION CARD

Audio Signal Generator

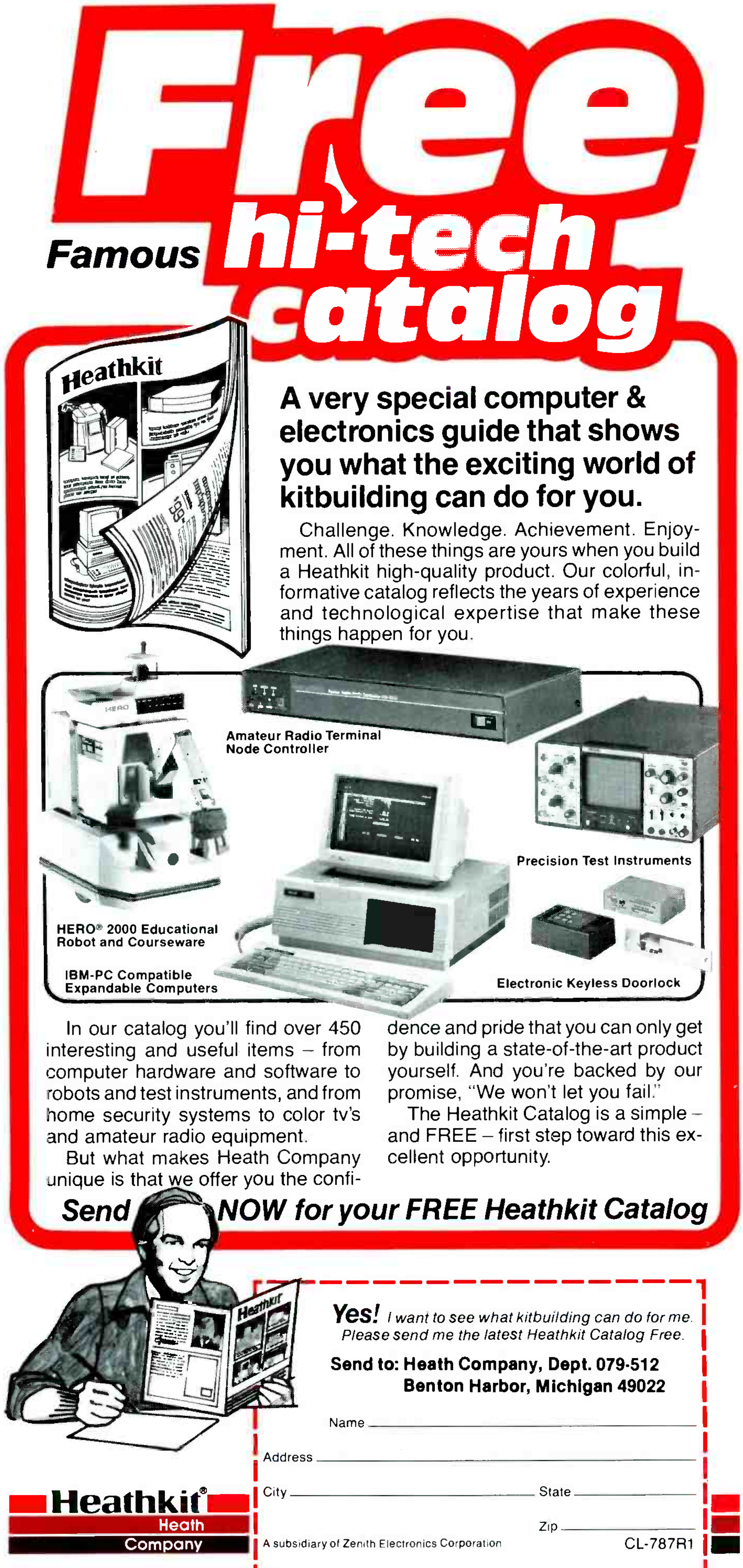
Brunelle Instrument's Model BTL 3344 sine/square audio signal generator offers a 10-Hz to 1-MHz frequency range, available in five



switch-selectable steps. Designed to provide a high-level output, the generator can deliver more than 7 volts rms at no load and more than 3.5 volts rms into 600 ohms in its sine-wave function. Output level is fully adjustable with a 10-dB-per-step, six-switch attenuator and continuous AMPLIFIER level control. Output impedance is a low 600 ohms, and attenuator accuracy is ±1.0 dB at 600 ohms load.

CIRCLE 14 ON FREE INFORMATION CARD

(Continued on page 57)



Logic Signal Measurements

How to use an oscilloscope to make basic measurements in digital logic circuits

By Robert Ramirez*

If you think digital logic is based on 1s and 0s, you're partially correct. When digital circuits are working logically—as they're supposed to—it's okay to think strictly in terms of 1s and 0s. But when things go wrong (counters don't count, printers don't print, modems don't communicate), you may have to start thinking analog to find the problem and fix it.

Always keep in mind that digital logic is really based on analog signals. Ideally, these signals represent 1s and 0s (fixed high and low states), but in reality are still analog signals. As such, they are subject to all the whims of the analog world, such as attenuation, distortion, noise, propagation delay, and so forth. What looks like a 1 may not really be a good, solid 1 because of amplitude or offset variations that don't meet threshold requirements. A 1 could even be two 1s because of noise-margin violations. Or it could be a 1 at the wrong time, or only sometimes, because of timing-margin violations.

Troubleshooting these "analog-based" digital problems is best done with an oscilloscope. Though any oscilloscope will do for simple problems, to find out what is really going on in marginal logic situations, you need a good scope and some additional measurement tricks.

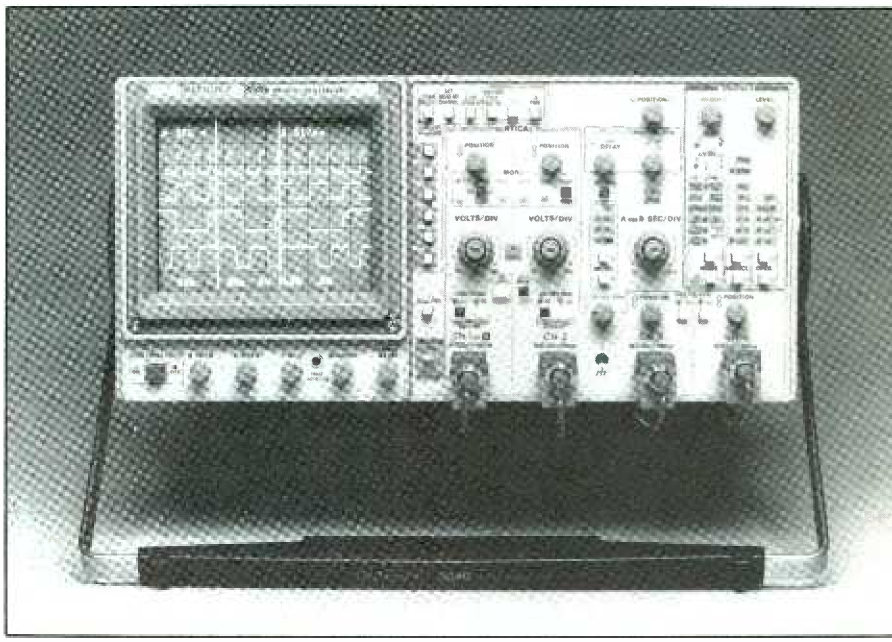


Fig. 1. Modern oscilloscopes provide more bandwidth at lower prices and with more measurement convenience features, such as direct-readout measurement cursors and even pushbutton measurement selections.

Good Scope Defined

Bandwidth is the most commonly talked about scope specification. In fact, manufacturers often include it in their scope names. The Tektronix 2246 100-MHz Oscilloscope shown in Fig. 1 is one such example. The bandwidth specification tells you the frequency range of sinusoids that the scope will display without amplitude attenuation. Almost without exception, dc and very low frequencies are implied in the specification. The scope's amplitude measurement accuracy (such as, vertical accuracy = 2%) is guaranteed up to the specified bandwidth, which is commonly fixed at the 3-dB down point, or the point where the amplitude of the displayed signal drops to half what it was within the major portion of the rated bandwidth.

Notice the reference to "sinusoid" in talking about bandwidth. By definition, a digital signal is *not* a sinusoid, though it is made up of many sinusoids. All of these sinusoids, except for the fundamental frequency, are of higher-frequency harmonics. For example, Fig. 2(a) shows a 5-MHz clock such as might be used in a personal computer. It has a dc component and a 5-MHz fundamental frequency. These two frequency components are indicated by vertical amplitude lines in the clock spectrum of Fig. 2(b). Notice that there are other components present at odd

*Tektronix, Inc.

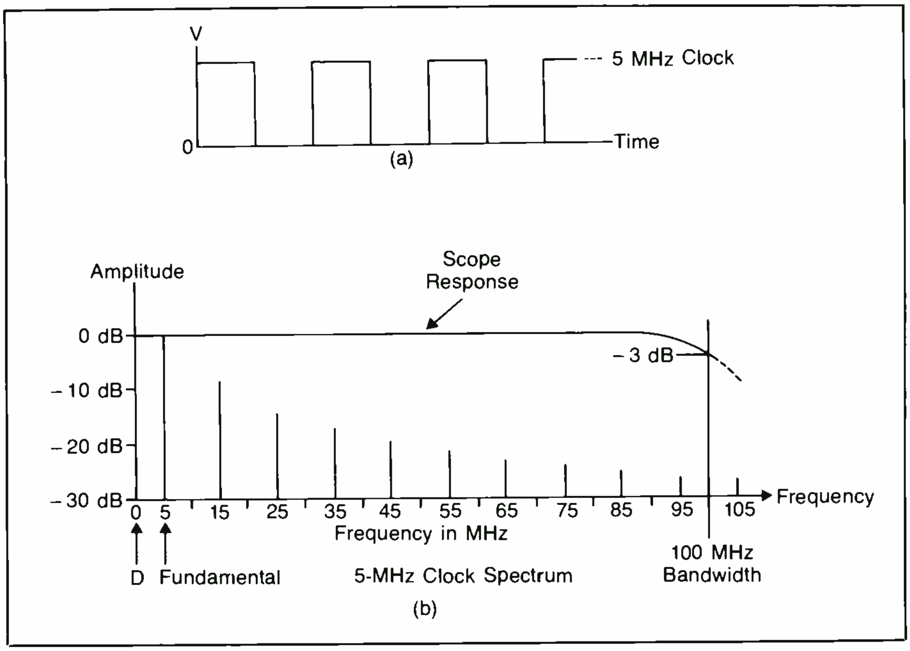


Fig. 2. Digital signals (a) are composed of harmonically related sinusoids (b). Accurate oscilloscope displays require adequate bandwidth to include higher-order harmonics.

multiples of the fundamental (15 MHz, 25 MHz, 35 MHz, etc.) and that their amplitudes diminish with each successively higher multiple.

Higher-order multiples of the clock frequency are the harmonics that give the clock pulses their corners and fast transitions. If you use a scope that has too low a bandwidth, you basically filter out (attenuate) these higher harmonics and their contribution to pulse shape. A higher-bandwidth scope, as indicated by the response curve in Fig. 2(b), preserves more harmonics of the clock signal, or any other nonsinusoidal signal for that matter.

When dealing with digital signals, it is often more convenient to think in terms of scope risetime, rather than bandwidth and signal harmonics. Risetime indicates how fast the scope responds to an ideal voltage step. As a rule, a scope's approximate risetime is related to bandwidth by $T_r = 0.35/BW$, where T_r is risetime and BW is bandwidth in Hertz. Thus, a 100-MHz scope has a 3.5-nanosecond risetime.

Time Measurement Accuracy

Risetime Ratio (Pulse:Scope)	Approximate % Error in Time Measurement
7:1	1
5:1	2
3:1	5.5
2:1	12
1:1	40

Scope T_r = 0.35/scope bandwidth

Also, as a general rule for accurate time measurements, you should use a scope with a risetime that is at least five times greater than the risetime of the pulse you are trying to measure. Thus, a 3.5-nanosecond scope provides best accuracy (less than 2% error) on time measurements up to about 17 nanoseconds. But this can be pushed, as indicated in the Table, if less accuracy can be tolerated.

For accurate measurements, it is important that the bandwidth and risetime specifications be to the *probe tip*. Because this is not always done, some scopes are specified only to the input connector. A high-bandwidth scope is of questionable value if its bandwidth cannot be carried to the probe tip, down to what you are actually measuring. To be able to do this requires probes that are matched to the scope. It is a common measurement error to ignore this important link.

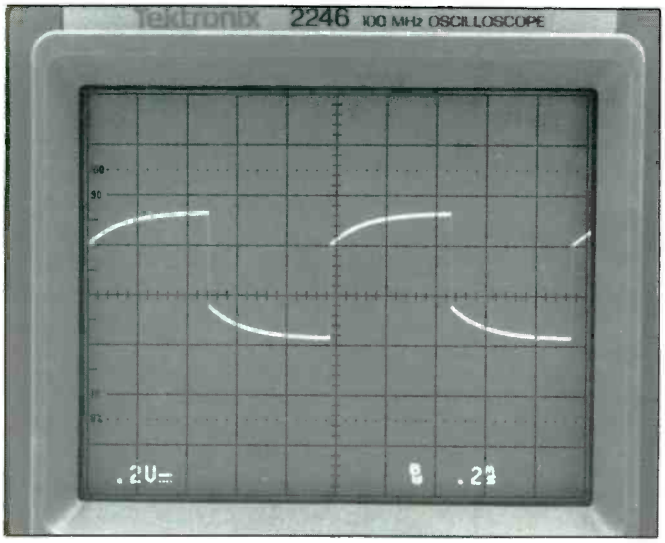
It is also a common measurement error to fail to compensate the probes before making measurements. Compensation is usually done with a screwdriver or twist adjustment on the probe. It must also usually be done at scope settings specified by the manufacturer. The effects of an uncompensated probe are shown in Fig. 3. Using an uncompensated probe can result in amplitude or risetime measurement errors.

Is a 1 a 0 or Two or None?

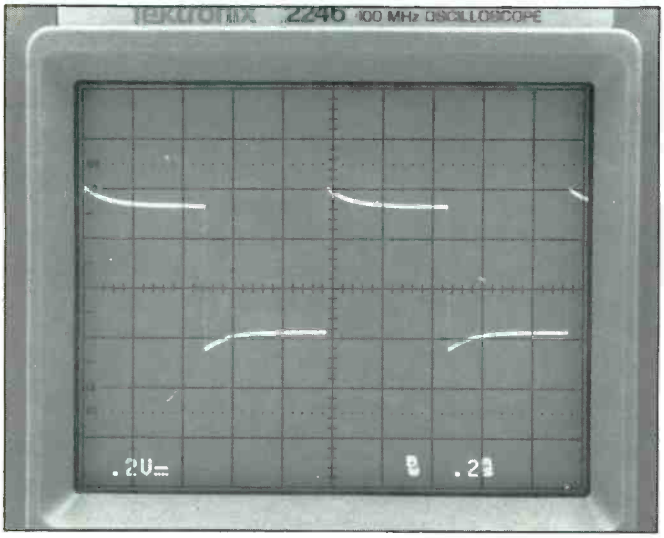
Selecting a good scope is the first step in making measurements. Putting it to proper use is the next step.

For example, in measuring digital signal amplitudes, it is important to recognize the type of signal being dealt with and to use proper scope input coupling. Figure 4 shows three typical signal types—bi-directional (a), uni-directional (b), and uni-directional with offset (c). Without a zero reference, uni-directional signals are indistinguishable from bi-directional signals. So it is important to, first of all, establish a 0-volt baseline on the scope display. This is done with the scope's triggering set to "peak-to-peak auto" and the probe input coupling switch set to ground. The resulting 0-volt display is then vertically positioned to a convenient scale line on the scope screen. Then probe input coupling is switched to the setting (ac or dc) for the signal to be displayed.

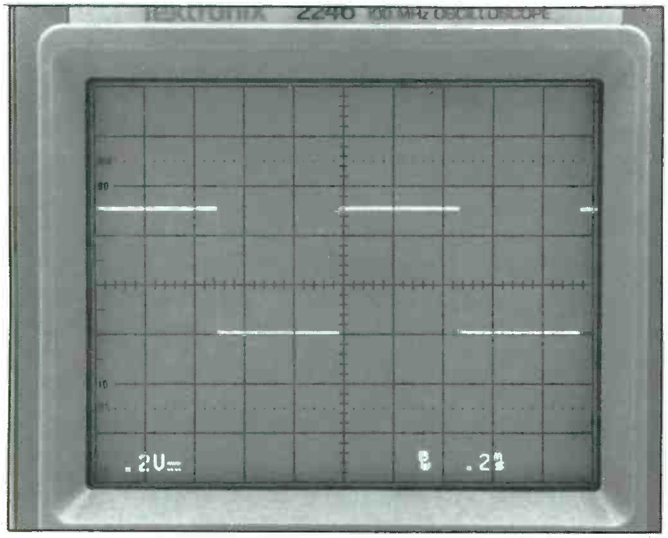
For most logic signals, dc coupling is the best setting. If ac coupling is used, uni-directional signals will have their dc component blocked and will appear as bi-directional signals. Even worse, any amplitude



(a)



(b)



(c)

Fig. 3. Probe compensation is important in measurement accuracy. Undercompensation (a) results in risetime errors; overcompensation (b) results in amplitude errors; proper compensation (c) results in accurate signal display.

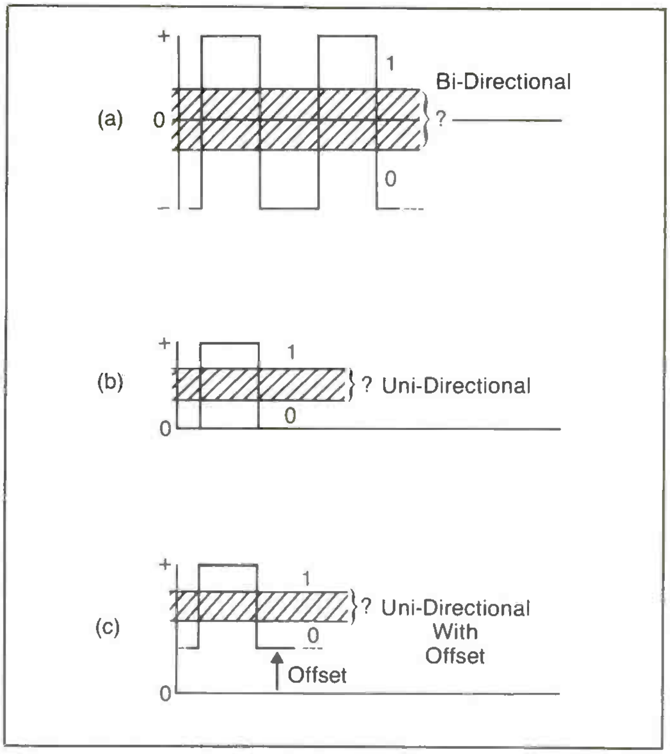


Fig. 4. Three typical types of logic signals. Shaded areas represent bands of indecision, where the signal could be sensed as either a logic 0 or a logic 1.

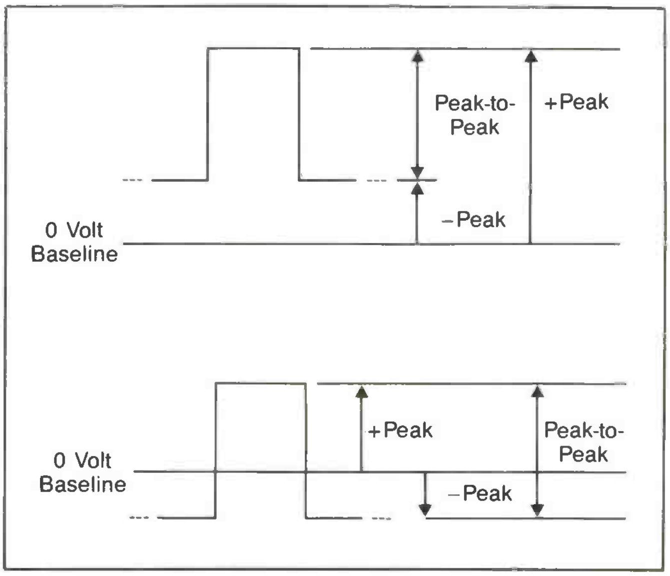


Fig. 5. Definitions of amplitude measurements relative to a 0-volt baseline.

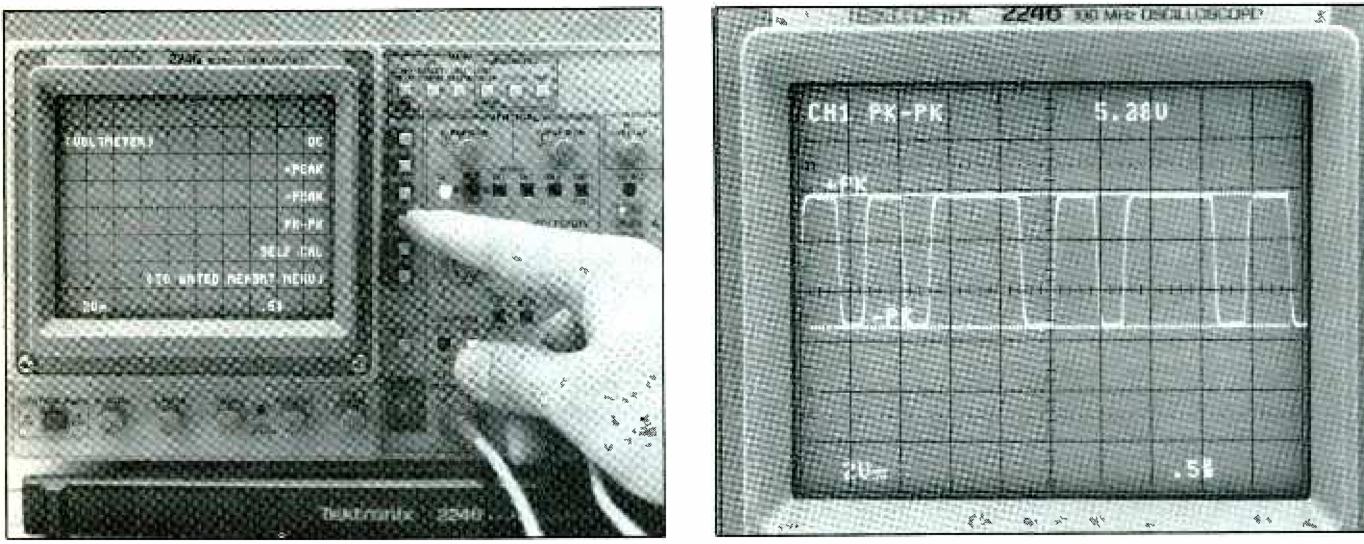


Fig. 6. A modern oscilloscope provides menu selection of measurements (a) and shows results on-screen (b) with readout and automatic cursor placement (dotted lines).

measurements will be ambiguous, since the signal is shifted from its actual dc baseline. Dc coupling, on the other hand, preserves the signal's dc component.

The importance of accurate amplitude measurements is further emphasized by considering the shaded "undecided" zones in Fig. 4. For example, if the logic signal in Fig. 4(a) is being loaded down or attenuated, it may not transition far enough to solidly pass the decision zone and become a solid logic 1 or 0. The signal could look like a valid logic signal, but its low amplitude could result in ambiguous detection of logic levels. In Fig. 4(b), low amplitudes could result in detection as all zeros. In Fig. 4(c), too much offset could result in an all 1s detection.

When troubleshooting logic circuits, it's not enough to just look at the signal and say, "yes it's there." The amplitudes must be measured to ensure that they solidly pass the 1/0 decision levels. Does the signal have sufficient peak-to-peak swing, or +peak, or −peak swing? Is there offset? Should it be there, and if so, is the offset value correct?

The definitions for these measurements are shown in Fig. 5. Typically, the measurements are made by counting divisions from the baseline and multiplying the count by the scope's scale factor readout. Modern oscilloscopes, such as the Tektronix 2246 GPS (General Purpose Scope), simplify this process considerably. As shown in Fig. 6, the 2246 GPS provides pushbutton selection of measurements from an on-screen menu. When a measurement is selected, the 2246 automatically keeps track of where the zero baseline is and makes the selected measurement with a built-in waveform voltmeter. The measurement result is displayed in the on-screen readout and is indicated on the waveform by automatic placement of measurement cursors, —the dotted lines in Fig. 6(b).

The measurement cursors shown in Fig. 6(b) can also be manually positioned on-screen to measure the voltage difference between any two amplitude points. This is useful, for example, in checking digital signal noise margins. By placing the cursors at the logic decision levels, you can easily observe whether noise, amplitude drift or signal aberrations are crossing the threshold and causing false ones or zeros (Fig. 7).

Is It a 1 In Time?

Measurement cursors offer the same convenience in making time mea-

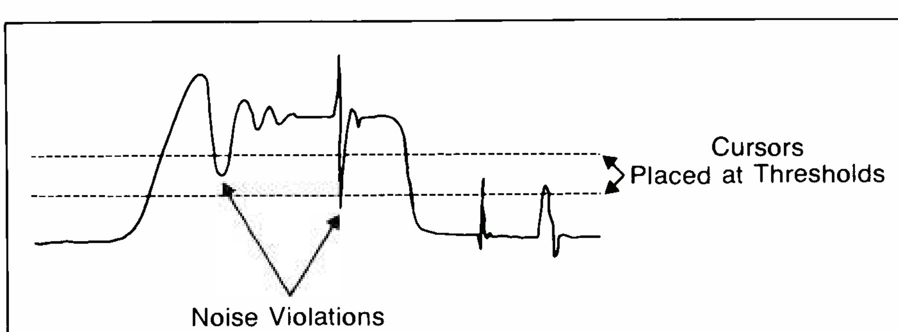


Fig. 7. Cursors can be manually placed for amplitude measurements, or (as shown) can be used as amplitude markers for observing noise violations.

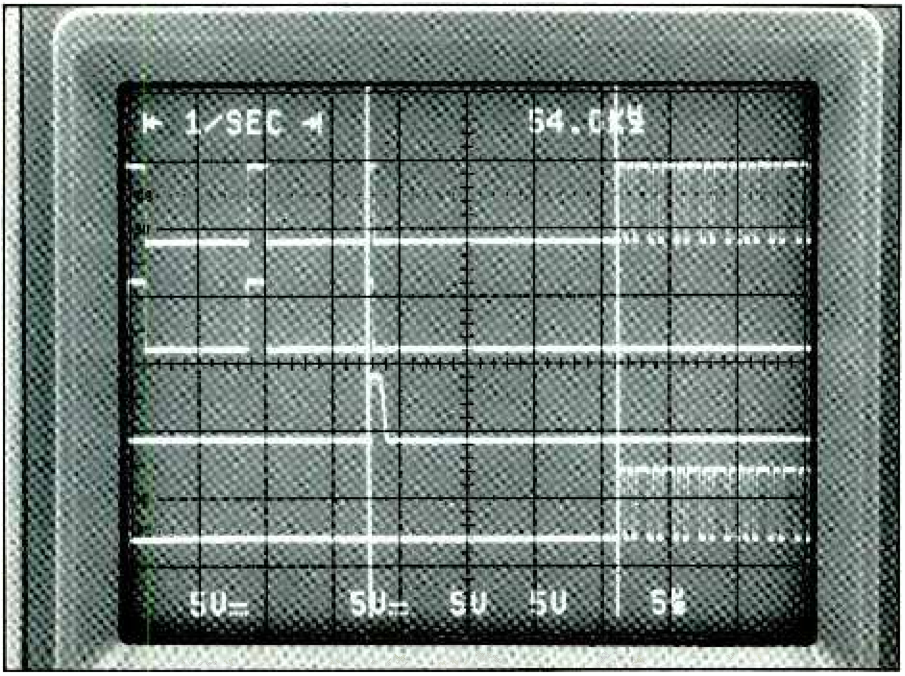


Fig. 8. Cursors can be used in a time measurement mode for checking pulse width, logic line-up (skew) and other timing relationships.

surements. This is shown in Fig. 8, where the cursors have been placed for a timing measurement between logic channels. The measurement result (time between cursors) is shown in the upper right of the display.

It is particularly important to note in Fig. 8 that multiple channels are being displayed. Multi-channel display capability is a necessity for logic signals, since many of the critical timing relationships are between logic channels. A dual-channel scope is needed at minimum for logic signal comparisons. However, a four-channel scope adds convenience by being able to display more signals simultaneously.

Note also in Fig. 8 how the cursors verify the signal edge lineup. A signal edge slightly offset from the cursors would indicate channel skew (time offset) between digital signal lines. For closer observation of skew, it is best to position the suspect signal on the scope's center screen division and select the × 10 horizontal magnification function. This expands the display horizontally by a factor of 10, effectively zooming in on the center of the display. In this expanded mode, you can get a higher resolution measurement of skew and determine whether it exceeds the timing margin specifications of the system on which you are working.

Channel skew is usually the result of mismatched delays in the logic circuits used in each channel path. This could be a design flaw, which can be corrected by buffering faster channels to delay or "de-skew" them. Or excessive skew can be the results of a circuit malfunction causing excessive propagation delay through a gate. These propagation delays—delay time between application of an input signal and appearance of an output response—are relatively simple to measure with a dual-channel scope.

To measure propagation delay, put the scope's channel-1 probe on the gate input and the channel-2 probe on the gate output. Then, in alternate sweep or chopped mode and with triggering set for channel 1, measure the time difference between leading edges on the resulting dual-channel display of the input and output logic pulses.

Other timing measurements you might want to make in troubleshooting a design are pulse width and pulse jitter. Pulse width is critical, since a "1" state must be maintained long enough to be recognized as a 1. This is generally referred to as minimum setup and hold time.

When pressing digital designs for maximum speed, it is easy to get pulse width violations. This can happen, for example, because of a small amount of channel skew at the inputs to an AND gate; the input time offsets can result in an ANDed signal that is too narrow for the next logic stage to recognize.

Even if pulse width is kept longer than the absolute minimum, there can still be occasional violations from pulse or timing jitter. These are generally referred to as timing margin violations. Again, measurement cursors serve as convenient markers for detailed observation of timing margins. The cursors can be placed at the timing limits around a transition. This allows you to easily see occasional jitter or timing drift that violates the margin limits.

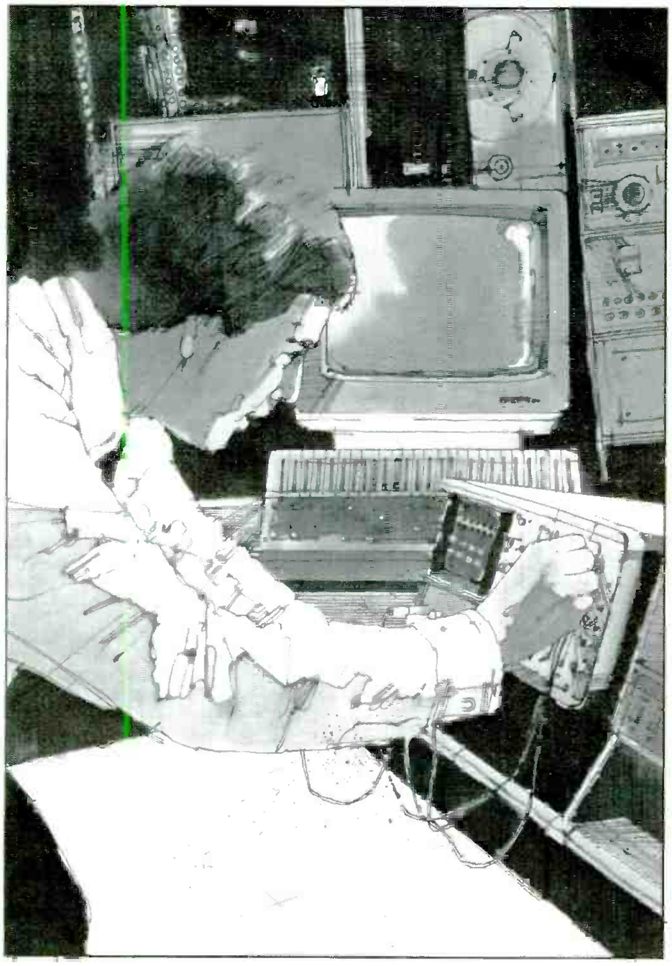
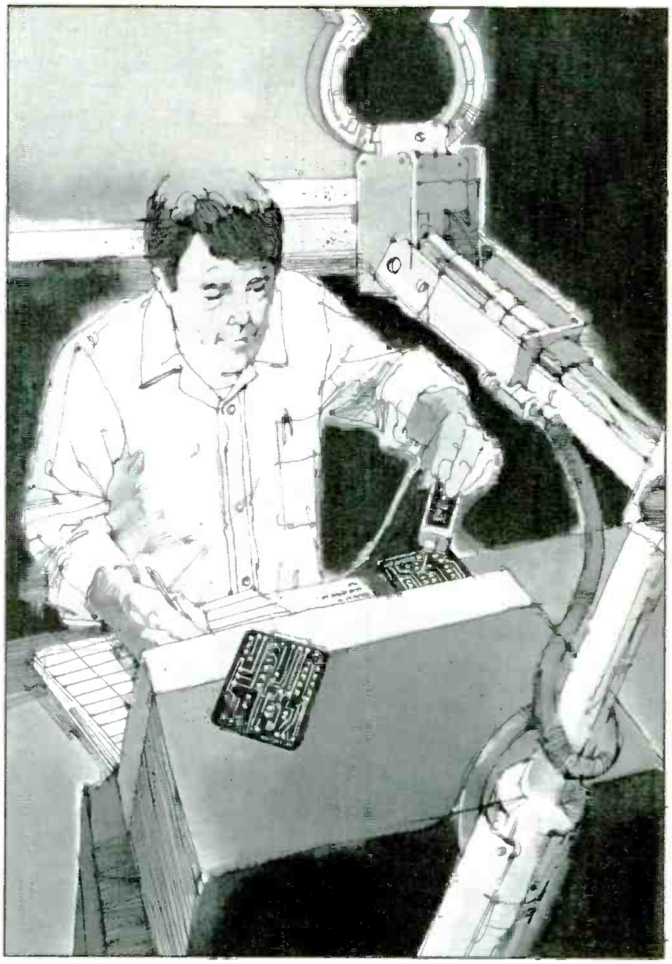
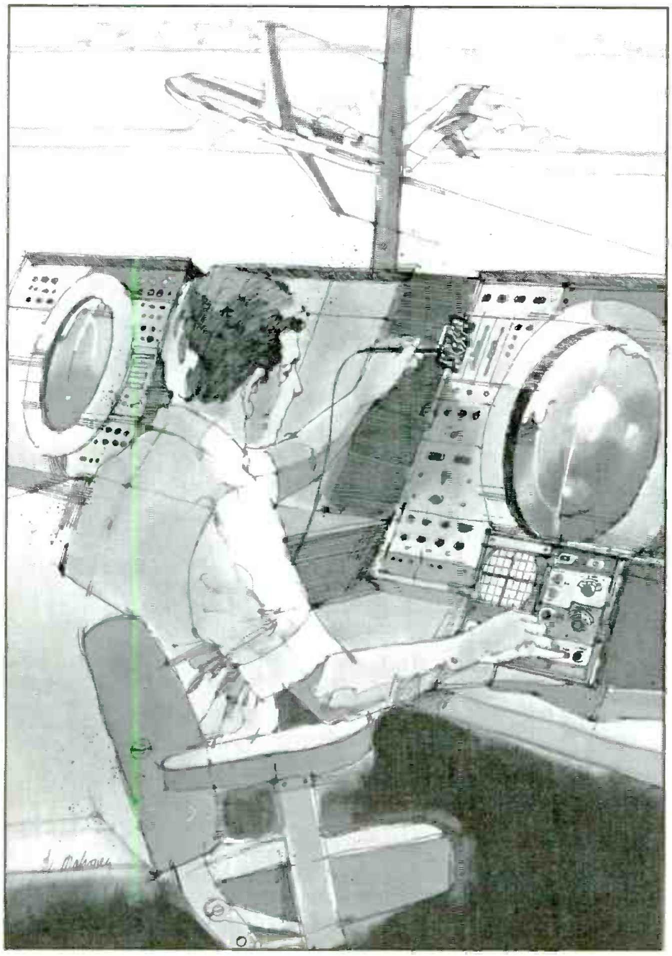
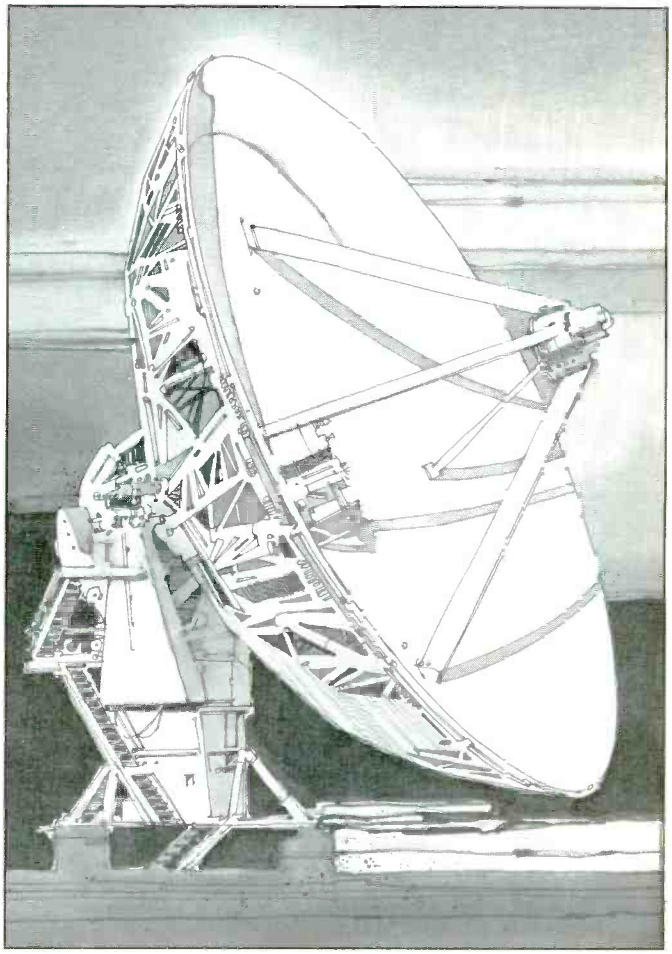
Overshoot Kills CMOS

Generally, sufficient logic amplitude and correct logic channel timing relationships will solve most digital circuit problems. However, with today's more sensitive circuits, too much logic swing can be just as bad as not enough.

Overdriving a logic element can cause excessive saturation and extend transistor storage time. This results in pulse stretching, which can cause logic or timing errors or force you to run the circuit at a lower than desired clock rate.

Even if your nominal signal high is

(Continued on page 91)

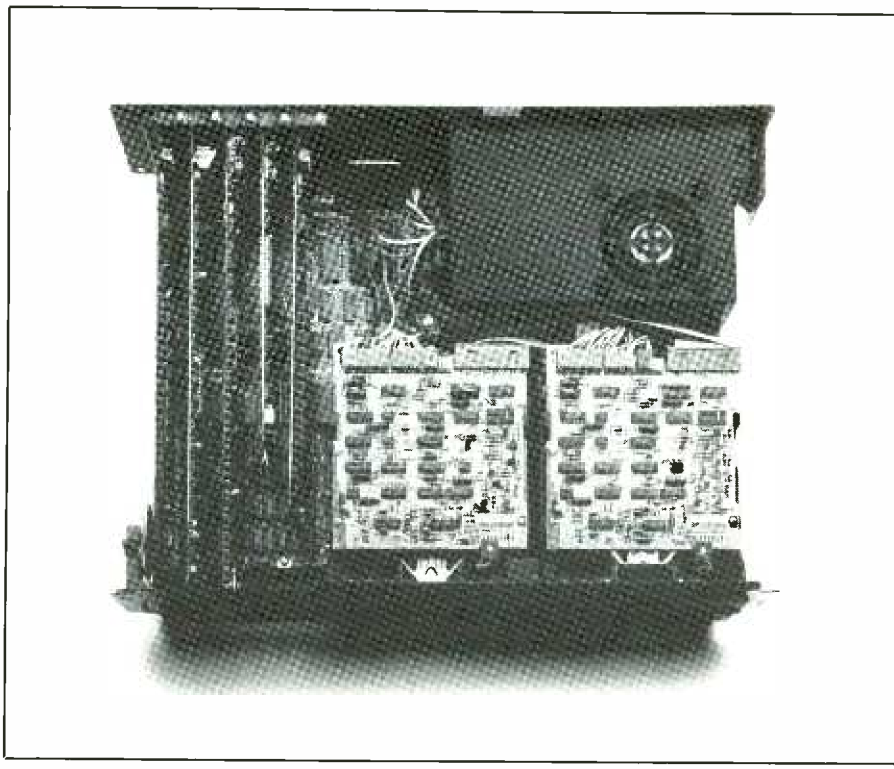
Adding A Hard-Disk Drive

An important upgrade operation for the IBM PC and XT and compatibles is examined here, focusing on installing standard hard drives and newer hard-disk cards.

Hard-disk drives are no longer a luxury. For many computer users, they're as necessary as an automatic transmission in an automobile. If you're one of the millions of owners of a floppy-disk-based IBM PC or compatible, you've doubtlessly considered adding one. Today it's easier and less costly to do than ever before.

The advantages of having a hard-disk drive are well known: faster operating speed and greater data storage capacity. It's common to enjoy a 10 to 20 times increase in data reading and writing time with a hard disk, as compared to a floppy, for example. Equally important, storage capacity of a typical hard-disk drive bought for upgrading purposes is 20 megabytes, compared to the 360K capacity of a floppy disk. (You can, of course, get a 10-MB hard disk and spend less money, or a 40-MB one for giant storage purposes, but the 20-MB drive is the most popular.)

As welcome as it is to significantly increase data access time from a mechanical contrivance, storage capacity has been the driving force for adding a hard-disk drive today, due to the convenience of holding a host or programs on one disk. This eliminates the constant bother of having to remove and insert floppy disks again and again. You cannot imagine the delight of pressing a key or two to get a listing of synonyms in a screen window without changing disks or even exiting the program you're in. New vistas of operating convenience are opened through use of many memory-resident programs—desk accessories, macros, disk managers, etc.—that can be automatically loaded from a hard-disk drive instead of going through all the floppy-disk motions that would otherwise be required.



An inside view of an IBM PC that is a candidate for a hard-disk drive. The power supply bulks large behind the full-height floppy-disk drive electronics, though it is sadly underpowered.

If you own an old IBM PC, the PC1 with a 64K system board, its BIOS ROM will have to be changed in order for your system to recognize the existence of a hard-disk drive. The ROM's date must be 10-27-82 or later. To check the date, simply enter DEBUG from your disk-operating system (DOS) and then type the following: "D F000:FFF5 FFFC" and press ENTER. The screen will display the date. If it's earlier than noted, you'll have to exchange the ROM, which costs about $30.

Also, the original IBM PC's power supply provides only 53.5 watts, which may or may not be sufficient, depending on the new drive you're installing and what you've got in the way of total memory and other expansion boards. It's easy to substitute the power supply, which should be 130 watts or even 150 watts. About $75 or so will do it should this be needed.

Drive Choices

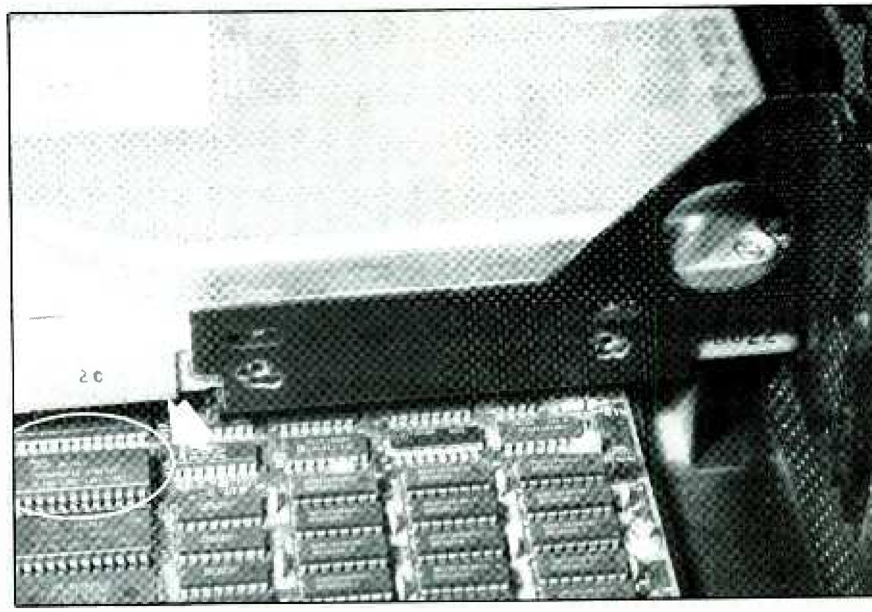
You've got lots of choices to make. Should you get an internal hard-disk drive or an external one? If you plan to have a drive with 10 MB or 20 MB, as most upgraders do, by all means get an *internal* drive. You don't want to take up any more space than you have to.

Should you get a hard-disk drive and separate constroller or an all-in-one hard-disk card? There are a few considerations to weigh here. For example, if you have two full-height floppy-disk drives, you'll want to remove and eliminate use of one of them in order to mount a hard-disk drive (with separate controller) in its place. If your present installation has two half-height floppy drives, one atop the other, then you've got the space to install a hard drive (even two half-heights) and retain use of both diskette drives.

Alternatively, if you have to give up one of your floppy drives—but don't want to—you could go the hard-disk *card* route. You could do this in any case, naturally. Keep in mind, though, that a hard-disk card is more costly than a basic separate drive/controller. We're assuming here that you're not planning to buy top-of-line drive/controller models, which cost much more than the under-$400 price mentioned, though they feature greatly increased speed, super sturdiness and all. You'll pay at least $100 more for the card and probably a few hundred more for a name brand. The card drives will usually (but not always) provide faster access time, however, and you eliminate installation efforts, since you simply plug them into an expansion slot. No cables or anything. Also, the cards draw very little power, so you might be able to avoid having to buy a new power supply.

If you go the separates route, be sure you get a bezel with your kit to cover the half-height area that will be exposed when you install a half-height (the likely choice) hard-disk drive.

You should know that access-time speeds can be an overrated factor, since there are other considerations that affect how quickly you can read and write data. There's an interleave factor for the distribution sequence of sectors, data transfer time, and



If your BIOS ROM (U33 IC) is dated before 10/27/82, you will have to replace it in order for the hard-disk drive to be booted.

About the ROM

IBM has not always supported hard-disk drives for the PC. The problem stems from a missing code in the older BIOS (Basic Input/Output System) chips. ROM chips manufactured before the fall of 1982 are in this category. To find the date of your ROM chip, run the following BASIC program:

```
10 KEY OFF: CLS
20 DEF SEG = HF000
30 LOCATE 12,40
40 FOR X = HFFF5 TO HFFFE
50 PRINT CHR$(PEEK (X));
60 NEXT X
```

If you see a date of October 27, 1982 or later, your computer can support a hard disk.

For those with a BIOS date that reads before October 27, 1982, your machine cannot support a hard disk. Fortunately, there are two fixes. The first is done using software. Most manufacturers of hard-disk drives include a diskette of hardware-related programs along with their products. Among the programs, you'll find a software patch to DOS that installs the missing BIOS code into your system. Unfortunately, every time the system is shut down, the code is lost and has to be reinstalled on power-up before the hard-disk drive can be used.

The second cure involves replacing the BIOS chip inside the machine. The procedure is an easy one. Simply locate your old *U33* ROM chip on the motherboard and replace it with an updated ROM chip available from IBM. The IBM Cat. No. is 1005, and it sells for about $30.

Be advised, however, that you cannot purchase the chip outright. You must first remove your old ROM chip and exchange it at an IBM-authorized dealer for the upgraded version.

other indexes to weigh. As an example, a PC XT'a hard-disk drive might have an average access time of, say, 85 milliseconds, while an IBM AT's drive might benchmark at 45 ms. Not bad, eh? Now let's look at one other factor, *transfer* time. Here, the XT might be 1,220 ms, while the AT would be about 610 ms under the same conditions (a large fragmented file). Clearly, average access time has to be weighed against other factors. So it is *one* of the benchmarks to consider and the one likely cited, but others could be much more important. File size, file contiguousness, and a program's disk intensiveness are other factors that must be taken into consideration.

Deciding to go the hard-disk drive upgrade route, which about 15 percent of *Modern Electronics* readers indicate they will do within the year, according to a study made, does not represent an overwhelming investment in money, and installation can be as easy as snapping in a board or a little work physically mounting a drive and then plugging in its controller and cables. The benefits, however, are enormous and immediately realized. It represents a giant step in operating efficiency, raw power and convenience.

Here are personal experiences of three people who installed hard-disk drives in a floppy-disk-based IBM or compatible machine: a separate drive/controller (Seagate's popular half-height ST225); a 20-MB hard-disk card (Maynard Electronics' "OnBoard 20"); and Western Digital's 10-MB "File Card" hard-disk card and Memory Enhancer. Each is distinctly different.

1. The Internal Hard-Disk Drive/Controller

If you own an IBM PC or clone, you undoubtedly realize how dated the machine has become. It's now puny compared to today's powerhouses like the IBM PC/XT, PC/AT and many compatibles. There are several add-on options that can give performance punch to your present system. Among the most useful is the hard-disk drive. Dollar for dollar, a hard disk is the best performance investment you can make to your system today. A 20-megabyte drive that cost $1,800 only two years ago now sells from some vendors for less than $400.

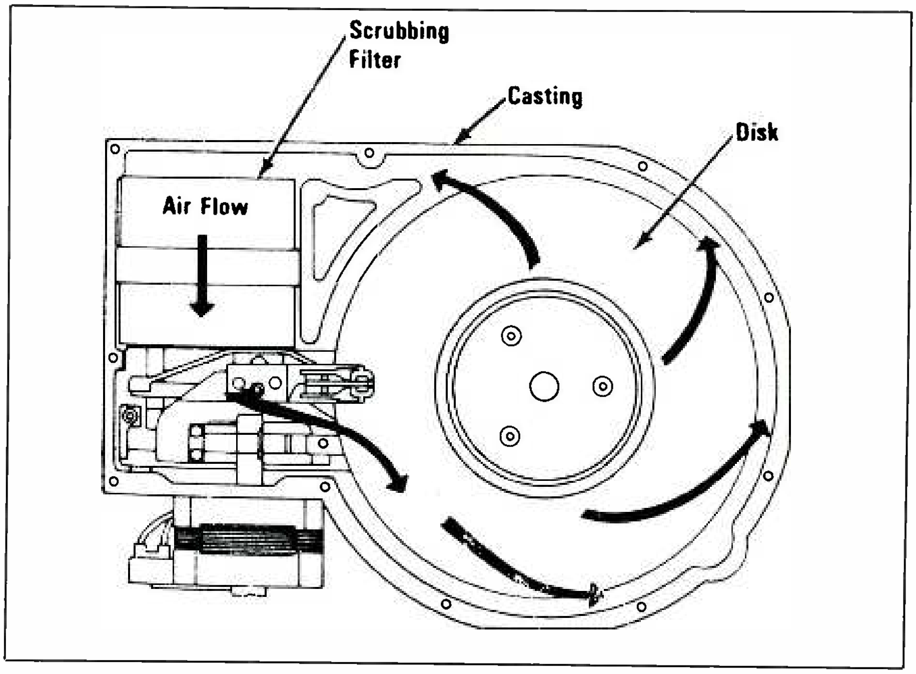


Fig. 1. The hard disk spins at the high speed of 3,600 rpm, creating a ground effect that allows the head to actually float above the platter without touching it.

Installing a Hard-Disk Drive

Installing a hard-disk drive into your system is a relatively simple procedure. Most dealers sell hard-disk kits that contain the hard-disk drive, a hard-disk controller card, necessary cables, front panel bezel replacement, and an installation manual. With the kit, installing a hard-disk drive takes less than 30 minutes. I used a Seagate ST225 hard drive in this instance, which is a 20-MB, half-height unit that's widely sold by mail-order houses.

For convenience, we demonstrate the procedure using an IBM PC, but owners of PC compatibles should be able to use the same method. The first step, of course, is to make sure that the power cord is disconnected.

Remove the rear-panel screws holding the outside case in place and slide the cover forward, taking care that the center screw support doesn't catch on the system's cables. You may need to tilt the case slightly to avoid snagging the front panel.

Next, decide where you want to install your new hard drive. Hard-disk drives come in many sizes, including ½-height,

⅔-height and full-height, and the size of the unit plays an important role in where it can fit in the chassis. The easiest route is to remove the "B" floppy-disk drive and replace it with the hard disk, assuming you've got full-height drives. If you have half-height floppy drives, one atop the other, then you've got a clear area to install the hard drive and you can retain use of both floppy drives. (And you don't have to spend any time removing the second one.)

The "B" drive is held in place by two screws located to the right of the unit as viewed from the front. Remove these screws. Then gently slide the unit forward until you can disconnect the cables connecting the drive to the power supply and controller card. Tuck the controller cable safely out of the way, as it is no longer used. Continue to slide the drive forward until it's clear of the case. You're now ready to install the hard disk, in this case, the Seagate 20-MB model.

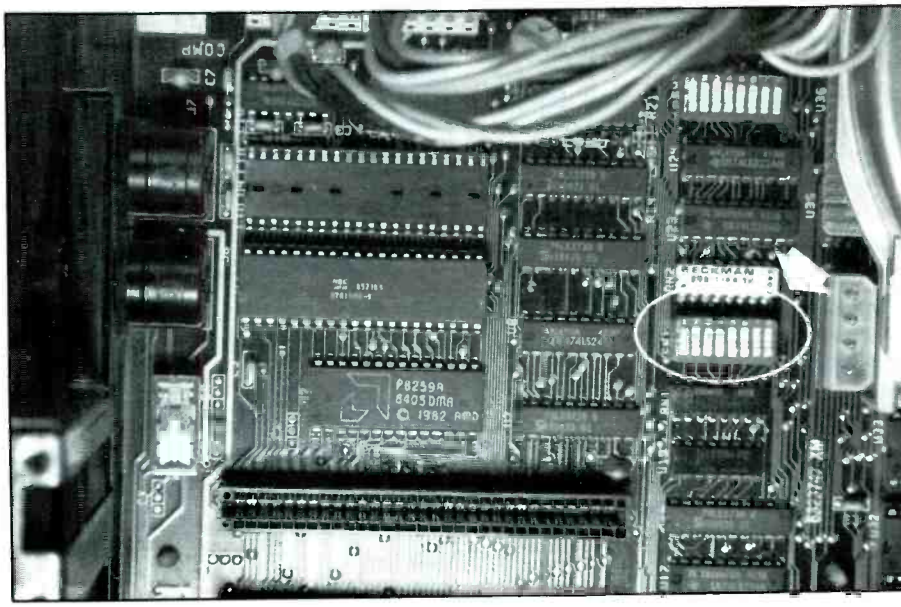
Somewhere in the manual is a listing of computer switch settings to make for your new disk drive. The switch may be either a jumper plug or a DIP switch that "tells" the disk drive whether your system contains more than one hard-disk drive or not. Manual in hand, select the proper drive setting.

Now slide the drive into the slot previously occupied by the "B" floppy drive. Before you secure it with the two screws removed from the floppy-disk drive, connect the power supply cord and controller cables. One controller cable has 34 pins, the other 20 pins, and both have a locating key that prevents you from installing them incorrectly. The opposite ends of these two cables connect to the controller board.

While most controller boards come properly configured from the factory, it's possible that a switch setting or two may have to be changed to accommodate your system. If so, make the changes now.

While on the subject of setup switches, it's now time to configure the computer's motherboard switches to reflect your system changes. The change is made to Switch Block 1, pins 1, 7 and 8. Pin 1 should be OFF and pins 7 and 8 should be ON, as shown in Fig. 2.

Complete installation by plugging the controller board into an open expansion slot in your computer. Be aware that the board is susceptible to damage from



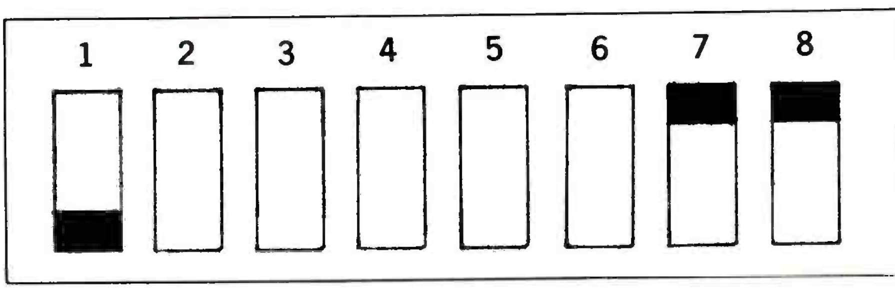
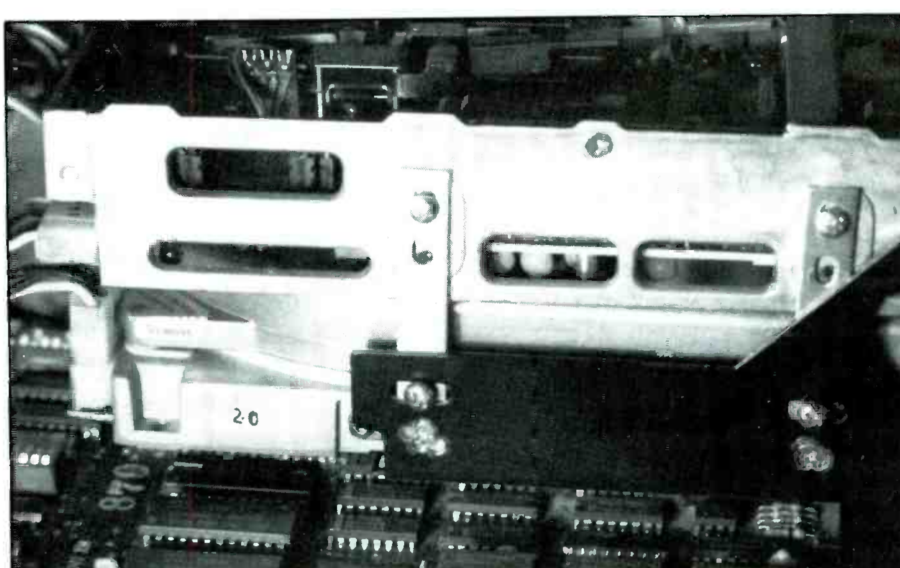


Fig. 2. Before using the hard-disk drive, the Number 1 setup switch must be reconfigured, as detailed in the above drawing.



When installing a half-height hard-disk drive in an IBM PC, it may be advantageous to mount the hard disk just below a half-height floppy-disk drive, rather than in the B-drive opening. This frees the right-hand slot for future expansion. Metal straps are used to secure the two units to the chassis mounting.

static discharge. Therefore, make sure your body is free of static electricity by touching your hands to the metal chassis before handling this or any other adapter board. It will probably be necessary to route the controller cables so that they are not in the way of the cover.

If your hard drive is only half-height, which most are, your kit contains a bezel that fills the empty slot above the hard drive on the front panel. Install it now. Check your work for errors, and then replace the outside cover.

Formatting

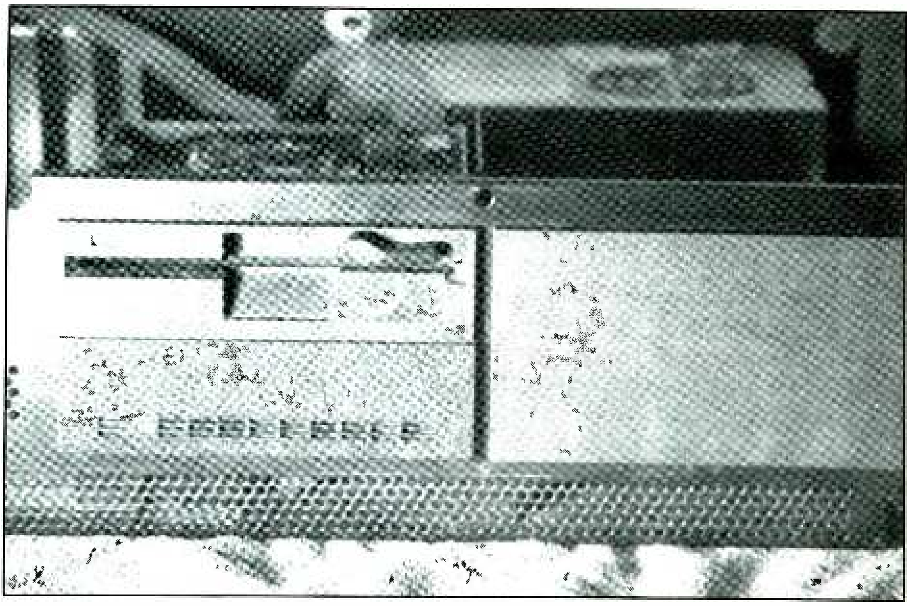
Your hard disk is now ready for service. Unlike floppy diskettes, though, your hard disk requires two types of formatting before it can be used: a physical format and a logical format. Both formats are made using your disk-operating system (DOS Version 2.xx or 3.xx).

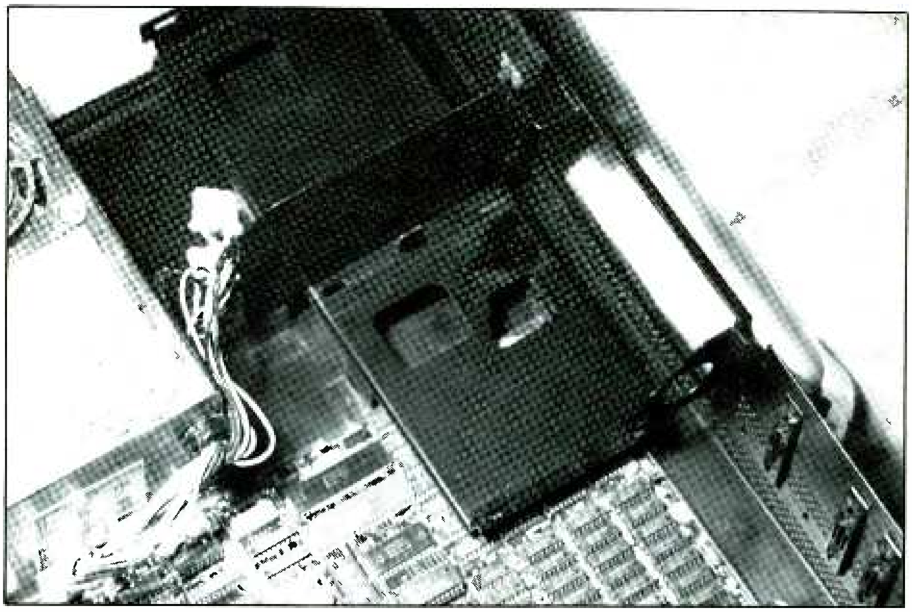
Physical formatting arranges the structure of the information on the disk media. Information is organized into sectors and clusters. A sector is an area on the disk that contains 512 bytes of data. A cluster is a group of sectors that the hard disk, for management purposes, treats as one.

Let's say, for example, that you have a file containing 1,000 bytes. Obviously, this file requires two 512-byte sectors of disk space. But the hard disk doesn't recognize individual sectors *per se*. Such a chore would take up much too much management space on the disk. What the drive does is group sectors into clusters of 4, 8 or 16, and treats them as one. When writing a file to the disk, you're actually writing to a cluster.

This arrangement would be fine if all files were of a size commensurate with the size of a cluster. But they're not. If we were to write our 1,000-byte file to a disk formatted with four sectors to the cluster, only half of the available sectors would be used, leaving a full 50 percent of the cluster empty. And, regrettably, no other file or record can make use of these left-over sectors. They are assigned one file and one file alone, no matter what their size.

Generally, cluster size is specified by the disk maker at the time of manufacture. To reset the size of the clusters, you must use the FDISK program found on





An IBM PC with all disk drives removed is shown in upper photo. Lower photo shows a half-height hard-disk drive installed below a half-height floppy drive at left, with second drive slot at right covered by a bezel. Other installation arrangements are possible.

your DOS program diskette to erase the previous cluster settings.

The type of DOS you're using has an effect on the size of the cluster. DOS Version 2.1, for example, formats its disks using a 4K (8-sector) cluster and doesn't support hard-disk drives larger than 10 MB in capacity. DOS 3.1, on the other hand, formats in 2K clusters and supports disk drives of up to 32 MB.

With the DOS diskette in drive "A," turn on your machine and let it boot. At the DOS prompt, type: "FDISK" and press ENTER. You are now given a menu of FDISK options. Choose option [3]: deleting the DOS partition. Essentially, this command wipes your disk blank, including the formatted cluster size. A warning screen will appear informing you that the information on the hard disk is about to be destroyed, to which you respond with a "Y."

You must now create a new DOS partition using option [1] of your FDISK menu. The process is automatic; simply press ENTER in response to all questions.

The hard disk is now ready for logical formatting. The logical format prepares the drive with DOS-specific information vital to system operation. At the DOS prompt, type "FORMAT" C:/S/V" and then hit ENTER. The FORMAT command sections the disk and lists any bad sectors, while the /S and /V parameters place the boot commands and a label on the disk, respectively. You will be warned of data loss at this time, but not to worry. Proceed by answering "Y" to the statement.

Depending on the size of the disk involved, logical formatting can take up to several minutes to complete, so relax. The formatting process is complete when you are asked to enter a disk label name of up to 11 characters long. I suggest using the DOS version for the label; i.e., DOS 3_1 (notice that periods are not acceptable label characters).

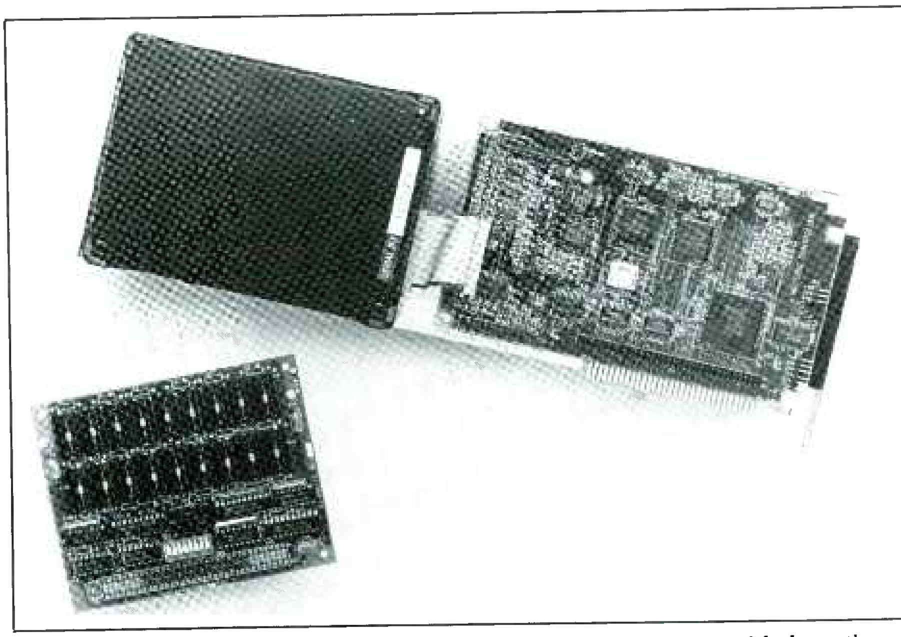
The hard disk is now ready for use. The average access time of the Seagate ST225 I installed is 68.5 ms, using a Core International test disk. This disk drive's high speed and large storage capacity, as compared to floppies, is impressive. Once you get accustomed to using your hard disk, you'll wonder how you ever got along without it.

—TJ Byers

2. FileCard

Adding a hard disk to your IBM PC or XT or compatible computer has been made even easier with hard disk/controllers that plug right into an expansion slot. Two representative models are examined here: Western Digital's "FileCard" and Maynard Electronics' "OnBoard."

Western Digital, which had previously marketed its wares through OEM channels, has now gone retail with some products, including the 10-Mbyte hard-disk drive card examined here that can be placed in an IBM PC/XT or compatible expansion slot. Its 3.5" drive, which is approximately 1" wide, is attached to a Western digital controller card. An optional memory card, which can hold up to 512K of RAM, can be attached to the board. Suggested retail price of the FileCard is $795, and the memory card is $99 with 0K of RAM installed. (The memory daughterboard is being given free by many dealers with a FileCard purchase.)



Western Digital's low-power, 10-MB FileCard combines mass storage with the option of RAM memory on a small daughterboard (lower-left) that mounts on hard-disk controller card without taking up additional slot space.

Installation

Installation of the card is straightforward and is as simple as adding any other kind of expansion board. The manufacturer suggests anchoring the drive on its far side with screws, which is easiest to do on the IBM PC or XT. On other systems, like the Compaq or AT&T 6300, a special bracket is included to accommodate the peculiarities of each computer's chassis.

If FileCard is not the first hard-disk drive to be installed in the system, certain jumper wires on the board must be changed. These changes are thoroughly detailed in the manual.

Attaching the memory board to the card is also a simple process. The card plugs into a 34-contact/double-row connector on the board and is secured by two screws at the other end. Then the DIP switches on the board and in the system must be correctly set according to the amount of memory employed. This step is also well-detailed in the manual. Since the component side is installed face-down, adding only a hair-width to the FileCard, it doesn't infringe on an adjacent slot's turf.

The width of the drive section on FileCard causes it to use 1½ slots. The extra half slot that FileCard uses means that you cannot put a full-size expansion board next to a FileCard unless you use Slot 1. To do this, you will have to move the internal speaker. Otherwise, only a half-size expansion board can be installed next to FileCard.

Once you load FileCard into an expansion slot, your hardware chores are over, but there still remains a software setup to perform. Normally, a hard disk must undergo a low-level or physical formatting, and then a logical formatting with the DOS FORMAT command. Western Digital, however, makes things as easy as pie for the customer, shipping the disk already physically formatted, and with an install program to do the rest of the setup task. So typing "INSTALL" is normally all that is necessary in most cases to get the drive up and running.

Sometimes, however, programs on a hard disk can become damaged in shipping and the work done at the factory must be repeated. In our case, the INSTALL program bogged down before it completed its task. It was then a matter of trial and error to see how much the INSTALL program had accomplished and what was left to do. Although the INSTALL program simplifies the procedure of getting the disk up and running, there is no substitute for knowing the DOS procedures themselves. For example, the INSTALL program creates only a DOS partition on the disk. If you want more than one partition, you have to use the DOS FDISK command anyway.

Using the Hard Disk

In its quest to make FileCard the easiest product to install and use, Western Digital also includes an excellent hard-disk management program called XTREE from Executive Systems (Sherman Oaks, CA). This utility program helps you to manage the hard disk by making it easy to create subdirectories and to view the layout of the disk once multiple directories are in use. XTREE also makes it a snap to copy and delete one or more files on the hard disk. This program is a smart addition to the product.

One of the reasons to buy a hard disk, besides capacity, is for speed. Unfortunately, FileCard falls short in this area. The disk is rated with an average access time of 147 milliseconds. When subjected to our Core International test for disk speed, we measured the average access time to be 164 ms. Normally, a hard drive on an IBM XT has an average access time of 93 ms, using the same source, though its rating is 80 ms or so.

We wondered why FileCard's access time lagged behind that of most other hard disks. A little research revealed that its rotational speed is only 2,322 rpm in contrast to a hard-disk's standard 3,600 rpm (a floppy drive revolves the disk at only 300 rpm). Further, its transfer rate is 3.2 Mbits/sec. compared to an industry standard of 5 Mbits/sec. Interestingly, we also discovered that we could not sense a difference in speed between it and hard-disk drives with twice the speed in the same machine. Perhaps we would with heavily fragmented files. But FileCard was plenty fast in use.

Another drawback of the drive is that you don't get to see the red indicator light when it goes on, since it is tucked away inside the unit. This was a problem for us when the INSTALL program crashed, for we really didn't know if the drive had stopped or not, and thus waited longer than we should have to abort the program.

Once up and running, however, we observed that FileCard's automatic head-parking feature does more than activate when power is shut down. It also parks the heads when you don't use the computer for 5 seconds or so, emitting an easily heard whirring sound as it does so. The drive itself is very quiet. Sometimes, hard-disk noise can be bothersome, since the disk is constantly spinning. With FileCard, this high-pitched noise is satisfactorily muffled.

Though you lose a slot when installing a FileCard (you'd lose half a slot anyway for the separate controller if you install a conventional hard disk), you do gain an extra floppy-disk drive that would have to be removed when installing a standard internal hard disk (unless half-height drives are used). The extra floppy drive is always useful in a system. Too, if you have a machine with a 10-MB hard disk and you need more storage capacity, it represents a way out beyond dumping the 10-MB drive to substitute a larger-capacity drive or adding a desk-space-taking external drive.

Power drain of FileCard is only 5.3 watts, which is another plus for PC owners whose power supplies can be strained by hard disks requiring more power. Adding the memory plug-in card to FileCard, fully populated with 512K of RAM, adds only 0.75 watt.

The memory board can be a Godsend to users who have not yet brought their computers up to full capacity. It accommodates two rows (nine devices each) of RAM. This can be 18 256K chips (512K), 18 64K chips (128K), nine 256K and nine 64K chips (360K), or nine 256K chips with one row unpopulated (256K). Thus, there are lots of expansion options without giving up another slot.

Another possible advantage of a plug-in hard disk like FileCard is its portability. At a weight of just 2 lbs. 4 ozs., it is very easy to remove FileCard from one PC and install it in another. However, one should handle a hard disk gently, since it is a fragile device that could lose its information if subjected to too much of a shock. FileCard's shock resistance specification is a nice 70 G when the heads are parked, however (and 5 G when not parked).

There are two sets of documentation for FileCard: one for the card and memory board and one for XTREE. The FileCard documentation is thorough and highlighted with many photos and drawings. However, it is probably wise to supplement the documentation with DOS documentation for hard disks. Documentation for XTREE is good, although the program is so simple to operate that documentation is probably not needed for most uses.

Western Digital's FileCard attempts to set a new standard for ease of installation and operation of a hard disk. For this benefit, the cost of a 10-Mbyte card is substantially more than for some faster standard 20-Mbyte internal disks. Is the benefit worth the cost?

I think it is in many, but not all, instances. It is, I believe, if you must add a second hard disk or if you don't want to give up one of your two floppy-disk drives. Or if you just don't want the bother of maneuveing an internal drive into place and squishing more cables into an already tight enclosure. Or if your power supply is the original PC1's underrated unit. Or if you need more RAM memory. In these cases, however, I'd spring for another $100 (list price) and get the 20-Mbyte FileCard instead of the 10-Mbyte examined here. It'll be one of the best-spent $100 in your life.

If the conditions cited are not one of your driving reasons, I'd recommend a standard internal hard-disk drive. They're a lot cheaper and not that difficult to install. Also, there are some hard-disk cards that are hundreds of dollars cheaper. They won't have Western Digital's magnificent-quality components and workmanship, though.

— *Joe Desposito*

3. OnBoard

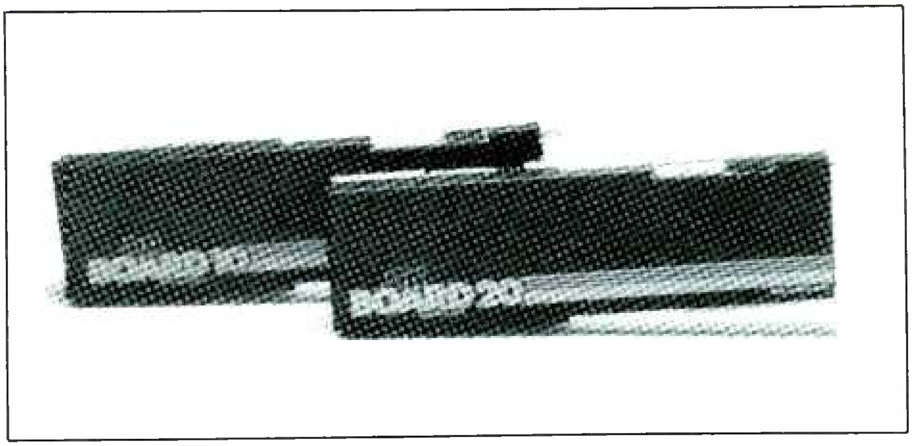
Maynard Electronics entered the hard-disk card arena early. Its OnBoard model is available in two storage capacities: 10 Mb and 20 Mb. (Like all counts of memory, there is actually more than stated since numbers are neatly rounded off. A 20-Mb drive is really a 21-Mb+ drive, for example, just as a 64K chip actually has more than 65K of memory.)

OnBoard typifies what most hard-disk cards look like, a rectangular body with one half containing the drive and the complementing other half the electronics and slot-connector contacts.

The $895 20-Mb drive tested is more costly than some hard-disk cards, but not the highest. Unlike many hard-disk drives and cards, the one we worked with had no bad sectors. (Hard disks often have a few imperfections, you know, so it's not unusual to get one with some bad sectors locked out at the factory. Not to worry if this is the case, since the storage memory lost is only a drop in the bucket.) The drive worked flawlessly for a half year while on loan, so its design/construction promises good reliability.

Using the floppy disk program supplied with the card, formatting the hard disk was almost as easy as installing it. Interestingly, the disk contains a program for early PCs that cannot boot a hard-disk drive. Copying the short program onto a floppy, the latter can be used as a key disk to boot the hard disk, obviating an absolute need to change an old ROM. This works with DOS 2.xx only. If you use DOS 3.xx, you'll have to get the new ROM. The support disk also contains programs for "parking" the hard disk for use when moving it to another location, a utility to indicate the hard-disk drive's BIOS number, hard drive diagnositics, and a Novell Netware network driver.

The owner's manual was unusually complete. In addition to lucid instructions, with print in two colors, the manufacturer took great pains in providing instructions in how to set up OnBoard to work with a variety of computers that have various hard-disk drive configurations. Hence, if someone has, say, a 10-MB drive that was standard with XT models for some time, and needs more data storage, he doesn't have to dump



Maynard Electronics' OnBoard 10 and 20 offer 10 and 20 MB of mass storage capacity, respectively. There are now 30-MB hard cards on the market as well.

the existing hard-disk drive; just add to it. Since OnBoard can control the second drive, with the addition of dual-drive cables available from Maynard that simply plug into a connector on the card, the original hard-disk drive's controller can be removed, saving a slot.

Another worthy feature of OnBoard is the ability to set up a screen indicator (flashing dot) and/or sound indicator (beeping sound) to let you know when the internal hard disk is operating. The indicators can be turned on and off. The hard drive, by the way, is unusually quiet in operation.

As with all hard-disk cards we know of, excepting Plus Development's "Hard-card," the Maynard card takes up 1½ expansion slots. That is, the drive portion's width of the card encroaches into the space of a second slot, while the electronics section does not. Thus, only a half-card can be used in front of OnBoard, as with most other hard cards.

There is an approach to make it possible to use a full-length card in front of OnBoard (or any other hard-disk card, for that matter). Just move the internal speaker's location to another area (where a half-length diskette drive controller card is usually plugged in) and plug the hard-disk card into Slot 1, which is the expansion slot farthest from the power supply. This way, the extra width of the card's drive extends towards the case's end, making it possible to mount a full-length card in Slot 2. Maynard not only recognizes this opportunity and shows how to do it in its manual, it also offers a free clip-on adapter to mount the speaker on the hard-drive card should such new speaker-mounting space not be available. Clever!

Internal diagnostics run automatically on power-up, says the manual. Since we never suffered with as much as a glitch in all the time we worked with the drive, so we'll take the maker's word for it.

The only criticism we can make relating to OnBoard is our initial impression of the absence of an automatic head-park feature when power is turned off. This is a good insurance policy to have, especially if something happens with the computer that prevents booting the support disk to park the heads for shipping or otherwise rough treatment. Checking this out with the company, I was assured that the drive did indeed have an automatic head-park feature upon shutdown that positioned the heads in a dedicated landing zone where data is not written or read. The "park" program, moving the heads altogether away from the media, goes farther to avoid any possible damage, said the company spokesman.

We did handle the card kind of roughly, jarring the computer many times, pulling the card and plugging it back in a number of times without parking the heads, but the thing just kept running without a problem. We also used a utility

(Continued on page 81)

An Audio/Video Distribution Amplifier

This device eliminates signal-loss problems usually encountered when trying to interconnect a TV receiver, one or more VCRs and similar products into a single video entertainment system

By Jack Cunkelman

The variety of video equipment used in home-entertainment systems has multiplied amazingly over the past ten years. People now have several VCRs, video cameras, laser-disc players, satellite TV receivers, cable TV converters, and computer video monitors, for example, as well as stereo hi-fi components. All of these sources are usually separate units that must be interconnected to make up a "system." How to do this without loss of any of the performance quality designed into each unit, which can cause a "grainy" picture or severe reduction of audio high frequencies, can be a real problem. A functional solution is building (and using) the Audio/Video Distribution Amplifier to be described.

The A/V Amplifier is a relatively simple, low-cost homebrew project that counters signal losses that can deteriorate reception. Additionally, it offers an orderly way to interconnect a bevy of video products. It provides three independent video and three independent audio outputs (all isolated from each other) and features *stereo* sound for each of its audio outputs so that it's ready to accommodate stereo TV broadcasts if you can receive them with the MTS stereo incorporated into newer TV receivers. If you need more audio and video lines than provided in the basic unit, you can build more Distribution Amplifiers as needed, just as inexpensively.

Interconnections

The most common interconnection method for the various devices used in home video entertainment systems has been to distribute the signal as r-f on a coaxial cable. The r-f signal contains both video and audio information that is modulated on an r-f carrier for delivery to the antenna terminals on a typical TV receiver, which is tuned to the particular channel designated for its reception. Modula-

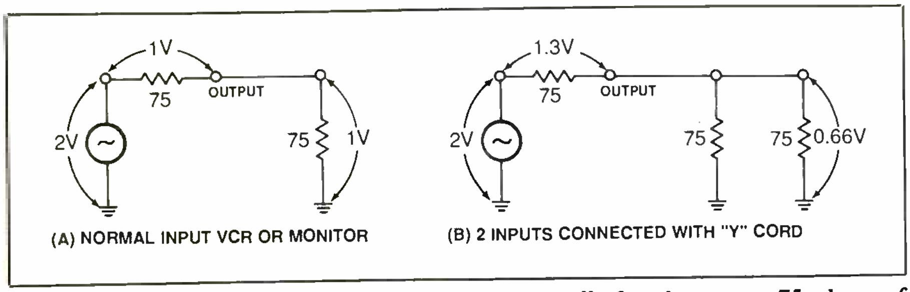


Fig. 1. Outputs from video equipment are normally 2 volts across 75 ohms of impedance. Matching such outputs with the same impedance causes a 1-volt signal to be delivered to the equipment being driven, as in the upper illustration. If two devices, both with an input impedance of 75 ohms were to be connected in parallel (as would be done with a Y connector) across the 75-ohm source impedance, each would receive only 0.66 volt of the signal, as in the lower illustration.

tion is accomplished by the same process TV stations use to send their program audio and video signals to you.

A VCR also applies this modulation process to the audio and video signals from tape. This combined r-f signal usually exits the VCR at a frequency that can be tuned to the TV receiver by setting its channel selector to either channel 3 or channel 4. (You select which channel you want the signal to be on by setting a switch in the VCR). The TV receiver, a second VCR or whatever other device is receiving the signal demodulates the r-f signal to extract the original audio and video information so it can deal with them separately.

The r-f/coax cable method of interconnection is the most straightforward and popular in current use. However, it is not necessarily the best. In fact, in a typical home installation that has more than three video devices that have to be connected to form a system, it may not even be practical.

Every time the audio and video signals are combined by a modulator and are then demodulated, a little of the signal quality is lost. If the signals are modulated and demodulated several times, deterioration becomes noticeable. Consider that a TV program recorded from a cable TV hookup has undergone the modulation/demodulation process three times before you finally view it. If you were to compare the original with the taped program, you would observe an obvious degradation in the taped version.

If you were dealing with a stereo audio signal, you would discover that one of the two audio channels is missing because the standard modulation process can deal with only one channel of audio. Thus, it is desirable to manipulate and distribute the audio and video signals separately. As consumers have become more quality-conscious, equipment de-

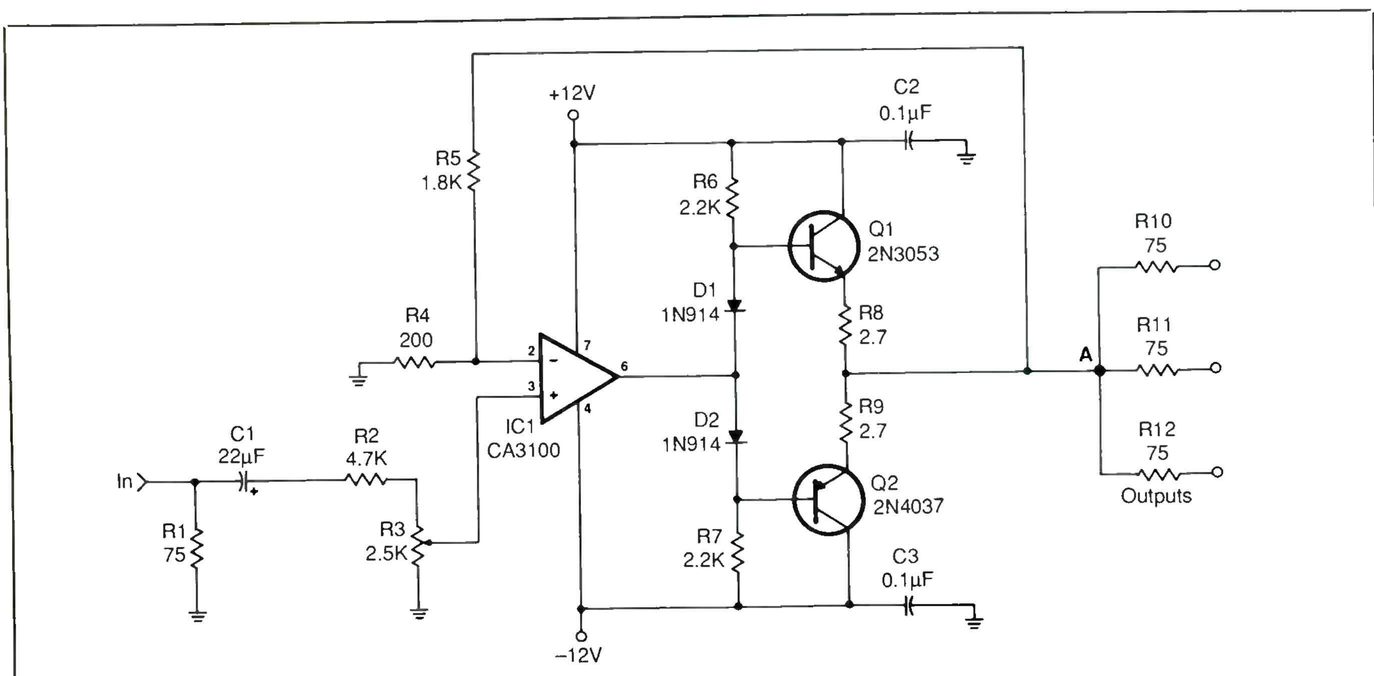


Fig. 2. The video portion of the Distribution amplifier.

signers have devised equipment that allows them to deal with audio and video signals separately.

Most home VCRs have separate video and audio input and output jacks, as well as the usual cable connector for the modulated r-f signal. The new generation of TV receiver/monitors now have audio and video inputs, as well as the usual r-f antenna terminals. Home video cameras also have individual audio and video outputs. The main problem, then, is in distribution of video signals to all of the devices that may be in a home video entertainment system.

The video output from a VCR, for example, consists of a 2-volt, 75-ohm signal (Fig. 1). The input of the receiving device (say, a TV monitor or another VCR) presents 75-ohm load to this signal. This is the terminating input. When both ends are connected, 1 volt of the 2-volt signal appears across the source termination and the remaining volt appears across the input termination of the destination device. If you were to connect two inputs to this one output, such as is done when you use a "Y" connector, the level across each input would drop to 0.6 volt. The result is a noticeable degradation in picture and/or sound quality.

Each receiving device requires its own separate feed because every input is terminated. Terminations are required to keep reflections off the interconnecting coaxial-cable line.

While audio distribution is not as critical in this respect, running separate isolated audio and video lines to each device is a good idea. Also, driving the audio interconnect lines from a low-impedance source allows you to use longer interconnect cables.

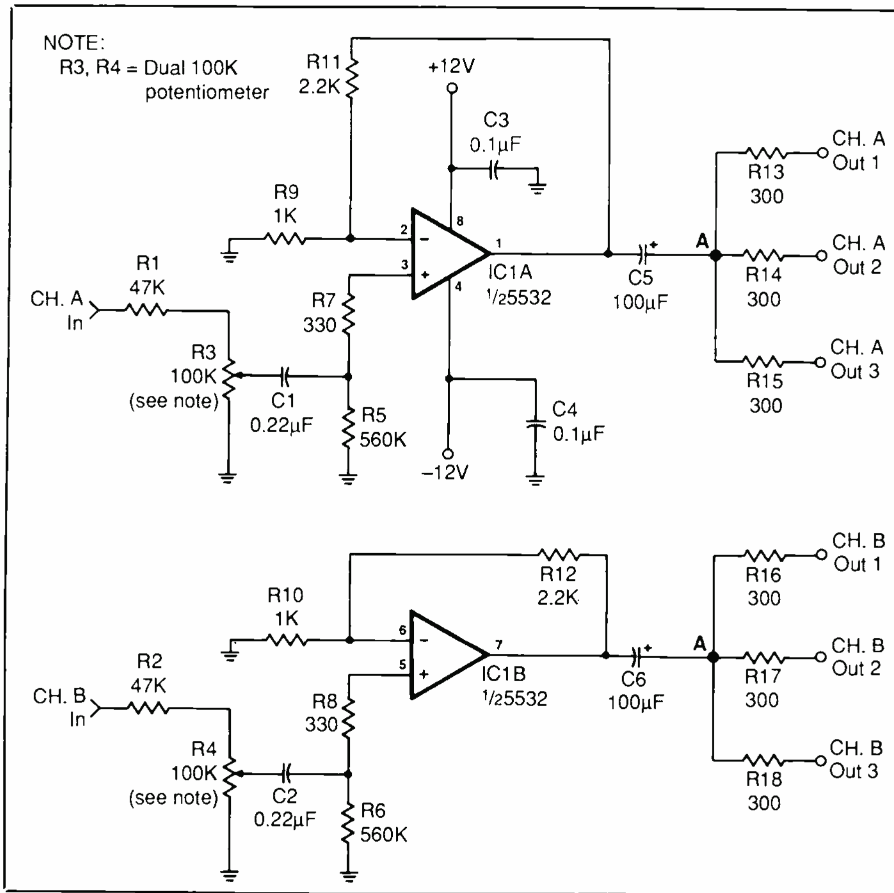


Fig. 3. The audio portion of the Distribution amplifier.

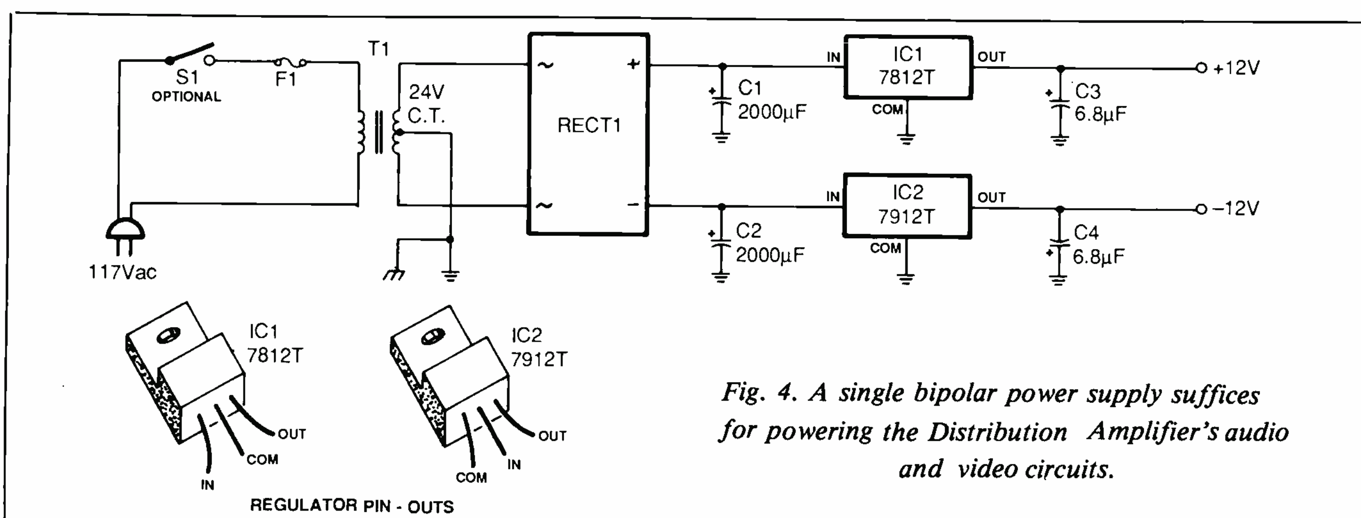


Fig. 4. A single bipolar power supply suffices for powering the Distribution Amplifier's audio and video circuits.

PARTS LIST

Video Amplifier
C1,C2—0.22-μF Mylar capacitor
C3,C4—0.1-μF disc capacitor
C5,C6—100-μF, 25-volt radial-lead electrolytic capacitor
IC1—5532 dual operational amplifier
All resistors ¼-watt, 5% tolerance carbon film
R1,R2—47,000 ohms
R5,R6—560,000 ohms
R7,R8—330 ohms
R9,R10—1,000 ohms
R11,R12—2,200 ohms
R13 thru R18—300 ohms
R3,R4—Dual 100,000-ohm, linear-taper potentiometer

Audio Amplifier
C1—22-μF, 16-volt radial-lead electrolytic capacitor
C2,C3—0.1-μF disc capacitor
D1,D2—1N914 diode
IC1—CA3100 BiMOS operational amplifier
Q1—2N3053 pnp transistor
Q2—2N4037 npn transistor
All resistors ¼-watt, 5% tolerance carbon film
R1,R10,R11,R12—75 ohms
R2—4,700 ohms
R4—200 ohms
R5—1,800 ohms
R6,R7—2,200 ohms
R8,R9—2.7 ohms
R3—2,500-ohm, linear-taper potentiometer

Power Supply & Chassis
C1,C2—2,200-μF, 25-volt axial-lead electrolytic capacitor
C3,C4—6.8-μF, 16-volt tantalum capacitor
F1—0.5-ampere slow-blow fuse
IC1—7812T +12-volt regulator
IC2—7912T −12-volt regulator
RECT1—100-volt, 2-ampere bridge rectifier
S1—Spst toggle or slide switch (optional)
T1—24-volt, 1-ampere center-tapped transformer
Misc.—Printed-circuit boards or perforated board and suitable soldering or Wire Wrap hardware; sockets for ICs in audio and video amplifiers; bayonet-type fuse holder or chassis-mount fuse block; 4-place phono-jack strip for video input and outputs (Radio Shack Cat. No. 274-322A or similar); 8-place phono-jack strip for audio inputs and outputs (Radio Shack Cat. No. 274-370 or similar); metal enclosure (Radio Shack Cat. No. 270-274A or similar 8¼"W × 6⅛"D × 3¹⁄₁₆"H box); ac line cord with plug; small-diameter coaxial or shielded cable; clip-on heat sinks for regulators in power supply (optional); insulated standoff post; pointer-type knobs for controls; labeling kit; clear spray acrylic (see text); ½" metal spacers (12); machine hardware; hookup wire; solder, etc.

Note: Etched, drilled and plated printed-circuit boards are available from Jack Cunkelman, P.O. Box 397, Milford, OH 45150: No. V11 video board for $7.00; No. A11 audio board for $7.00; No. PS11 power-supply board for $5.00. Add $1.00 P&H per order. Ohio residents, please add 6% state sales tax.

If you have audio and video jacks on your home-entertainment equipment (these are usually coaxial phono jacks like those used on audio equipment), you may want to utilize them and the Audio/Video Distribution Amplifier to be described to configure your system. The Distribution Amplifier's three video and three audio outputs (the latter with two stereo channels) should allow for maximum flexibility. The noticeable increase in audio and, especially, video performance will make building and using this project a worthwhile effort.

About the Circuit

Three separate circuits make up the Audio/Video Distribution Amplifier: the video, the audio and the power supply. The basic reason for this arrangement is that distribution amplifiers are designed to provide multiple isolated outputs of an input signal. By making the circuits separate,. it is relatively easy to maintain isolation.

In any distribution amplifier, the signal at the output is at the same level as the input signal. The Audio/Video Distribution Amplifier described here takes this into account. It also features variable gain for those situations where there is too great or too little a signal level for optimum viewing and listening. Thus, it eliminates the need for an extra signal attenuator and/or booster.

Three amplifiers are provided: one video and two audio. The video portion of the circuit, shown in Fig. 2, utilizes an RCA CA3100 BiMOS operational amplifier *(IC1)*. This op amp has excellent high-frequency response and should not be substituted. Transistors *Q1* and *Q2* boost the output current from *IC1*. Feedback is provided by *R5* to give the circuit linearity and stability.

Circuit gain is determined by the ratio of *R4* to *R5*. The values of these resistors were chosen so that a 1-volt signal across input terminator *R1* produces a 2-volt signal at point A when *R3* is set to the middle of its rotation.

Because point A is a very-low impedance, resistors *R10*, *R11* and *R12* serve as the sending-end terminators to provide the 75-ohm output impedance required to drive the coaxial interconnecting cables. Since point A is an ideal (almost 0-ohm) voltage source, whatever occurs at the output side of any one of the sending-end terminating resistors has no effect on the output sides of the other two sending-end terminating resistors. Hence, each output is isolated from the others.

Bypass capacitors *C2* and *C3* are required to prevent oscillations. Nominal bandwidth of this amplifier is 10 MHz. So high-frequency oscillations could be a problem if these bypass capacitors were not used.

Shown in Fig. 3 is the audio portion of the Distribution Amplifier. This circuit is built around 5532 dual op amp *IC1*, which handles the two channels of audio in a single integrated-circuit package. Since both channels operate identically, we will discuss only one.

Op amp *IC1* is a low-noise device that is optimized for audio applications. The input impedance of this Distribution amplifier is 47,000 ohms, which is set by *R1*. The gain of *IC1* is set by the ratio of *R11* to *R9*. With GAIN control *R3* set at its middle of rotation, the signal level at point A is the same as the input signal's level. This is different from the video Distribution Amplifier because the impedances of the loads connected to the outputs (the inputs of a VCR, for example) are usually 10,000 ohms or greater so that there is no drop across 300-ohm output termination resistors *R13*, *R14* and *R15*. (Note: *R3* and *R4* is a ganged dual-potentiometer, which allows the gain of both audio channels to be adjusted simultaneously.)

The low output impedance of the Distribution Amplifier allows you to make long runs to other equipment with no loss of high frequencies. Note once again that the +12- and −12-volt power buses are bypassed by *C3* and *C4*, respectively, to prevent unwanted oscillations.

A single bipolar power supply suffices for both audio and video portions of the Distribution Amplifier. The circuit for this power supply is shown in Fig. 4. After 117-volt ac line power is stepped down by *T1* to 24 volts ac, it is rectified to pulsating dc by bridge rectifier *RECT1*. The 24-volt pulsating dc output from *RECT1* is then filtered to clean dc by *C1* and *C2* and is regulated at +12 and −12 volts dc by *IC1* and *IC2*, respectively. Capacitors *C3* and *C4* serve as bypasses that prevent unwanted oscillations. POWER switch *S1* is an option.

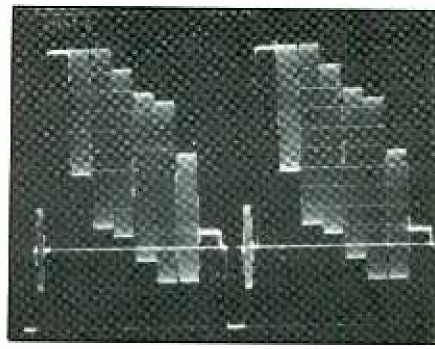
TECHNICAL SPECIFICATIONS

Audio Amplifier

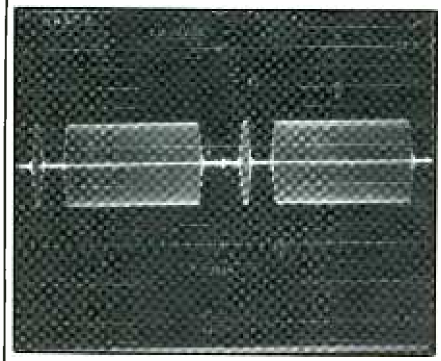
Distortion (at −4 dBV) . . . . < 0.02%
Signal-to-noise ratio . . . . >−70 dBV
Frequency response
. . . . 20 Hz to 30 kHz, ±0.1 dB
Clipping point . . . . +9 dBV

Video Amplifier

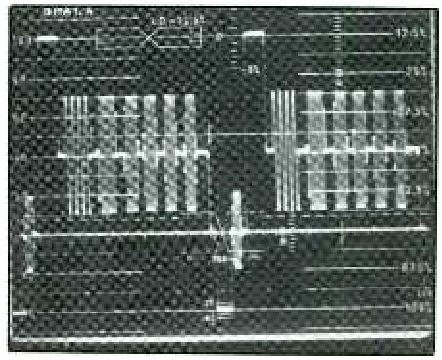
Differential phase . . . . <0.5 degree
Differential gain . . . . See photo



VIDEO COLOR-BAR RESPONSE



VIDEO DIFFERENTIAL GAIN



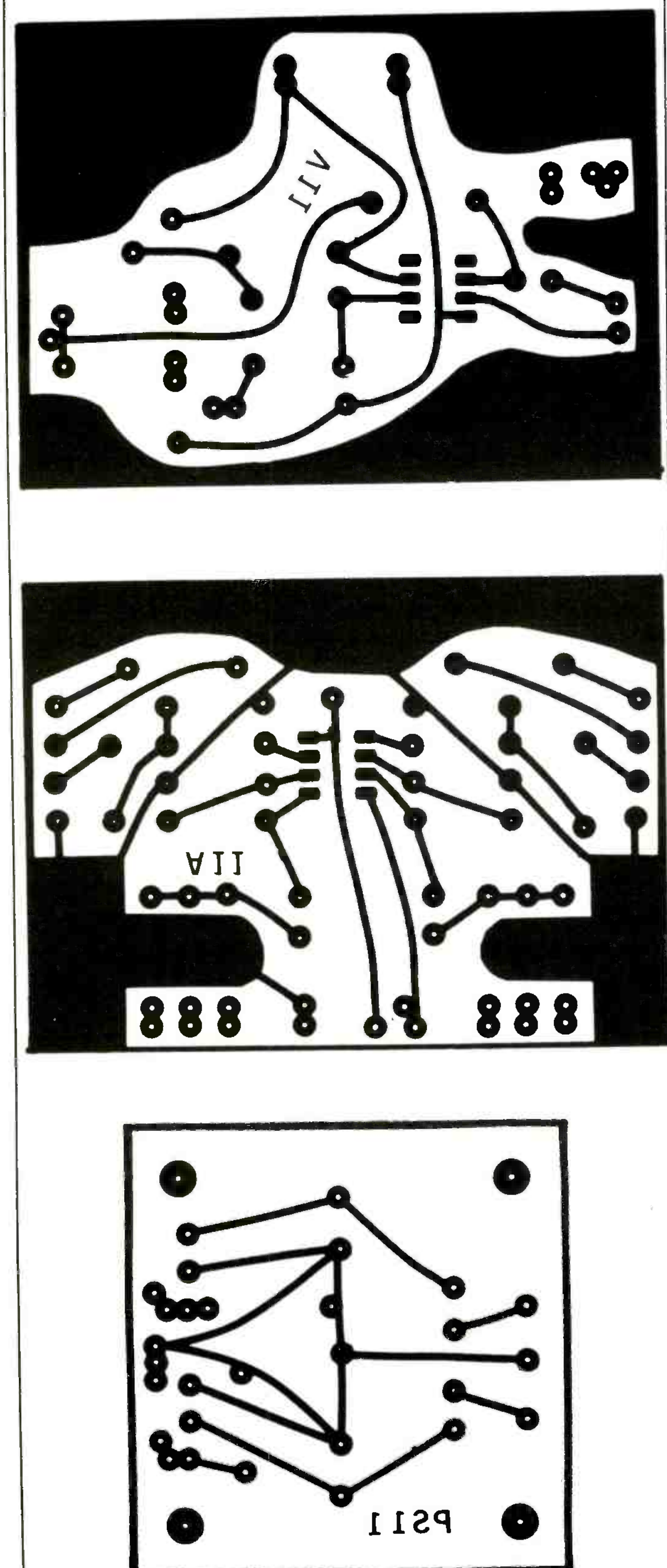
VIDEO MULTIBURST RESPONSE

Construction

Since the circuitry for all three sections of the Audio/Video Distribution Amplifier is fairly simple, any of a number of traditional methods of wiring can be used to build the project, though printed-circuit wiring is preferable. If you wish, you can fabricate your own pc boards, using the actual-size etching-and-drilling artwork in Fig. 5. Alternatively, you can purchase ready-to-wire boards from the source given in the Note at the end of the Parts List.

The audio and video boards are both the same size, measuring 3½″ × 2½″, while the power-supply board measures 2½″-square. Whatever wiring technique you use, the circuits can be built on boards of these dimensions. All wiring to and from these boards should be done neatly to avoid unwanted oscillations and crosstalk. Also, use sockets for the ICs on the video and audio boards, but not on the power-supply board.

Wire each board exactly as shown in Fig. 6, working on only one board at a time so that you do not make any component errors. Install only the sockets for the ICs on the audio and video boards—*not* the ICs themselves; these will be installed after you make voltage checks. Install and solder into place the resistors, followed by the capacitors (observe polarity with the electrolytics). When wiring the video board, make sure you install the transistors in the proper locations and that you observe proper basing. Also, make certain that the diodes are properly oriented.



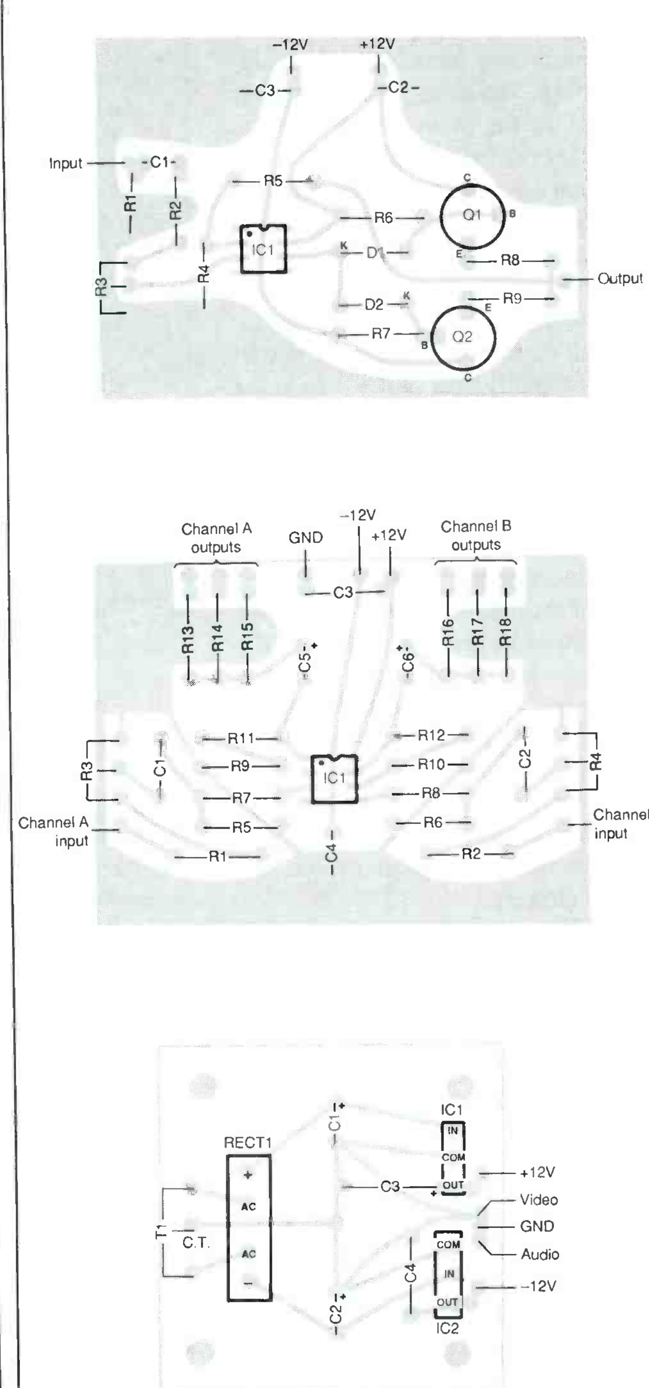


Fig. 5. The actual-size etching-and-drilling guides (left) to use if you plan on fabricating your own pc boards.

Fig. 6. Wiring guides (above) for the pc boards. These guides are also used to lay out circuit assemblies wired point-to-point with solder or Wire Wrap hardware.

Similarly, make sure the diodes are properly oriented, and make sure the regulators are installed in the appropriate locations, also properly based, on the power-supply board. Ditto for the bridge rectifier.

If you are using perforated board, arrange the components on the boards in the same patterns and orientations as for the pc boards. Use #22 solid hookup wire to interconnect all components. Route the wiring as directly and make it as short as possible.

Referring to Fig. 7, place the circuit-board assemblies inside the enclosure, in the locations shown and determine how long the wires that interconnect them must be. Make a note of the lengths needed and where they are to be installed. Remove the circuit-board assemblies from the enclosure. Prepare the wire lengths needed. Then install and solder them into place. Note that there are two +12-volt and two −12-volt output pads on the power-supply board, one set each for the audio and video amplifier circuits.

At this point, there should be no wires in the holes for the GAIN controls or the inputs to and outputs from the audio and video boards. There should also be no wires in the 24-volt ac and center-tap (*T1* secondary) holes in the power-supply circuit board.

Prepare 13 8″ lengths of hookup wire by removing ¼″ of insulation from one end of each. Plug the prepared ends of these wires into the output and control holes in the audio and video boards and solder the connections. When you are done, there should be 10 wires attached to the audio board and 3 wires attached to the video board.

Prepare both ends of three 7½″ lengths of small-diameter coaxial or shielded cable. To do this, remove 1″ of the outer plastic jacket, separate the shield back to the cut line, and strip ¼″ of insulation from the center conductor at both ends of the cables.

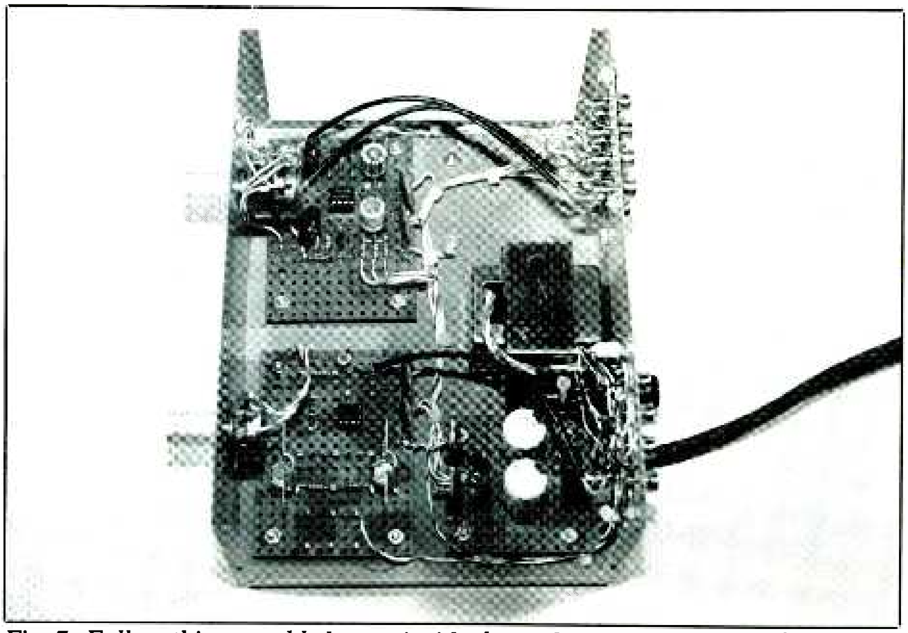


Fig. 7. Follow this assembly layout inside the enclosure to avoid interference between the power transformer and the audio and video circuits.

Tightly twist together the shield wires and sparingly tin with solder. Do the same for the fine wires in the inner conductors. Plug one end of each of the prepared cables into the "input" holes on the audio and video boards (shields to ground or common). Solder the connections in all six locations. The other ends of these cables and the previously installed wires will be connected later.

Now remove ¼″ of insulation from both ends of a 1½″ length of hookup wire. Connect and solder one end to a No. 6 solder lug. Plug the other end into the center-tap (C.T.) hole in the power-supply board and solder it into place.

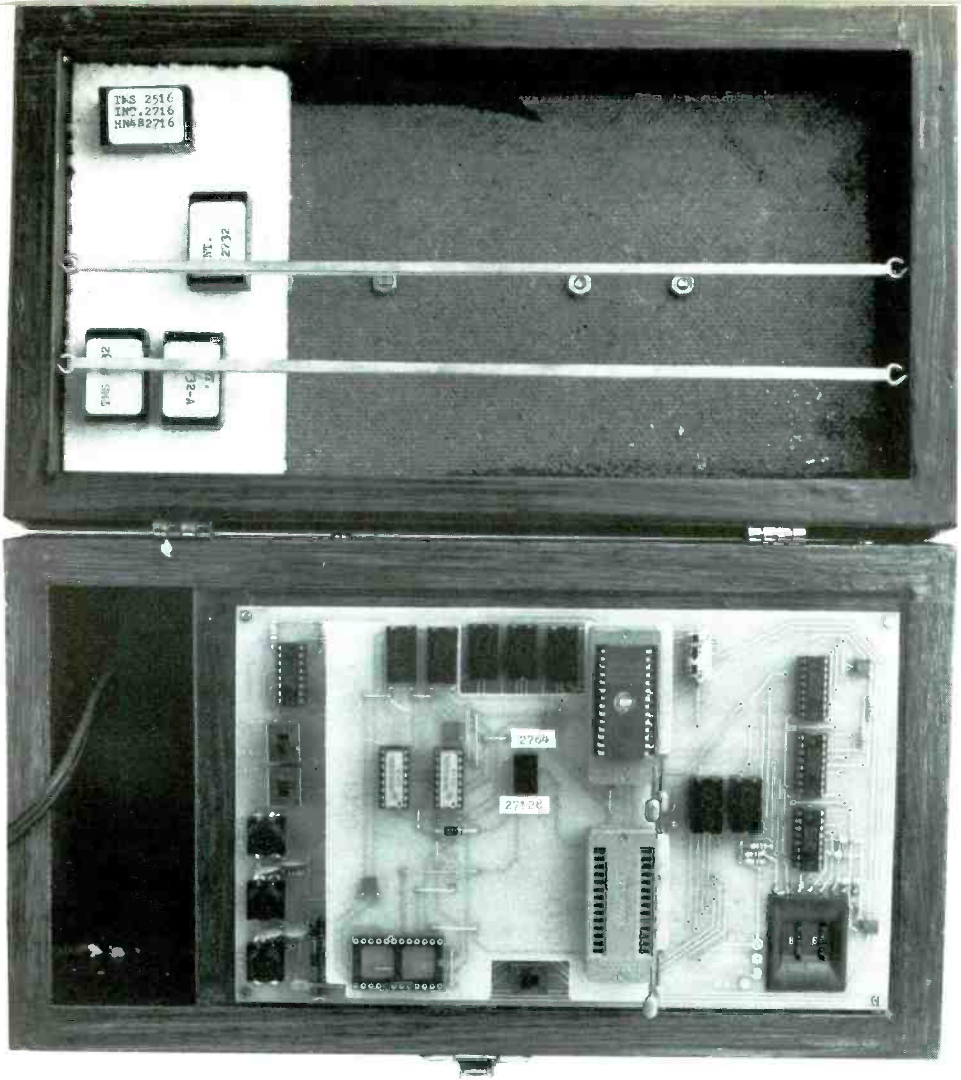
When you are finished wiring the boards, carefully inspect them for poorly soldered connections and solder bridges, the latter especially between the closely spaced IC pads. If you suspect a connection, reflow the solder on it and, if necessary, add more solder.

Flip over the boards and double check all components for proper values, locations and orientations. Clip small heat sinks onto the cases of *Q1* and *Q2* on the video board. The regulators on the power-supply board (*IC1* and *IC2*) run warm when the project is operating but do not require heat sinking. If you feel more comfortable with heat sinks, however, you can bolt onto the regulators small ones.

The enclosure for the project is not critical. Only two requirements must be met by it. One is that it must be large enough to comfortably accommodate the three circuit-board assemblies, power transformer, POWER switch (if used), GAIN controls, fuse holder and the input and output jack assemblies. The other is that it must be metal—*not* plastic—so that it fully shields the circuitry from electrical noise.

Machine the enclosure as needed, basing your layout on that shown in Fig. 7. The arrangement shown assures that there will be no interference between the power transformer and the audio and video circuit boards. Use the boards and power transformer themselves as templates

(Continued on page 86)



Stand-Alone EPROM Programmer

(Part 2, Conclusion)

Retrofit module plugs into the basic Programmer to allow programming of 64K and 128K EPROMs

By Walter W. Schopp

Last month, we presented details for building a sophisticated stand-alone EPROM Programmer capable of programming many popular 16K and 32K erasable programmable read-only memory (EPROM) devices. Its 12 address lines limited the project to use with 32K-maximum devices. This month, we present an upgrade retrofit board that expands the original Programmer's number of address lines to 20. This brings the total count up to FFFFF (1,048,276) to permit programming and reading up to 128K EPROMs.

All connections needed to cascade the two counters that add eight address lines are available at the Programmer's PERSONALITY socket. One required change in the original circuit is the conversion of the 24-pin sockets to 28-pin sockets that can accommodate 64K 2764 and 128K 27128 EPROMs.

The expansion board that adds the extra eight lines mounts over the EPROM Programmer's main board by plugging into the existing ZIF MASTER, PROGRAMMING and PERSONALITY sockets. The add-on board is cut to expose program data LED hex displays *DIS5* and *DIS6*, as well as address displays *DIS1*, *DIS2* and *DIS3* and locates two more displays to the left of the latter. The quick-lock/release action of the ZIF sockets on the original Programmer allow the retrofit board to be conveniently installed and removed as you change from one type of EPROM to another.

Locking the expansion board into the three ZIF sockets makes it an integral part of the original EPROM Programmer. A switch on the board lets you change the programming voltages as required for 2764 and 27128 EPROMs. Shown in Fig. 9 is

PARTS LIST

C18,C19,C20—0.1-μF capacitor
D14—1N4001 rectifier diode
DIS6,DIS7—TIL-311 LED hex display (Texas Instruments; available from Jameco)
IC18,IC19—74LS193 4-bit up/down counter
S6—Dpdt slide switch (No. 201 M2QE, available from C&K Components
SO4,SO5—28-pin ZIF Wire Wrap socket (Textool No. 228-3345; available from Jameco)
SO6—24-pin Wire Wrap IC socket (see text)
Misc.—Printed-circuit board; sockets for DIS1, DIS2, IC18 and IC19; two 24-pin Wire Wrap sockets for interconnect pins (see text); hookup wire; solder; etc.

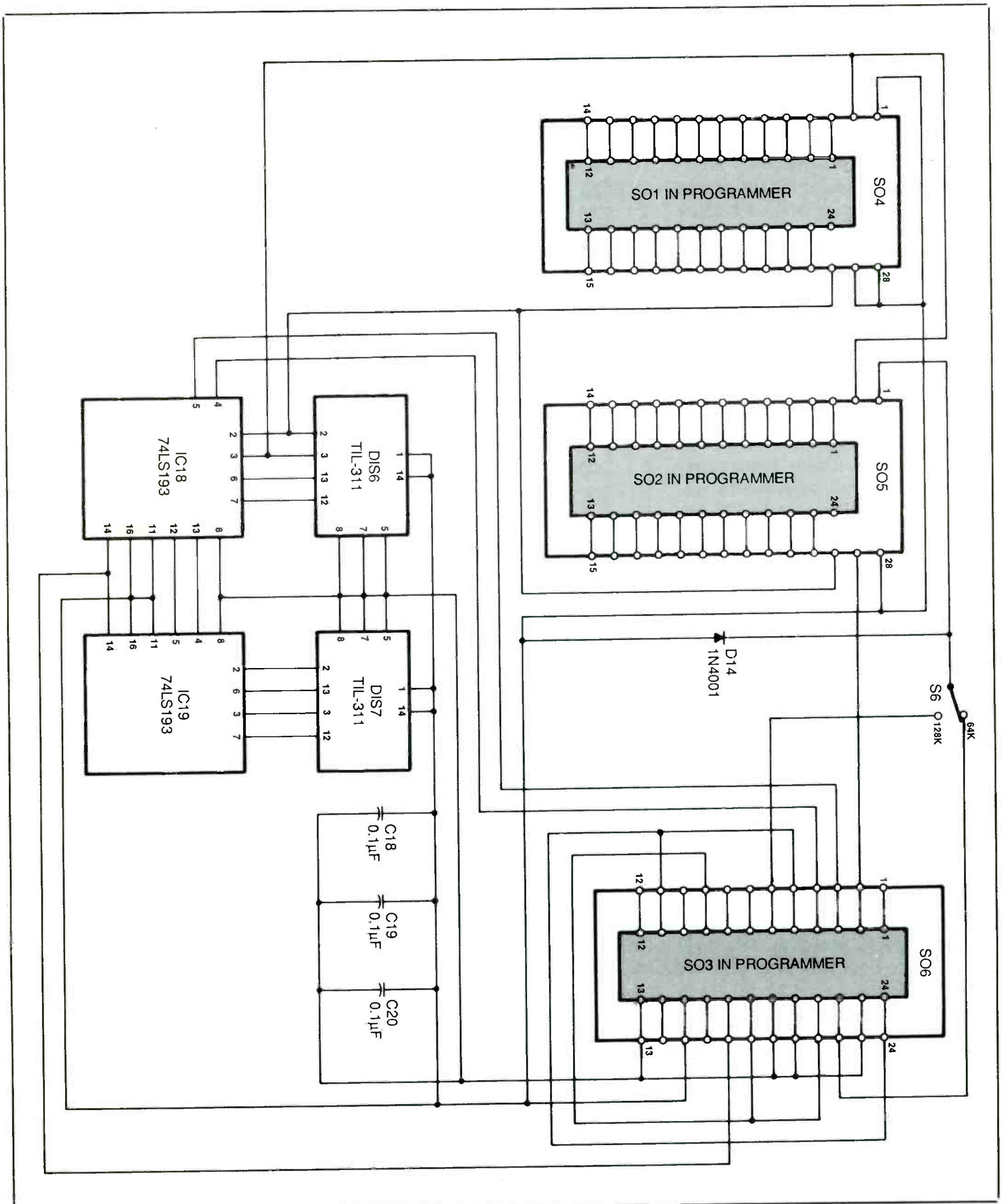


Fig. 9. Schematic diagram of retrofit circuit that converts original EPROM Programmer for use with large-capacity 64K and 128K EPROMs.

the complete schematic diagram of the add-on module.

Construction

As with the circuitry in the basic Programmer, printed-circuit construction is recommended for the add-on module. Though there are a number of wire jumpers on the retrofit board, the expansion adapter can easily be assembled on a single-sided pc board, the actual-size etching-and-drilling guide for which is shown in Fig. 10.

Etch and drill the pc board and trim it as shown so that the cutout areas will give access to *DIS1*, *DIS2*, *DIS3* and *S5*. Place the ready-to-wire board component side down on your work surface and, referring to Fig. 11, plug the pins of standard 24-pin Wire Wrap sockets into the holes provided for them at the *SO4* and *SO5* socket locations. Note that there are two columns each of 12 and 14 holes in both locations. Make sure you install these sockets in the 12-hole—*not* the 14-hole—columns through the *bottom* of the board! Tack solder diagonally opposite pins on each socket to the copper pads. Turn over the board and make sure all pins in both sockets go all the way into the holes and are flush with the top of the board.

Flip over the board and solidly solder all pins of both sockets to the copper pads. These connections must be mechanically as well as electrically secure. Carefully cut through each pin of both sockets as close as possible to the socket bodies—*not* the board—and discard the sockets. From here on, as you work with the board, be careful to avoid bending any of the pins.

Install and solder into place the wire jumpers at the locations shown in Fig. 11. You can use either insulated or bare solid hookup wire for the jumpers. Next, install the three capacitors, the dpdt switch and diode. Make sure you properly orient the diode before soldering its leads to the copper pads. Then install and solder into place standard sockets for *IC18*, *IC19*, *DIS6* and *DIS7*; ZIF sockets for *SO4* and *SO5*; and a standard 24-pin socket for *SO6*. If you wish, you can use a ZIF socket for *SO6*, though this is not necessary.

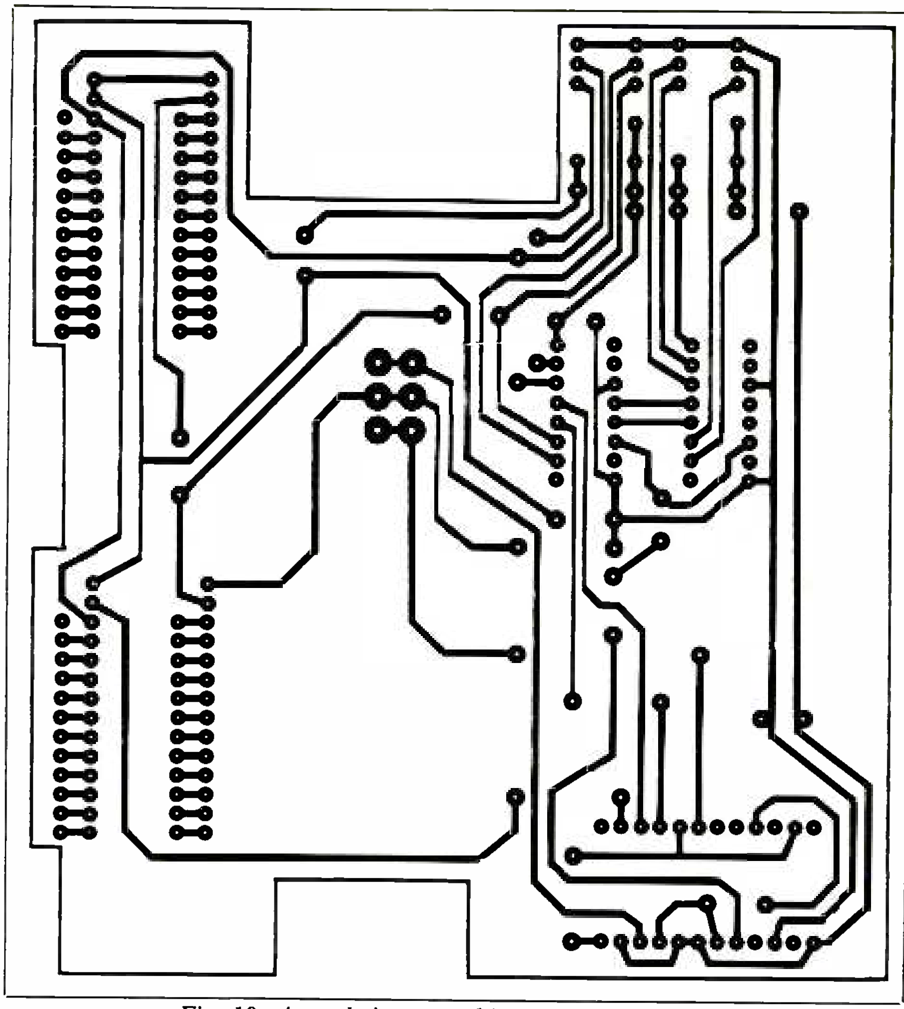


Fig. 10. Actual-size pc etching-and-drilling guide.

Note once again that certain pins are absent from the LED hex displays and that no board holes are provided for them. Therefore, as was done in Part 1 for *DIS1* through *DIS5*, clip off the pins of the *DIS6* and *DIS7* sockets close to the molded bodies for those locations where no board holes are provided. Also, when installing the ZIF sockets, orient their lock/release levers toward the bottom of the board. Push the *SO4*, *SO5* and *SO6* sockets down so that they sit solidly on the top of the board before soldering any pins to the copper pads on the bottom of the board. Save installation of the ICs and LED hex displays for last.

After all wiring shown in Fig. 11 is completed, flip over the board. Trim the pins of *SO4* and *SO5*—but not *SO6*—close to the board. You must now trim all pins in the *SO4*, *SO5* and *SO6* locations so that they protrude a uniform ⅜" from the bottom of the board. An easy way to do this is with a ⅜ length of small-diameter rigid tubing. Simply slip the tubing over each pin in turn and trim flush with the top of the tubing (see Fig. 12). When all pins have been trimmed,

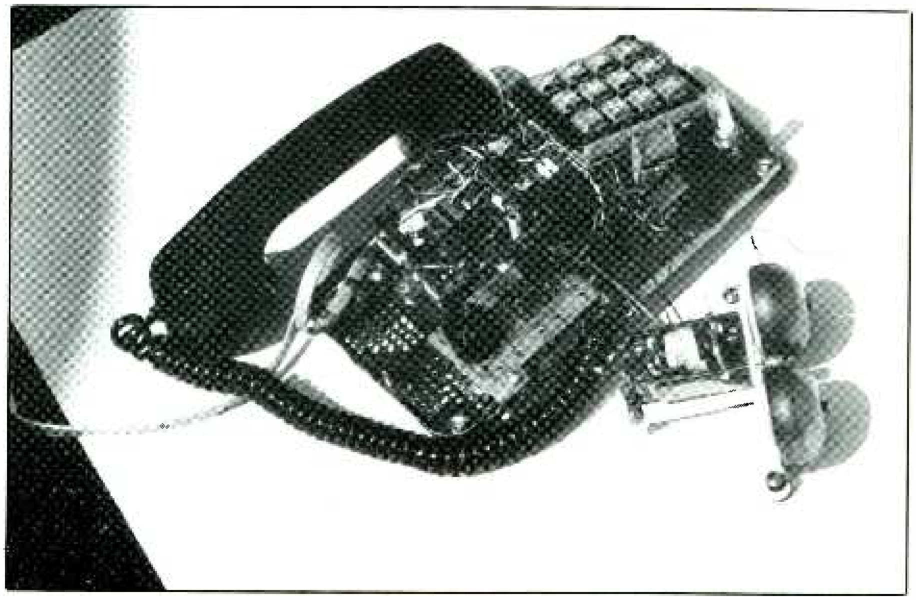
(Continued on page 82)

CIRCLE NO. 180 ON FREE INFORMATION CARD

The Ringer

A solid-state telephone bell replacement and stand-alone incoming-call annunciator

By C.R. Ball, Jr.



Ringer installed in place of standard bell inside a telephone.

Several new integrated-circuit ringers that can be adapted by hardware hackers to telephone applications have been introduced by Motorola. With these ICs and just a few components, you can build a module that replaces the bell in a conventional telephone, or house the circuit in a small plastic box so that it can be used as a stand-alone incoming-call annunciator with or without having a telephone handy. Since the ICs can drive low-current optical isolators and relays, the Ringer accessory to be described can even be used to power distinctive annunciators for outdoor use, provide a visual indication of an incoming call, and turn on electrical devices as a security measure.

If you have more than one telephone line coming into your home or office, you can have different tones for each line simply by changing ICs, resistor/capacitor values, or piezoelectric buzzers. The input impedance of the Ringer meets all Bell and EIA standards and fully complies with Part 68 of the FCC Rules and Regulations when built as described here. The stand-alone version uses 4- or 6-contact modular connectors for simple installation.

About the Circuit

Any one of three different versions of the Motorola IC tone ringer chip can be used in the Ringer. All three have basically the same circuitry, with each distinguished by a different suffix number. The circuitry is the same in all three cases and is illustrated in the block diagram in Fig. 1, along with the device's pinouts. The differences between the three chips are in the base frequencies and the values of capacitance that are used (see Table 1).

Because the Ringer is powered directly from the telephone line, it never needs batteries or ac line power to operate. The complete circuit for the project is shown schematically in Fig. 2. (Refer to Figs. 1 and 2 for the following description of circuit operation.) When a call comes in, the ac ring voltage that appears across the L1 and L2 (ring and tip) wires of the telephone line is rectified by a diode bridge inside the MC34017-x chip used for *U1* and is filtered by external capacitor *C4*. From here, it is used to power a tone generator and drive a piezoelectric buzzer or other device that has a current drain of less than 20 milliamperes.

Input signal detection circuitry activates the tone ringer output when the ring signal input (tip to ring on the telephone line) exceeds the threshold determined by the values of *R3* and *C2*. When the potential across the *R3/C2* network exceeds 1.2 volts dc, the threshold comparator enables the tone ringer. Transients produced by pulse-dialing telephones do not charge *C2* to a level sufficient to activate the tone ringer.

Once the tone-generating circuit has been activated by the threshold comparator, oscillator, frequency divider, warble frequency divider and push-pull output stages are enabled. The oscillator frequency is divided (the ratio depends on the spe-

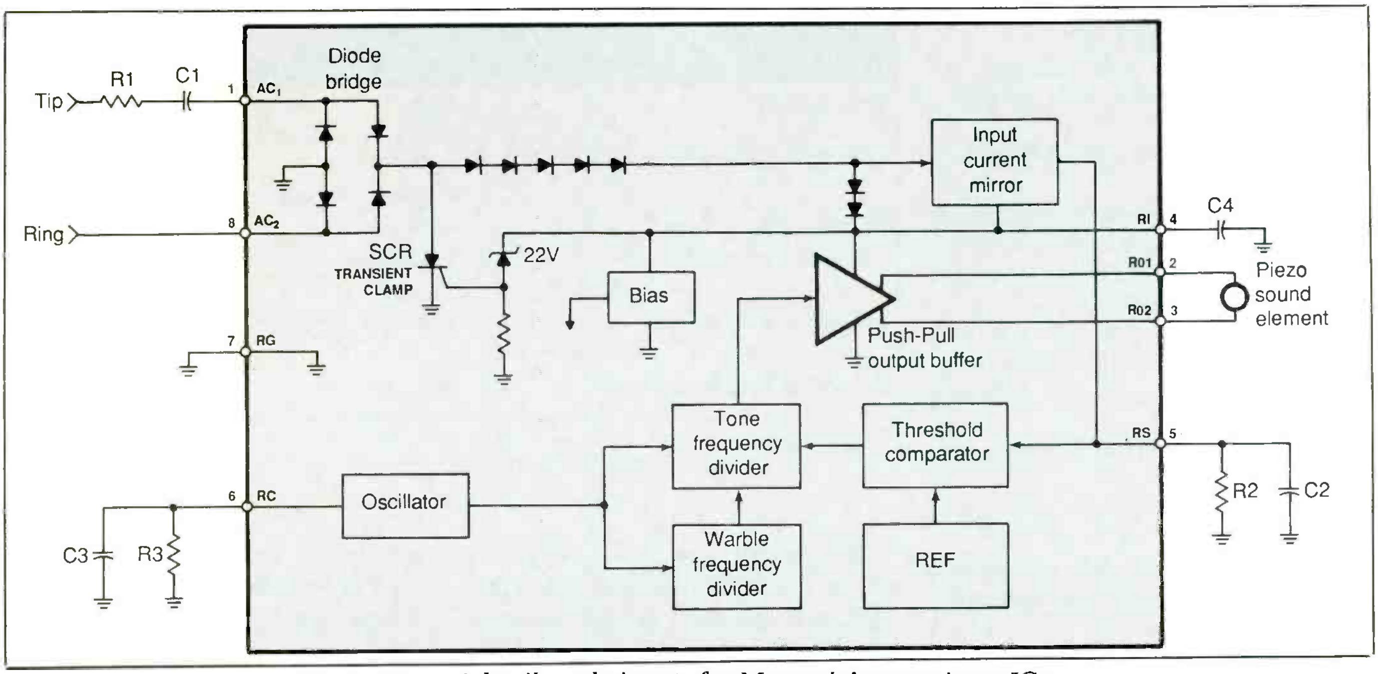


Fig. 1. Internal details and pinouts for Motorola's tone-ringer ICs.

Table 1. IC Frequency Specifications

IC Type	Frequencies (Hz) Base	Warble	Value of C3 (pF)
MC34017-1	1,000	12,500	1,000
MC34017-2	2,000	12,500	500
MC34017-3	500	12,500	2,000

cific version of the IC used for *U1*) to provide the basic tone, which is modulated by the warble tone.

The warble frequency of 12.5 kHz is common to all three versions of the Motorola chip. The base frequencies for each version are shown in Table 1.

This circuit is capable of sourcing or sinking up to 20 mA of current and can directly drive piezo transducers, optical isolators and low-current relays directly. If you wish to use other than piezo annunciators, an optoisolator interface is recommended to assure that the project operates within the guidelines set forth in Part 68 of the FCC Rules and Regulations that concern subscriber equipment connected to the telephone network.

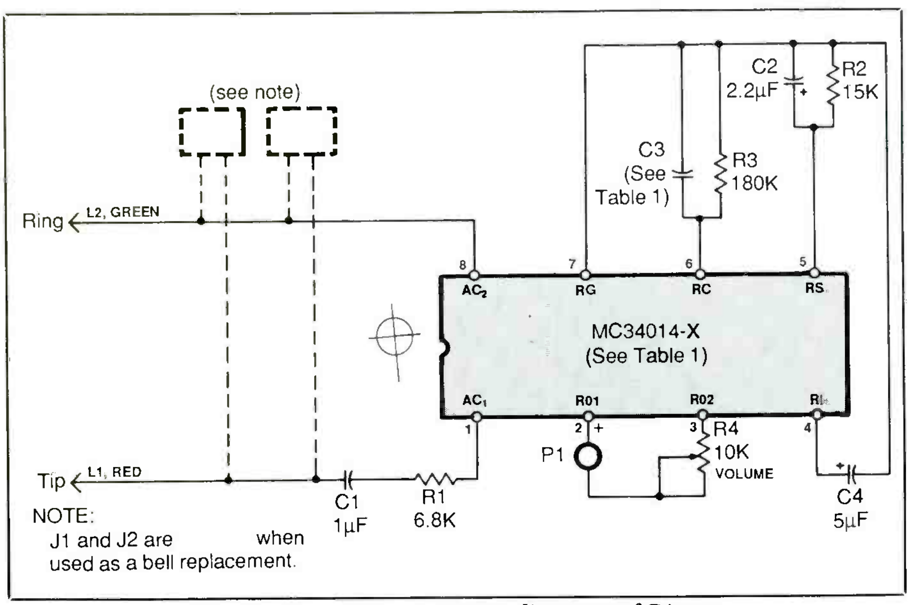


Fig. 2. Complete schematic diagram of Ringer.

Construction

It is possible to assemble the Ringer on perforated board using point-to-point wiring and suitable soldering or Wire Wrap hardware. However, printed-circuit wiring is recommended because of the close spacing of the modular connector pins and the danger of producing solder bridges. You can fabricate your own pc board using the actual-size etching-and-drilling guide shown at the left in Fig. 3. If you prefer, you can purchase a ready-to-wire board from the source given in the Note at the end of the Parts List.

Note in Fig. 3 the small tab that extends above the top of the guide. You

PARTS LIST

C1—1-μF, 200-volt Mylar capacitor
C2—2.2-μF, 16-volt tantalum capacitor
C3—See Table 1
C4—5-μF, 25-volt tantalum or electrolytic capacitor
J1,J2—Modular pc-mount jack (Berg No. 66011-001 or similar; available from Mouser corp., 2401 Hwy. 287 N., Mansfield, TX 76065)
P1—6-volt piezoelectric buzzer (Projects Unlimited No. 6A or similar)
R1—6,800-ohm, ½-watt, 5% tolerance resistor
R2—15,000-ohm ¼-watt, 5% tolerance resistor
R3—180,000-ohm, ¼-watt, 5% tolerance resistor
R4—10,000-ohm pc-mount trimmer or panel-mount standard potentiometer (see text)
U1-See Table 1
Misc.—Printed-circuit board; case for stand-alone version of project (Radio Shack Cat. No. 270-221 or similar); spade bolt (see text); spade clips or stab-on connectors (see text); machine hardware; hookup wire; solder; etc.

Note: The following items are available from Ballco Inc., P.O. Box 1022, Snellville, GA 30278-1022: pc board No. 851201 for $8.95 ppd; complete kit of components for bell replacement, No. RNG-B, for $14.95 plus $2.50 P&H. Georgia residents, please add state sales tax.

Table 2. Telephone Subscriber Line Specifications

Parameter*	Value	Condition
Central office voltage	−48 volts dc (positive ground)	on-hook
Central office voltage	−10 volts dc	off-hook
Central office voltage	105 volts ac, 20/30 Hz	on-hook ringing
Subscriber loop current	−20 to −30 mA	off-hook, CO seizure
Subscriber loop resistance	0 to 1,200 ohms	off-hook

* All tip to ring.

will include or omit this tab, depending on whether you plan to install the Ringer in place of the bell in your present telephone (include) or house it inside a stand-alone box for annunciation purposes (omit).

You can mount the pc board assembly directly in place of the mechanical bell ringer in a standard 500D (2500D Touch Tone™) telephone. If you plan to use the Ringer as an auxiliary device, trim the tab from the board to permit mounting inside a plastic or other weatherproof box that is only slightly larger than the board itself. Construction techniques are different for each type of installation. Therefore, first decide whether you want to use the Ringer as a bell replacement or as a stand-alone annunciator.

For bell replacement, do the following. Leave the tab on the pc board. Wire the board exactly as shown at the right in Fig. 3. Start wiring the board by installing a socket (or Molex Soldercons®) in the *U1* location. Do *not* install the IC in the socket until directed to do so. Next, install the remaining components in their respective locations in the normal manner. Pay careful attention to

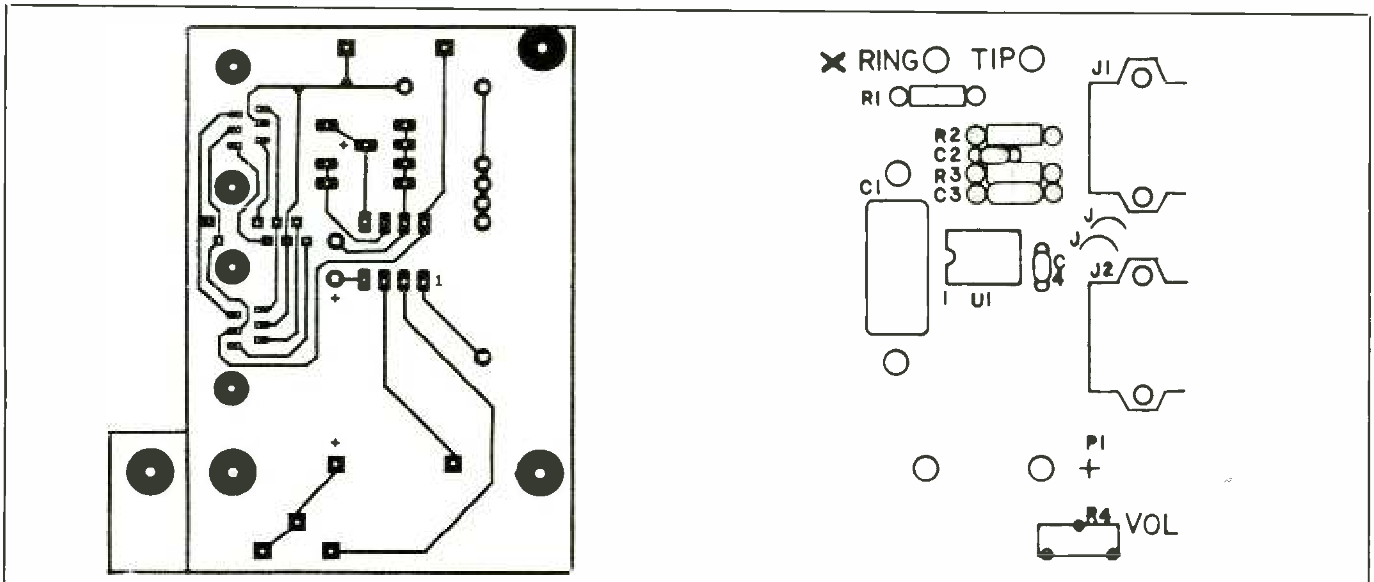


Fig. 3. Actual-size etching-and-drilling guide (left). Include tab at top if project is to be installed in place of bell inside a telephone; omit it if project is to be used as stand-alone annunciator. Wiring guide for pc board (right).

the polarities of the piezoelectric buzzer and electrolytic capacitors before soldering their leads to the copper pads on the bottom of the board. VOLUME control *R4* mounts on the *foil* side of the board so that it can be adjusted in the same manner as the original bell.

Remove ¼″ of insulation from both ends of two 6″ wires (preferably color coded for easy identification). Plug one end of these wires into the "tip" and "ring" holes in the board, and solder both wires into place. Solder a spade lug or stab terminal, depending on the needs of the telephone you have, to the free ends of these wires. Then install a spade bolt in the hole marked with an X, using No. 6 machine hardware.

Now, exercising standard procedures for safe handling of MOS

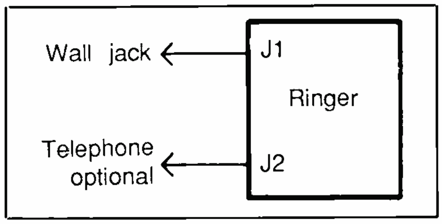


Fig. 4. Connections for stand-alone annunciator.

devices, install *U1* in its socket or Soldercons. If you are using a socket, make sure no pins of the IC fold under the device or overhang the socket before pushing it home.

For the stand-alone annunciator version, two modular jack positions must be available to provide the means for connecting the Ringer to the telephone-line wall jack and a telephone, modem, etc. Construction is much the same with this version as for bell replacement, except for installation of the two modular jacks and how VOLUME control *R4* is mounted. Here you mount *R4* on *top* of the board, adjacent to the piezo buzzer. Two jumper wires, as detailed in Fig. 3, are also needed.

To mount the modular jacks, position the pins in the holes and snap the plastic retainers into the board. Then solder the connector pins to the copper pads on the bottom of the board. Use extreme care when soldering these very closely spaced pins into place. Once again, reserve installation of *U1* in its socket or Soldercons until the last step in wiring/installation and practice safe handling procedures for MOS devices.

Drill holes in the case for mounting the circuit-board assembly and

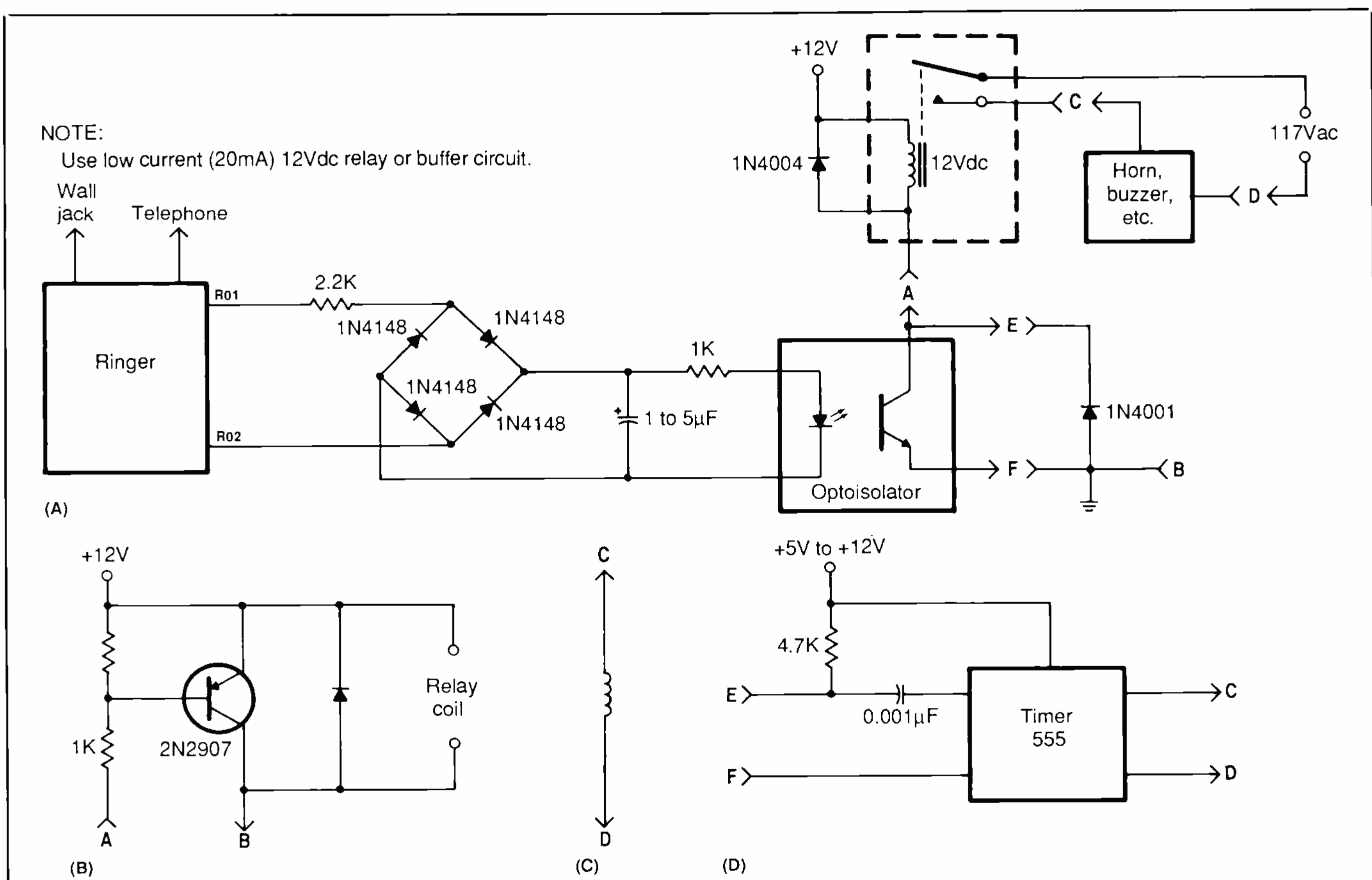


Fig. 5. Various add-on arrangements for different annunciator applications.

for access to the VOLUME control. For easier volume adjustment, you might want to substitute a conventional panel-mount potentiomter of the specified value for the trimmer control shown in the photos and connect it to the board with short lengths of insulated hookup wire. Notches for the modular jacks can be drilled and shaped with a file or be punched out with a nibbling tool.

Whichever version of the project you are assembling, it is imperative that you thoroughly clean the board after assembly. Use a flux remover for this step.

Before putting either version of the Ringer into service, it is a good idea to test it. Do this by temporarily connecting one lead of a 4,700-ohm resistor lead to either the ring connection on the board and an ac line cord with plug to the other resistor lead and the tip connection on the board. Insulate both connections so that you do not get an electrical shock or damage the circuit. Plug the line cord into an ac outlet. You should hear the piezo buzzer sound if everything is okay. If not, disconnect the line cord from the ac outlet and rectify the problem.

Installation

As a bell-replacement module, the Ringer can be mounted directly in place of the existing bell in a telephone. Some telephones have screw terminals, others pull-off terminals. Carefully disconnect the wires from the bell to the telephone network (there are usually four wires). Tighten the screws if your telephone uses them. Remove the existing bell and replace it with the Ringer. Some of the hardware may be interchangeable in this operation, depending on the telephone's manufacturer and the date of manufacture.

Connect the tip lead to the green wire and the ring lead to the red wire coming from the telephone line. These can be either screw or stab-on connectors, which also depends on manufacturer and date of manufacture. The corresponding terminals to which the incoming telephone line connect inside your telephone will be labeled with either "T" and "R" or "L1" and "L2."

When connecting the Ringer, polarity is not important for bell-replacement applications because the ring signal is an ac voltage and a diode bridge inside *U1* in the project takes care of managing polarity as well as rectifying the ring voltage. In stand-alone annunciator applications where modular jacks are involved, polarity is *very* important. You cannot dial out on a standard Touch Tone telephone if the tip and ring connections are reversed; though this does not matter for most automatic dialers and modems.

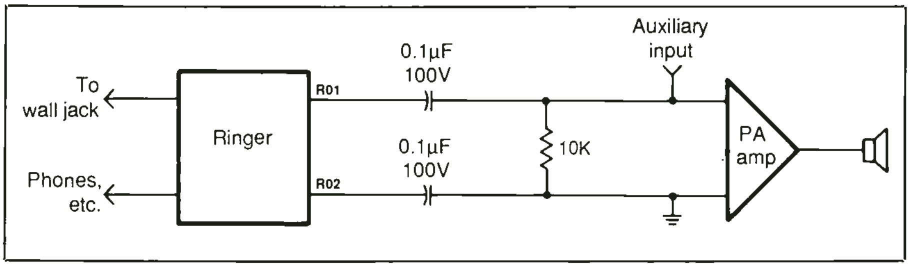


Fig. 6. Amplifier/speaker arrangement for using Ringer in high-noise applications. Warble tone is amplified and fed to trumpet speaker.

Applications

There are a number of applications to which the Ringer can be put. The following detail a few of them:

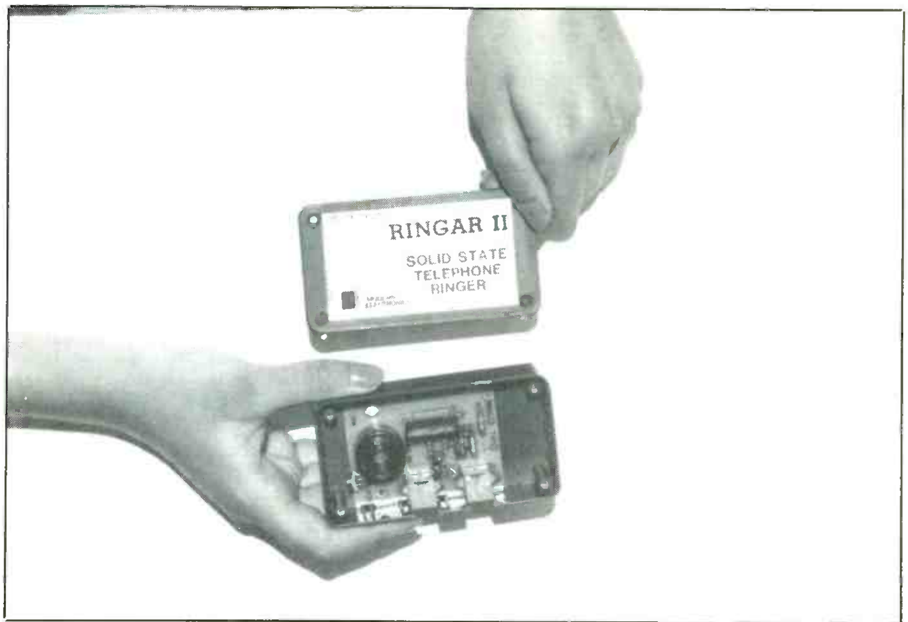
Stand-Alone Auxiliary Ringer. Here, the Ringer is used for remote locations—such as a patio, a garage, etc.—where you might not have (or want) a telephone but wish to know when a call is coming in. Install the Ringer as shown in Fig. 4.

- *Stand-Alone Loud Annunciator.* Use this arrangement for outdoors

Table 3. Network Progress Tones

Tone	Frequency (Hz)	On Time (sec.)	Off Time (sec.)	Condition
Dial	350 + 440*	cont.	N/A	Off-hook
Busy	480 + 620	0.5	0.5	Line busy
Ringback	440 + 480	2.0	4.0	Ring indication
Network Busy	480 + 620	0.2	0.3	Network circuits congested
Reorder Tone	480 + 620	0.3	0.2	Local circuits congested
Off-Hook	1,400 + 2,060 + 2,450 + 2,600	0.1	0.1	Off hook beyond time-out period

*Electronic Central Office



Assembled stand-alone annunciator.

and high-noise areas. The voltage from R01 and R02 that normally drives the piezoelectric buzzer is rectified, filtered and used to drive an optical isolator, as shown in Fig. 5(A). Use of the optoisolator and relay as shown ensure isolation of the telephone line from the 117-volt ac line as per Part 68 of the FCC Rules and Regulations. Fig. 5(B) shows an optional circuit that can be installed between the + 12-volt power bus and collector output from the optoisolator if more buffering is needed for relay-drive circuits. An audio amplifier and speaker can also be used, as shown in Fig. 6.

● *Stand-Alone Visual Annunciator.* This arrangement is used for very noisy locations, for the hearing impaired and where audio annunciation is not acceptable, such as in recording studios, operating rooms, etc. A typical arrangement for this is shown in Fig. 5(C). Actually, though the circuit shows a 117-volt ac line-powered lamp, you could use a 12- or even 6-volt dc source and lamp instead.

● *Security.* The circuit in Fig. 5(D) can be used to activate lights, a radio or some other electrical appliance or device simply by calling your home from wherever you happen to be. In this circuit, point E from the circuit in (A) is coupled through a 0.001-microfarad capacitor into the "trigger" input of the 555 timer circuit, point F goes to the timer circuit's ground, and there is nothing connected to point A coming off the optoisolator. Points C and D of the 555 timer circuit are relay outputs from that circuit.

When this circuit is installed, a call placed by you will turn on designated lights or sound devices for predetermined periods of time you select. The 555 timer block here represents a timer-driven relay circuit you build separate from the project. For details on how to build such a circuit and timing resistor/capacitor values, see Forrest M. Mims III's *555 Timer IC Circuits* published by and available from Radio Shack (specify Cat. No. 276-5010).

● *Other.* Since the Ringer can be powered from the 117-volt ac line, it can also be used to replace the annoying buzzer on a clothes dryer. This is just one of the many non-telephone applications for this project.

Advanced CD Player

Kyocera's newest CD player, the Model DA-710CX, offers 16-bit digital filtering and antiresonant chassis construction. Four Fine Ceramics spacers inside the chassis isolate key components from external vibration, and optical coupling isolates the digital and analog stages from each other. Features include a direct digital sub-code output port for use with future digital components; third-order Bessel-derived low-phase analog filters; three-beam laser tracking; gold-plated output contacts; dual D/A converters; and compatibility with Kyocera's Full Stereo Remote Control Network.

Also featured is a complete array of control features: 16-track programmability with illuminated 20-key panel for direct access of tracks; skip forward and back; repeat track; repeat disc; repeat track selections; and fast forward and reverse. The supplied 24-function wireless remote controller duplicates all front-panel controls, except power on/off. A background music function plays tracks on the disc in random sequence. A fluorescent digital display indicates the track and time elapsed or remaining. Also provided are a headphone jack with volume control and play activation with an external timer.

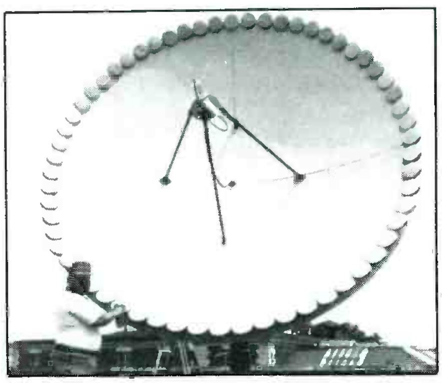
The player measures $18\frac{1}{8}$"W × $12\frac{1}{8}$"D × $3\frac{9}{16}$"H and weighs 14.5 lbs. $800.

CIRCLE 11 ON FREE INFORMATION CARD

TVRO Antenna Absorbers

Microwave Filter Co.'s (E. Syracuse, NY) Model 5552 absorber disk kit is designed to reduce TI (terrestrial interference) by as much as 10 dB when the disks supplied in it are placed around the perimeter of a satellite-TV antenna. The disks are said to prevent TI caused almost solely by reradiation of energy on the disk's rim. They serve as an alternative to filters that are usually ineffective against wide-band interference.

The kit is available for any size or shape of dish antenna. Each disk in the kit is approximately 6" in diameter and 1.25" thick and is weatherized to prevent moisture absorption.



The disks are designed to be placed at 0.25" intervals around the antenna, using the double-stick tape included in the kit. Price for any given kit is determined by the number of disks required for the given antenna.

CIRCLE 30 ON FREE INFORMATION CARD

HARDWARE HACKER

More on Omnicrom; genlocking video images; v/f converters; the Postscript language; an easy printed-circuit process

By Don Lancaster

Lots has been happening on the *Omnicrom* front since we last looked at this exciting new process that lets you cheaply get full-color from the toner image provided by a copier or laser printer. First and foremost, the *Kroy Sign Systems* people have taken over production, marketing, and distribution of this material in the U.S. This should mean much better availability and considerably lower prices. The new name is "Kroy Kolor." There are also some new goodies now available that include binding and laminating materials, plus all sorts of sign holders. For samples and more details on all this, contact Randy Bailey at Kroy.

Quite a few Hardware Hacker readers have been using a plain old iron to fuse the Omnicrom sheets. To do this, you either work upside-down or else place a sheet of paper or a muslin or cotton pressing cloth between the iron and the transfer sheet. I skipped this critical step and ended up with a gorpy mess.

Two other tips: A clay-coated and smooth paper works best, provided that the toner itself will stick to the paper. An obscure paper called "Paloma Matte" by *Butler Paper* performs very well. For the sharpest image, be sure to quickly separate the sheets after fusion.

We'll look at another "mess with the toner" product that ridiculously simplifies hacker printed-circuit boards shortly. But first . . . .

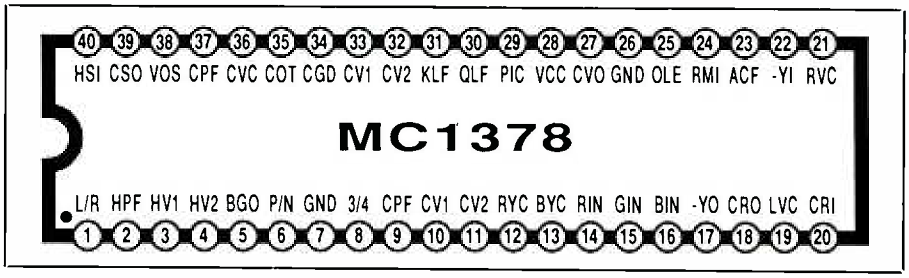


Fig. 1. A Motorola integrated circuit for genlocking by synchronization.

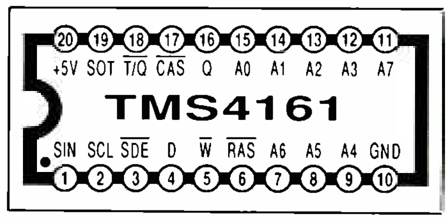


Fig. 2. A Texas instruments integrated circuit for genlocking by frame grabbing.

Tell me about genlocking.

Genlocking is the missing ingredient to letting personal computers truly interact with "real" video from a VCR, cable, CD disk, or studio. A genlock lets you synchronize and lock one video source to another so they can be superimposed, windowed, or whatever.

For instance, a home-video freak might use his personal computer for titling, cuts, fades, and video wipes. A couch potato might unknowingly use a genlock to watch nine channels at once. An educator might use genlocking to overlay computer-generated text over a full-resolution video picture. A scientist might do the same for crosshairs, image processing, or feature identification. Cable people routinely use genlocking to overlay fixed or crawling ads and public service messages.

In a TV studio, there are countless uses of genlocking. One of the oldest and neatest is the "chroma key" process that saves having to make large color maps and such. No, that weather turkey is not pointing to a map. He is pointing to a bright blue square on the wall. The map is on a color slide. When the chroma key circuits see bright blue, they switch to the map. When they see an arm, they switch back to the weather turkey.

Now, genlocking must be and should have been the centermost feature of all personal computers since day one. Yet, except for a limited genlock on the Amiga and a full genlock on some Sony microcomputers that are totally unknown outside of a TV studio, none of the more popular personal computers have very much in the way of genlocking available. With video on CD ROM just around the corner, this is totally inexcusable.

There are two main ways to handle genlocking. With a true genlock you absolutely and positively synchronize both systems so that their scan rates, line position, and sync pulses are identical.

While the true genlock has traditionally been complex but fairly cheap, there are all sorts of problems on a personal computer. Not the least of these is that most personal computers do not use interlace and have standards different from broadcast-quality TV. Another problem is providing the fast locking needed to track a VCR or other jittery outside video source.

The second method is called "frame grabbing." With a frame grabber, you store an entire picture or two from the one system and play it back to the second. You can easily get from one set of wildly different video standards to another, and no actual locking of the local source is needed. This used to take a humongous and ridiculously expensive analog or digital memory. Today, of course, large digital memories are trivial and nearly free.

Fortunately, there are at least two new integrated circuits available that greatly simplify the genlocking process. And, while not cheap, they are sanely priced.

Motorola elected to go the true genlock route with their MC1378 video synchronizer. The pinouts of this chip appear in Fig. 1; more details can be found in the MC1378 data sheet, applications note, and in graphics chip set data pack.

This chip is basically a group of phase lock loops (PLLs) that first lock the vertical sync pulses to each other and then lock the individual horizontal scan lines. Special provisions are made to handle VCR jitter. For this chip to work, interlace and true NTSC timing would seem to be essential, and the MC1378 must take over and substitute for the main system clock on whatever is doing the computing. Thus, while it looks great on paper, I don't yet see any obvious way to drop this dude into an Apple or a Mac.

The second chip is the *Texas Instruments* TMS 4161 Multiport video RAM, which is also available as 4-bit and 5-bit SIMM modules (TMS 4161 EP4 and EP5). Figure 2 shows the pinouts, and more tech details are found in TI's *MOS Memory Data Book.* These versatile multiport RAM chips are easily used for frame grabbing.

From the computer side, this chip looks and acts like a plain old 64K × 1 dynamic RAM. From the television side, the chip looks and acts like a high-speed video shift register that holds an entire line of pixels. Lines can be any multiple of 64 pixels, with 256 lines of 256 pixels being a good hacker starting point.

Once during each horizontal blanking interval, a transfer command is given that moves the stored computer bytes into the line shift register. This is the only time that any synchronization or arbitration is needed between the computer and the television source. At all other times, the computer is free to write to RAM in any order it likes, while the TV is free to clock out the pixels at its chosen rate.

One way to eliminate virtually all arbitration is to grab two frames and write to the first one while you are reading the second. But a wait state generator can do the same arbitration faster and simpler. A plain old blanking interrupt can sometimes be used instead.

The number of chips you need depends on how fancy you get. For a simple black-and-white titler, one of these chips will do the job, giving you one bit per fairly large overlay pixel. If you want to get fancy and add finer resolution, gray levels or color, you set up multiple "pixel planes" as needed. For instance, 5 planes would get you one of 32 gray levels, while 12 planes would let you pick any of 4096 colors from an Apple IIGS or similar pallette.

The usual way to get from noninterlace to interlace is to write the same pixels to both the even and odd interlaced fields.

Denser and cheaper multiport video RAM chips and modules are just around the corner, and a $50 frame grabbing genlock is not all that far away. Naturally, *Modern Electronics* is most interested in any construction project on a reasonable-cost genlock that would drop into a mainstream-type computer.

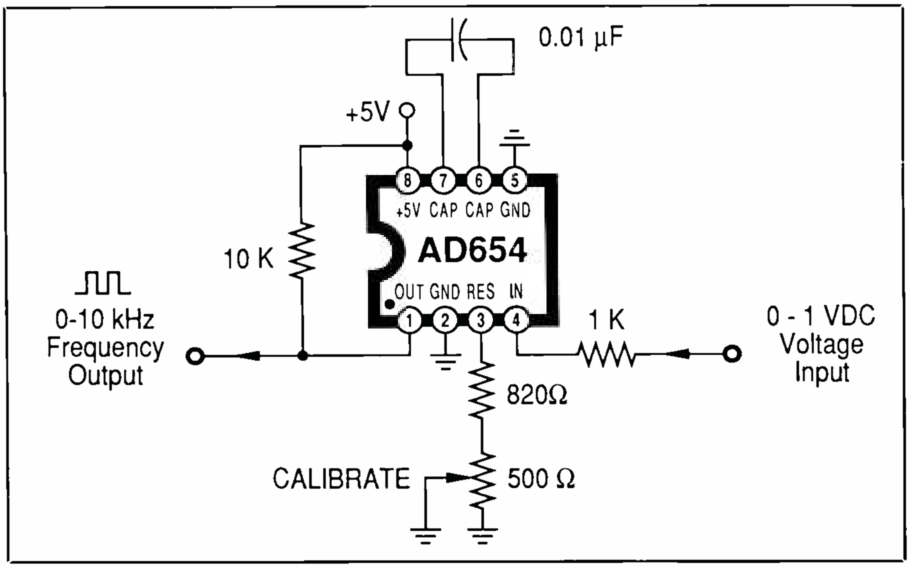


Fig. 3. A simple voltage-to-frequency (v/f) converter circuit.

What is Postscript?

Postscript is the exciting new page-description language from *Adobe Systems* that is fast becoming the *de facto* desktop publishing standard for laser printing and typesetting.

There are some outstanding advantages to Postscript. First and foremost, it is fun to use. In fact, the language is downright addictive. Postscript generally lets you build much higher quality images much more flexibly and with incredibly more power.

Another major advantage is its device independence. This means that the very same textfile that is sent to a laser printer can later be sent to a typesetting machine for much higher print resolution.

Text and graphics can be mixed in any manner anywhere on the sheet to the full available resolution of the printer. You can easily translate (move), scale (magnify or reduce), or rotate (twist) any image any way you want. You can even arbitrarily map any text and graphics image onto virtually any surface.

As many of you already know, all of the Hardware Hacker graphics (and original text) is done using Postscript, working from Applewriter on the IIGS and driving a Laserwriter Plus.

Many hundreds of Postscript fonts are now available, and any individual font can be shown any size from 3 point to 65,000 point. (72 points = 1 inch) Thus, you can letter anything from a tiny model railroad sign to the name on your town's water tower, all with a single procedural font. Fonts can easily be stretched in any direction, leaned, outlined, clipped, or modified for other special effects. You can even create your own very-high-quality custom fonts.

Postscript has a very strong cubic spline drawing and curve-tracing ability that can let you draw smooth and continuous curves six ways from Sunday. Photographs and grays are easily included, although the final halftone quality depends on the printer you have in use.

In fact, it is Postscript that has made Apple's Laserwriter Plus the best-selling printer in the world today. That is in dollar volume; the best selling printer in units sold is the Imagewriter. And yes, that's for *all* printers used on *all* personal computers!

There are several good ways to get started with Postscript. Two are the *Postscript Cookbook* and the *Postscript Reference Manual*. If you can't find these locally, I have a few extra copies on hand here. No, I didn't write them, but I sure wish I had. My own Postscript books are still in the works. You'll also want to subscribe to *Colophon*, which is Adobe's free Postscript newsletter.

I have lots of free printed Postscript demos and routines that you can run if you call or write. I've also got a fancy "Postscript Show and Tell" that now runs under just about any word processor, editor, or telecomm program, on just about any personal computer. You can also use the Hardware Hacker phone number for free Postscript help.

If you want to tackle a really advanced hacker project, just write and then debug your own Postscript interpreter for the Imagewriter or another dot matrix printer. I must get around 30 helpline calls a day requesting this. The language itself is in the public domain, so there's nothing stopping you except for some personal time and effort.

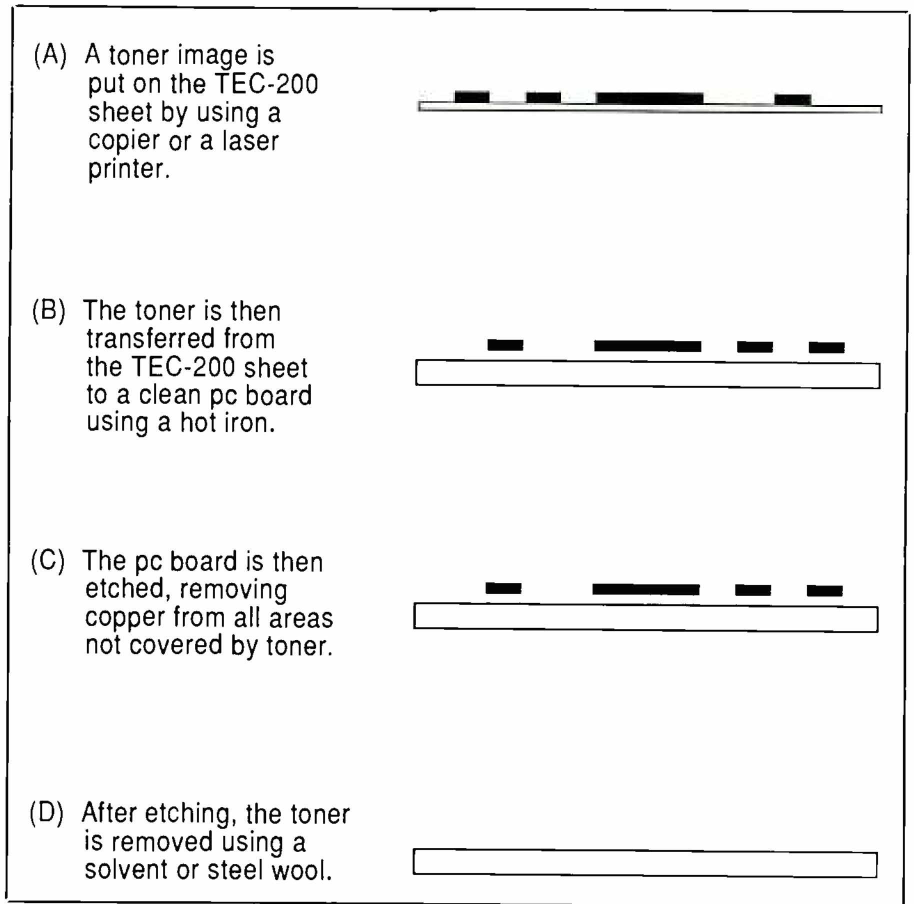


Fig. 4. How TEC-200 sheets simplify hacker fabrication of pc boards.

How can I measure voltage with my personal computer?

The secret to measuring voltage with a personal computer is to hang a beastie called a "voltage-to-frequency converter" onto an input port line and then use a machine-language software routine to count the frequency for a tenth of a second. Even a cassette input port can often be used, and the technique works on just about any personal computer.

Simple, cheap, and reliable V/F converters in the past have been hard to find. The obvious 555 timer route is difficult to use accurately, especially with a ground-referenced input. And game paddle inputs are often hard to use, limited in range, and inaccurate.

Instead, Fig. 3 shows a brand new *Analog Devices* chip called the AD654. This chip sells for around $4, gives you a 0-to-10-kHz square wave output, and needs only a single +5-volt supply. Resolution can be 0.1 percent or better.

Frequency is calibrated by changing

Computer Parts Galore, Inc.

1 800 431 9008

DISC DRIVES

- 360K CAPACITY, DSDD
- 1/2 HEIGHT, 48 TPI

PANASONIC JU455-5..........$109.00ea
2 for $199.00
QUMETRACK 142.................$ 79.95ea

CABLES

PARALLEL...The standard cable used to hook up an IBM or compatible to a printer.
8'.......$8.95   10'.......$9.95

Serial Cables...DB25 to DB25-all pins connected
8'.......$8.95   10'.......$9.95

Extension Cables...36pin centronics connectors. Male on one end, female on other end.
8'.....$10.95   10'.....$12.95   20'.... $19.95

All types are fully shieled

IBM COMPATIBLE KEYBOARDS

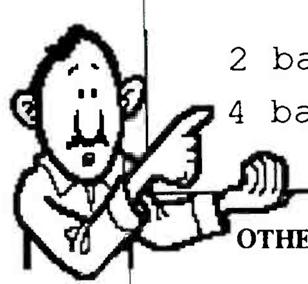
FCC TYPE ACCEPTED - 1 YEAR WARRANTY!

- Model 5151 (pictured).......................$74.95
  Seperate keypad and cursor pad. PC and XT compatible.
- Model 5060......................................$64.95
  LED status panel, large return key, automatically switches between AT and XT!
- Model 5150......................................$54.95
  XT compatible. Laid out just like the genuine article. Lighted Num Lock and Caps Lock keys
- Model 5161......................................$88.95
  The biggest, the best. Similar to 5151 but switches automatically between XT and AT compatibility. Has a large return key.

Don't Pass Up This Bargain!

AA SIZE NICADS

2 battery pack $1.79
4 battery pack $2.79



OTHER STUFF YOU MIGHT NEED

PC & XT extender board.............$19.95
Parallel switch box x 2.............$39.95
Parallel switch box x 4.............$44.95
Serial switch box x 2...............$39.95
Serial switch box x 4...............$44.95
Parallel printer card, fully assembled, fully addressable.......................$23.95
20 MEG hard drive - Seagate ST225 & controller card...........................$389.95
Uninterrubtable power supply, 250 watt capacity......................................$229.95
8 slot case. Great housing for our motherboards or you can put your real IBM stuff inside. Takes side switch power supply. Room for four drives.....................$49.95
AT look alike case but designed to house an XT type motherboard..........$59.95
Monitor swivel base, 12" size........$11.95
Monitor swivel base, 14" size........$12.95
Dust cover covers your monitor and your whole computer. Don't take chances with your investment..........................$9.95
Oscilloscope probes-switch selectable to 1x or 10x. In 10x, freq. response is DC to 100MHz...................................$29.95
150 Watt power supply-direct bolt in replacement. Has four drive connectors & motherboard connectors. 1 year warranty, FCC type accepted.......................$89.95

MONITOR CHASSIS

A complete monitor. Requires composite video input and for power it uses 21VAC. On board controls for focus, vertical hold, brigthness, contrast, vertical size, horizontal hold.

AMERICAN MADE!
A SUPER DEAL
$19.95

640K Motherboards in your choice of flavors:

Flavor One: Totally Bare, no parts at all. Comes with a parts list. Parts placement is clearly silk screened on the board. Not a turbo board..$29.95
Flavor two:Assembled & tested with 0K installed. 2 layer construction. BIOS included..................................$129.95
Flavor three:Same as two but 4 layer.......................$149.95

FLAVORS TWO & THREE ARE TURBO (8MHz) BOARDS

Computer Parts Galore, Inc.
56 Harvester Avenue
Batavia, NY 14020
NY RESIDENTS CALL
1 716 343 6133

CIRCLE 75 ON FREE INFORMATION CARD

Terms: Our minimum order is $10.00. There is a shipping and handling fee of 5% for UPS ground delivery. Minimum shipping & handling is $2.00. If you want your order sent COD, there is an additional $2.50 charge. FOR COD ORDERS, we only accept CASH, CERTIFIED CHECK, OR MONEY ORDERS unless you are a big corporation or have previously established credit with us.
On phone orders, we also accept VISA, MASTER CARD, & AMEX.
PREPAID MAIL ORDERS can be paid by personal check, but allow two extra weeks for processing.
RETURNED ITEMS ARE SUBJECT TO A RESTOCKING FEE.

the 500-ohm trimpot. You can run at 100 kHz by using a 1,000 pF capacitor instead, but most personal computer software might not be able to keep up with this higher rate.

Two gotchas: For maximum accuracy, you should have a 1,000-ohm source impedance; so you may want to drive this from an input buffer of some type. And, don't forget that pullup resistor on the open collector, or you won't be able to see the output square wave.

Your software routine should count changes on the port line for a tenth of a second or so. Note that all possible routes through the software routine must take *exactly* the same amount of time.

Let us know what other uses you can come up with for this extremely simple measurement circuit.

Is there a simple process for making printed-circuit boards?

There sure is. There's an exciting new product out called a TEC-200 transfer sheet available from *Meadowlake*. These are nothing but 8½ × 11 sheets of clear Mylar or whatever that may or may not have some special coating on them. Cost is between 40 cents and a dollar per sheet, depending on quantity.

Figure 3 shows how these TEC-200 sheets work. The process is alike but different somehow from the Omnicrom or Kroy Kolor stuff.

The sheets possess the magic property that toner from a copy machine or a laser printer will *loosely* stick to them. What you do is first copy the *positive* printed circuit image you want onto the Mylar sheet. Then you place the imaged sheet, toner side down, onto an extremely clean printed circuit board. You then apply a hot iron to melt the toner. The toner will now stick to the copper much better than it does to the Mylar, so when you peel the Mylar off, a toner image stays on the copper cladding on the pc blank.

You next use the toner as an etch resist! No photography, no silk screening, and no resist pens are needed at all.

Sometimes you will have to reverse the image. To do this, just image onto Mylar once, and then recopy from the Mylar, toner up and backed by a white sheet of paper. Note that the final toner pattern on the copper pc material should have black toner where you want copper to remain and clear where you want copper to be etched away.

Your copper pc material must be scrupulously clean. Scour it *twice* for five minutes each time, using a chlorine bleaching cleanser from the grocery store, and drying the board on a fresh inside turn of a roll of paper towels. Note that totally clean copper is wettable by water, and you'll get a smooth and unbroken flow only when clean enough.

A reducing copy machine can be used for oversize artwork. Since fingerprints are a no-no, always handle the sheets and the pc material by the edges only.

A brand new process? Hardly. Back in the old days when *Xerox* machines were far too cumbersome and much too expensive for plain old paper copies, they offered a similar process that directly transferred toner onto an unetched pc board, but as part of a room sized, ridiculously expensive and extremely hard-to-use machine.

You can probably think of all sorts of other uses for this new material, since you are now able to put a toner image on virtually anything that will sit still and can stand brief application of a hot iron. Callouts for the other side of the printed-circuit board are one big possibility, while instant dialplates are another.

Laser printers work beautifully with this stuff. You can even put Omnichrom or Kroy Kolor over the final toner!

Apparently, the material can stretch or deform slightly. This should not hurt use for most homebrew printed-circuit projects, particularly if you are careful and practice a time or two on less-critical work. You should trim the sheet to within ½" of the image before actually fusing the toner to the printed-circuit board. If any retouching is needed, the usual resist pen can do the job.

The *Meadowlake* people have a special Hardware Hacker offer of five sheets for

NAMES AND NUMBERS

Adobe Systems
1870 Embarcadero S120
Palo Alto, CA 94303
(415) 852-0271

Analog Devices
One Technology Way
Norwood, MA 02062
(617) 329-4700

Kroy Sign Systems
Scottsdale Airpark
14555 N. Hayden Rd.
Scottsdale, AZ 85260
(800) 521-4997

Lambda Semiconductors
121 International Dr.
Corpus Christi, TX 78410
(800) 255-9606

Maxim
510 N. Pastoria Ave.
Sunnyvale, CA 94086
(408) 737-7600

Meadowlake
25 Blanchard Dr.
Northport, NY 11768
(516) 757-3385

Motorola Semiconductor
Box 20912
Phoenix, AZ 85036
(602) 244-6900

Precision Monolithics
1500 Space Park Dr.
Santa Clara, CA 95052
(408) 727-9222

Powerconversion
2472 Eastman Ave. B-34
Ventura, CA 93003
(805) 658-0933

Texas Instruments
Literature Response Center
P.O. Box 809066
Dallas, TX 75380
(800) 232-3200

five bucks. Be sure to use the secret password "tinaja" with your order. And be sure to let me know what new and exciting uses you dream up for this great new process.

What's new in tech literature?

Analog Devices has an expanded and revised *Analog-Digital Conversion Handbook* out. This well written hardbound textbook is a cut above your typical in-house "official company line" publications. It is worth the $32 price. You can also get a free subscription to their *Analog Dialog* house organ by contacting Cammy O'Brian per the Names and Numbers box.

There's also a *Linear and Conversion Applications Handbook* available from the *Precision Monolithics* people. While the ap notes are aimed primarily at premium op amps, there's a lot of good info here that can be applied to most any old bargain op amp.

For the latest in power-supply design, check into the *Power Supply Circuits Handbook* by *Maxim,* the *Lambda Semiconductor Applications Handbook*, and *Powerconversion* magazine.

For a new product of my own, check out the newly bound reprints from my *Ask the Guru* column.

As our usual reminder, this is your column and you can get technical help per the Need Help? box below. If you haven't done so already, be sure to write or call for your copy of the brand new free stuff list. **ME**

NEED HELP?

Phone or write your **Hardware Hacker** questions directly to:

Don Lancaster
Synergetics
Box 809
Thatcher, AZ 85552
(602) 428-4073

SOFTWARE FOCUS

MacPublisher II for Plenty of Desktop Publishing Power

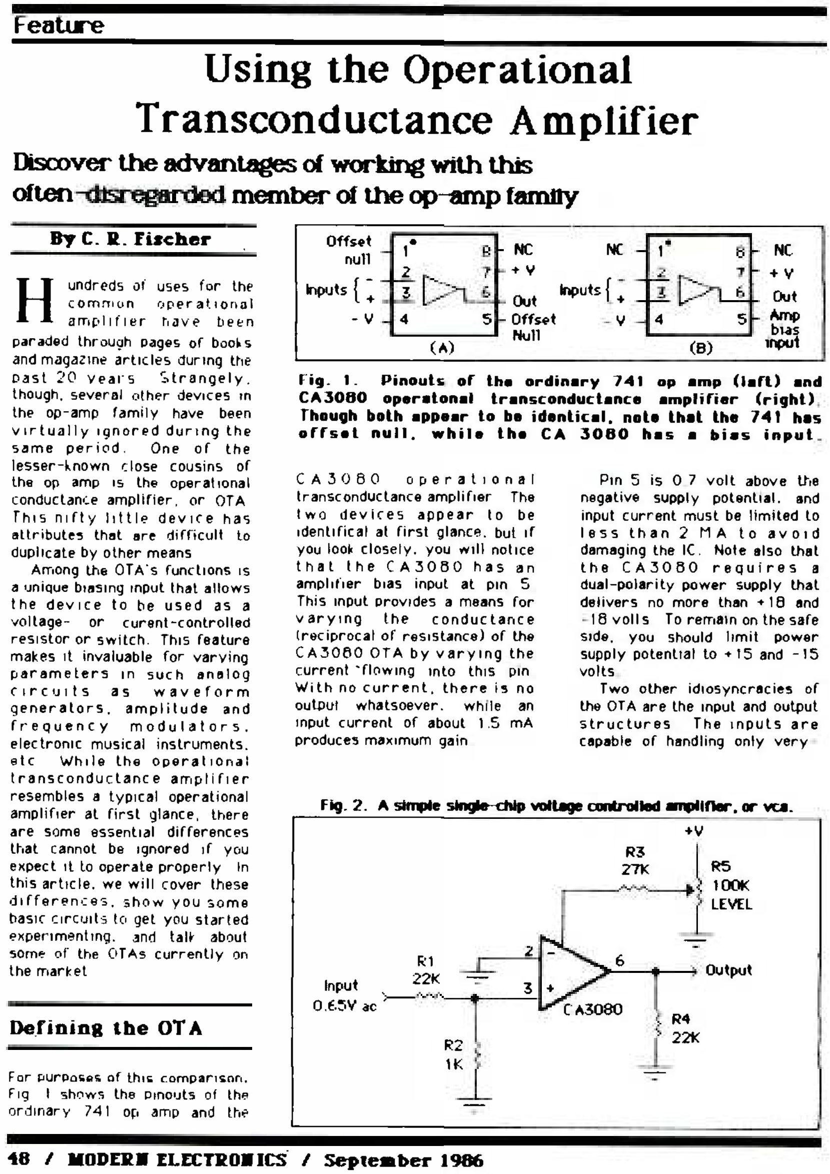
By Mike Nikolich

The desktop publishing revolution has helped revitalize the personal computer market, and the computer that's probably owed the biggest debt of "thanks" for this is the Apple Macintosh. There is a wide variety of desktop publishing software available and in the works for the IBM PC and its many compatibles, too, as well as Apple II, Commodore and Atari computers.

Since many of us either run or belong to clubs that regularly produce monthly bulletins, a desktop publishing software package could be of value, giving the material a more respectable appearance. Moreover, most of you are in the business world and could well use a relatively inexpensive in-house computerized publishing system.

If you're a Mac user, a good example of an inexpensive, yet powerful new desktop publishing software package is Boston Software Publishing's MacPublisher II. Its suggested list price is $195 (I got mine for $140).

MacPublisher II is the souped-up version of MacPublisher, the desktop publishing package that virtually got the whole ball rolling in the first place. (The company was recently acquired by Letraset, whose name is virtually synonymous with presstype.)



Feature

Using the Operational Transconductance Amplifier

Discover the advantages of working with this often-disregarded member of the op-amp family

By C. R. Fischer

Hundreds of uses for the common operational amplifier have been paraded through pages of books and magazine articles during the past 20 years. Strangely, though, several other devices in the op-amp family have been virtually ignored during the same period. One of the lesser-known close cousins of the op amp is the operational conductance amplifier, or OTA. This nifty little device has attributes that are difficult to duplicate by other means.

Among the OTA's functions is a unique biasing input that allows the device to be used as a voltage- or curent-controlled resistor or switch. This feature makes it invaluable for varying parameters in such analog circuits as waveform generators, amplitude and frequency modulators, electronic musical instruments, etc. While the operational transconductance amplifier resembles a typical operational amplifier at first glance, there are some essential differences that cannot be ignored if you expect it to operate properly. In this article, we will cover these differences, show you some basic circuits to get you started experimenting, and talk about some of the OTAs currently on the market.

Defining the OTA

For purposes of this comparison, Fig. 1 shows the pinouts of the ordinary 741 op amp and the CA3080 operational transconductance amplifier. The two devices appear to be identifical at first glance, but if you look closely, you will notice that the CA3080 has an amplifier bias input at pin 5. This input provides a means for varying the conductance (reciprocal of resistance) of the CA3080 OTA by varying the current flowing into this pin. With no current, there is no output whatsoever, while an input current of about 1.5 mA produces maximum gain.

Pin 5 is 0.7 volt above the negative supply potential, and input current must be limited to less than 2 MA to avoid damaging the IC. Note also that the CA3080 requires a dual-polarity power supply that delivers no more than +18 and −18 volts. To remain on the safe side, you should limit power supply potential to +15 and −15 volts.

Two other idiosyncracies of the OTA are the input and output structures. The inputs are capable of handling only very

Fig. 1. Pinouts of the ordinary 741 op amp (left) and CA3080 operatonal transconductance amplifier (right). Though both appear to be identical, note that the 741 has offset null, while the CA 3080 has a bias input.

Fig. 2. A simple single-chip voltage controlled amplifier, or vca.

48 / MODERN ELECTRONICS / September 1986

This remake of a September 1986 page from Modern Electronics *is just a sample of what can be done with MacPublisher II.*

Huge Documentation

MacPublisher II is designed for the full gamut of Macs—from the tiny 128K version to the hard-disk models. Issues can be as long as 96 pages (limited by disk storage) and can include up to 256 articles (each carried over, if desired, into 16 separate fragments up to 256 pages).

When you open the MacPublisher II package, one of the first things you notice about the documentation is that it is huge—nearly 300 pages! Despite this massive amount of documentation, BPSI makes it easy for you to produce your first page in just a few minutes. This is done through a three-tiered approach to teaching the software.

The opening sequence is called "The Ten-Minute Issue." Here, you are introduced to the basics of laying out articles and cropping photos. From there, you progress to "Basic MacPublisher" and "Advanced MacPublisher." By providing this "stepping-stone" approach to teaching the program, it's possible to master MacPublisher II in a few days. However, there is one word of caution to anyone thinking of becoming an "instant expert"—be patient. This complex program takes time to learn well.

One of MacPublisher II's major strengths is that it puts the full control of the program in the user's hands. This is both good and bad. The good is that it provides you with a great deal of flexibility in designing and laying out pages. The bad is that a user must have a thorough understanding of the program to take full advantage of its powerful features.

When you open a new issue, you open a blank representation of the page you'll be working with (it's called the "mini page"), and a blank article window to the left. Text can be entered directly into the article window from MacPublisher's word processor (albeit, a cumbersome task) or from Microsoft Word or MacWrite files. A telecommunications program also is provided (NewsWire DA) for sending and receiving text files. A separate program allows you to transmit pictures which are sent in Xmodem format, the standard for binary files.

Existing issues open to a dummy page, which features solid blocks of text and graphics. Each block displays information about the element it represents such as the name of text blocks, number of lines, number of characters, and carryover articles (if any). Picture blocks are presented in white.

Other symbols Mac users will recognize include the familiar Apple icon for desk accessories, a file menu, edit menu, format menu, font, style and size menu. Two new menus are layout and print.

To create a new issue, you must choose the type of printer you're using (Imagewriter I/II, Laserwriter, etc.), name the issue, and then set page margins, the number of grid columns and the spacing between columns.

Page margins can be set in inches, picas/points or centimeters. For added precision in layout, the page can be divided into as many as 48 equal columns (or grids). The grids can be used as merely visual guides or they can be "snap to guides" which force text and graphics to line up to them. Finally, if desired, you can adjust the spacing between columns.

To keyline articles, you use a pair of electronic scissors. The scissors are accessed by clicking on the gray desktop background or by selecting the "scissors" command from the layout menu.

Powerful Layout Features

Although items can be laid out in a freeform manner, MacPublisher II includes several features which ensure accurate and reliable placement of text and graphics. One of these commands is "snap to grid," which automatically causes items to snap to the closest left-hand margin.

Another handy tool for aligning articles is "snap to guides." With this command, you set the distance (in either inches, points/picas or cm) that the text or graphics will appear from the top margin and left hand margin of the page.

A third way to make accurate layouts is by calling up an item's specification sheet once you've laid it out on the page. The spec sheet covers everything from the distance the article is located from the top and side margins (called "x" across and "y" down, respectively), as well as leading (space between lines), kerning (space between characters) and various shades of gray that can be used. The spec sheet also allows you to change type styles, type faces or even substitute articles, if desired. (This later feature is handy for laying out columns that repeat in a publication each issue. The new copy simply replaces the old in seconds.)

Two other ways to adjust layouts are either through the program's maxi page command, or with depth justification. Maxi page provides a full screen view of exactly what the page looks like. I generally perform all initial layouts in mini page and then switch to maxi page for last-minute adjustments. With depth justification, text can be made to fit in a specific vertical space (the leading is adjusted so that the text fits perfectly).

Mixing Fonts Difficulty

One annoyance about MacPublisher II is that typefaces and sizes cannot be varied with a body of text. To get around this problem, you must set your body copy as separate articles from the headlines and subheads.

When an article has been clipped for layout, any amount of left-over is divided into a carryover. MacPublisher II allows for up to 16 carryovers per article. Each carryover is treated as a separate article and it can appear in a different font, style and size than the copy that preceded it in the previous carryover.

Although articles can be carried over manually, one of MacPublisher's most powerful features is auto flow text. Using this command, when an article has been clipped into carryovers, any newly-added or deleted text will push the other carryover text either forward or backward. Another powerful feature is auto re-layout, which causes changes made in article or picture windows to be made to the layout pages automatically. Both features are user-selectable, rather than defaulted (like Pagemaker).

For precise layouts, several different rulers can be accessed. The desktop ruler measures depth, and can be placed anywhere in the layout. To use it, simply click on the ruler to see how many inches from the top you have available for copy or graphics. The window ruler can then be used to measure the copy or graphics so that an exact block is laid out.

With these powerful tools available, it is relatively simple to wrap text around photos, or match copy to a specific size. For those of us who don't want to measure every block of text, MacPublisher II even can lay out text automatically. To take advantage of this feature, simply use the "scissors" to lay out an article on the mini or maxi page. If the article extends below the bottom margin of the page or "snap to guide" setting, a dialog box will ask you whether the text should be laid out as is, clipped to fit, or canceled (with a clipline inserted into the original article so that a precise layout can be made). Another way to adjust layouts is to activate auto flow text and use the sizer box to adjust text blocks either up or down.

Graphics Are Cumbersome

In contrast to the ease in which text can be laid out on a page, creating and using graphics with MacPublisher II is a bit more tedious.

Graphics can be created from MacPublisher II's graphics palette or brought in from existing MacPaint or MacDraw files. To use a MacPaint or MacDraw image, you must convert the file to a "MacPublisher picture." Luckily, this is a simple matter which is done as soon as you try to load the graphic to the clipboard.

A copy must be made of each graphic before it can be used in the program. Then, with your copy of the original artwork, you must make a second copy to the software's clipboard.

Once the clipboard copy is made, the camera can be called up from the edit menu. The camera actually is a transparent grid which fits directly over the clipboard image. To make a camera photo, simply click on the image. A mini camera "flashes" and you are instructed to name your new MacPublisher photo.

Artwork can be cropped once it has been laid out by using the sizer box. To restore the dimensions of the artwork, you must hold down the shift key while adjusting the sizer.

While the above method is adequate for making minor adjustments, a far better way to crop photos is by using the desktop and window rulers in the camera *before* snapping your image. The camera can be cropped to conform to full page, half-page, third-page, ¼-page, ⅔-page and ¾-page sizes, or adjusted to whatever desired width and depth by either using the sizer box or calling up the specifications sheet.

Creating original images with the graphics palette takes a little getting used to. The palette allows you to create horizontal and vertical ruled lines, rectangles (with either square or rounded corners) and circles. Every graphic created is a combination of three pen lines which can be of any thickness and have any of 99 different patterns. Rectangles and circles also can be filled with a fourth pattern.

Although the palette isn't difficult to work, I found the procedure for keying rules and boxes a bit awkward. Unfortunately, for each rule that's placed on a page, a separate new file needs to be created. It's too bad that the program wasn't designed with a graphics palette similar to Pagemaker's, which allows you to directly create squares, circles, rules, etc., without having to measure or copy the image to the camera.

The Acid Test

Is it possible to use a desktop publishing program such as MacPublisher II to produce a professional-quality newsletter? To take it through the paces, I recreated a page from the September, 1986 issue of *Modern Electronics.*

The text was entered in and typeset using MacPublisher II's word processor and outputted on an Apple Imagewriter printer. Graphics were created using MacPaint.

As you can see from the accompanying illustration, it is possible to create a professional-looking page from MacPublisher II. This example took me about 90 minutes to typeset, keyline and create the original artwork.

For a more professional appearance, the article could have been typeset on an Apple Laserwriter, which provides 300 dpi (dots per inch) resolution. While a Laserwriter doesn't come cheap, the good news is that many laser typesetting services are available that will typeset a page for approximately $10. Many "instant print" shops also offer this capability. As a result, it's not necessary to invest thousands of dollars in printing equipment to produce a professional-quality piece.

Conclusion

To sum up my experiences with this software package, MacPublisher II is a powerful, professional-quality page make-up program that is well thought-out and moderately easy to use. While its capabilities may exceed the needs of many of us, for those who are professional writers or who have the need to create professional-quality newsletters, brochures, books, etc., it offers tremendous value for the money.

(Available from Boston Software Publishers Inc., 1260 Boylston Street, Boston, MA 02215.)

Keychain Electronic Projects

Forrest M. Mims III

The transistorized "pocket" radios of a few years ago were usually much too bulky for a shirt pocket. The most remarkable physical feature of today's shirt pocket electronic devices is that they really *do* fit in a shirt pocket. In fact, several ultra-thin credit card-sized radios and calculators can be easily slipped into the same pocket.

The frontal dimensions of today's pocket electronic devices are not surprising. But their amazing thinness is an impressive technological achievement. In fact, it is so impressive that until six months ago I was convinced that it was impossible for individual electronics experimenters and engineers to duplicate this feat by hand.

Fortunately, this gloomy outlook has been completely reversed now that miniature surface-mountable components (SMCs) are becoming more widely available. Working with SMCs requires new assembly techniques and careful attention to detail. Nevertheless, I have found that finished circuits made with SMCs can often be assembled more rapidly than conventional circuits using traditional components with leads. Moreover, the tiny size of SMCs and the fact they can be attached to both sides of a circuit board (with either solder or conductive adhesive) provides unprecedented design flexibility. Thanks to surface-mount technology, it is now possible for experimenters and small companies to again take the lead in designing and building creative personal electronic devices.

Though circuits made with SMCs are surprisingly easy to design and assemble, finding surface-mountable components can be difficult. But this situation is beginning to change. For example, the Mouser Electronics catalog lists a variety of surface-mountable resistors, capacitors, ICs and LEDs. If you live in or near a major city, you can purchase SMCs from electronics distributors that represent SMC manufacturers. At last fall's giant WESCON electronics trade show, I found a dozen or so companies that sell assortments of surface-mountable parts. Vector Electronic Company, a firm well known to electronics prototypers, was a pioneer in bringing such kits to market.

The previous two issues of *Modern Electronics* featured a two-part article describing surface-mount technology. This article, which replaced this column, included details about surface-mountable components and soldering methods. Also included were construction details for three miniature circuits made with SMCs. (Back issues are available for $2.50 each.)

The remainder of this column is devoted to three additional circuits whose miniature size is made possible by SMCs. Even if you don't now care to assemble one of these circuits, you will gain a better appreciation of surface-mount technology by reviewing the details of their construction.

Keychain Light Meter

While visiting an office-supply store recently, I discovered some plastic identification tag holders with attached key chains. Those tag holders are made of sturdy plastic and have a 2-millimeter opening for insertion of a small identification card. They appeared to be just the right size for housing miniature surface-mount projects, so I bought several. The keychains are distributed on a wholesale-only basis by the W.T. Rogers Company (Item No. 1132) and retail for around 70¢ each. I purchased mine from the Paul Anderson Company, a large office supplier in San Antonio, Texas.

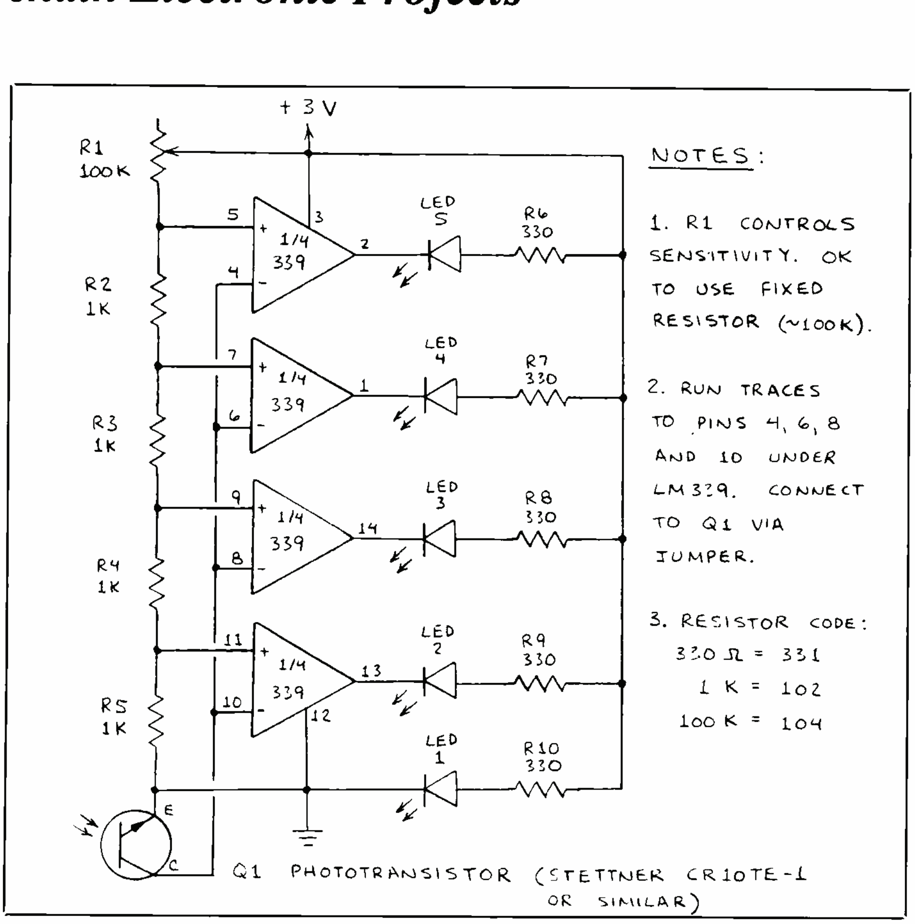


Fig. 1. Light meter with LED bargraph display.

Figure 1 is the schematic of the first circuit I installed in one of those tag holders. This circuit can be used to indicate voltage and resistance by omitting phototransistor *Q1*. With *Q1* in place, the circuit becomes a rudimentary light meter. When *Q1* is dark, all the output LEDs glow. Conversely, when *Q1* is saturated with light, none of the output LEDs glow. Intermediate levels of light cause varying numbers of LEDs to glow in bargraph fashion.

Known as a parallel or flash analog-to-digital converter, the Fig. 1 circuit consists of a parallel array of comparators, each of which is connected to a reference voltage provided by a tapped voltage divider. Resistors *R1* through *R5* form the voltage divider. The LM339 contains four comparators on a single chip and is an ideal choice for this circuit. The output of each comparator directly drives one of *LED2* through *LED5* through current-limiting resistors *R6* through *R9*. Power-on is indicated by *LED1*.

Figure 2 will help you better appreciate the significance of surface-mount technology. This is a photo of the Fig. 1 circuit (less *Q1*) assembled with conventional through-hole components. (Its construction was described in *Integrated Circuit Projects,* Volume 4, a book I wrote for Radio Shack in 1975.) At 0.45 cubic inch, the keychain version of the circuit occupies less than half the volume of the 9-volt battery (1.1 cubic inches) that powers the conventional version of the Fig. 2 circuit.

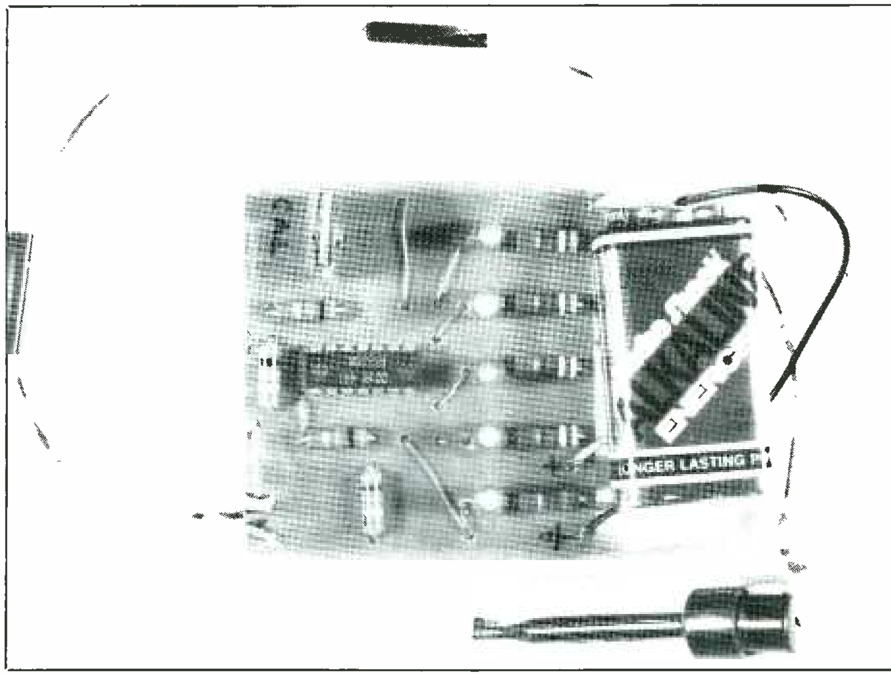


Fig. 2. LED bargraph assembled using conventional components.

Figure 3 shows the etched circuit board I made for the keychain light meter. The 0.5-mil thick board is double-sided and can be easily cut to size with scissors. A 12″ × 18″ sheet of this board is available for $2.50 from Edmund Scientific (Cat. No. #R35,652).

Only one side of the board is used for the light-meter circuit. However, surface-mountable components can be soldered to both sides of a double-sided board if provisions are made for making interconnections between the two sides.

As for the board's layout pattern, there isn't one. Instead, I sketched an approximate layout on a notepad. Then I cut the board to size and polished it with steel wool. Next, I placed the various components, including a 2016 lithium coin cell, on the board and marked their terminal or pin locations with a pencil. After removing the components, I penciled in the desired traces. Pins of the LM339 that were to be interconnected were interlinked under the chip. After tracing the penciled traces with a fine point resist pen (Radio Shack Cat. No. 276-1530A or similar), I covered the back of the board with a protective layer of tape and etched away all unwanted copper. Total preparation time was around 45 minutes.

Caution: Always follow the manufacturer's recommendations regarding safety and disposal when using circuit board etchant products. Remember that etchants will permanently stain clothing and painted surfaces and corrode metal.

Incidentally, notice that the board in the upper photo in Fig. 3 shows three solder bumps strategically located around the perimeter of the coin cell. These are simply three small copper lands designed to receive solder bumpers that secure the coil cell in place when the board is slipped into the ID tag holder.

After the board is etched, all component footprints must be plated with either solder or tin to permit soldering. TINNIT™ tin plating chemical is available from The Datak Corp. Or standard rosin core solder can be flowed onto the board's copper traces. It is important to avoid applying excess solder. After plating the board, use desoldering braid to remove any excess solder. For best results, the solder layer should be very thin and as flat as possible.

Wire the board by first positioning the LM339 in place and securing it flat against the board with a piece of masking tape across one end of the chip. This done, touch the pointed tip of a 15-watt soldering iron to a corner pin and apply just a tiny bit of solder. Because of the pretinning of the board's copper traces and the plating on the IC pin, the connection will be instantly made. When a secure connection has been made, carefully remove the tape and make sure the remaining pins are still aligned. If they are, solder the opposite corner pin. Then solder all remaining pins. Use very little solder in all cases.

Chip resistors and LEDs can also be soldered into place with the help of masking tape. Simply attach a chip component to the board with a small piece of tape across one end of the chip. Solder the exposed end as described above. If necessary, gently press the end of the chip into the solder with a pencil eraser or other implement to make sure it is flat against the board. Remove the tape and solder the remaining end to the board. Do *not* try to press the second end of any chip component downward since the other end is already soldered rigidly in place.

This is one reason why it's important that the solder plating over the component footprints be very thin and flat.

Use as little solder as possible when attaching the SMCs. In fact, you may be able to use no solder at all if the solder coating you applied to the footprints is very flat and uniform. In this case you might be able to reflow the solder over the pins or around their terminals by simply pressing them against their footprints with the tip of the iron. Should you accidentally bridge two or more traces with solder, immediately remove the bridge with desoldering braid.

Figure 4 shows the completed keychain light meter (lower photo). Note that only one jumper lead was required (from pin 6 of the LM339 to *Q1*). Though I planned to use a surface-mountable trimmer resistor for *R1*, I later substituted a fixed 100,000-ohm resistor.

Before building this circuit, I spent a good deal of time wondering how to make a switch that would fit into the 2-millimeter space inside the keychain tag holder. Though I tried several approaches, the simplest proved to be the best. The switch is simply the L-shaped piece of 5-mil unetched pc board shown in Fig. 3 covering part of the coin cell. Both sides of the L are covered with transparent tape, which is trimmed to match the outline of the L. A narrow strip of tape is removed from the coin cell side of the end of the L that covers the cell. One end of a short length of wrapping wire is soldered to the opposite end of the L. The other end of this wire is soldered to the negative supply trace on the circuit board. The switch is completed by securing it to the end of the board with a short piece of transparent tape that functions as a hinge.

Test the circuit by placing a coin cell, positive terminal down, between the switch and the board. When the exposed copper along the underside of the end of the L is pressed against the negative side of the cell, *LED1* should light. As *Q1* is darkened, *LED2* through *LED5* should turn on in sequence.

If the board passes its operating test, insert it into the tag holder. If all goes well, *LED1* will light when the power cell end of the tag holder is squeezed. If

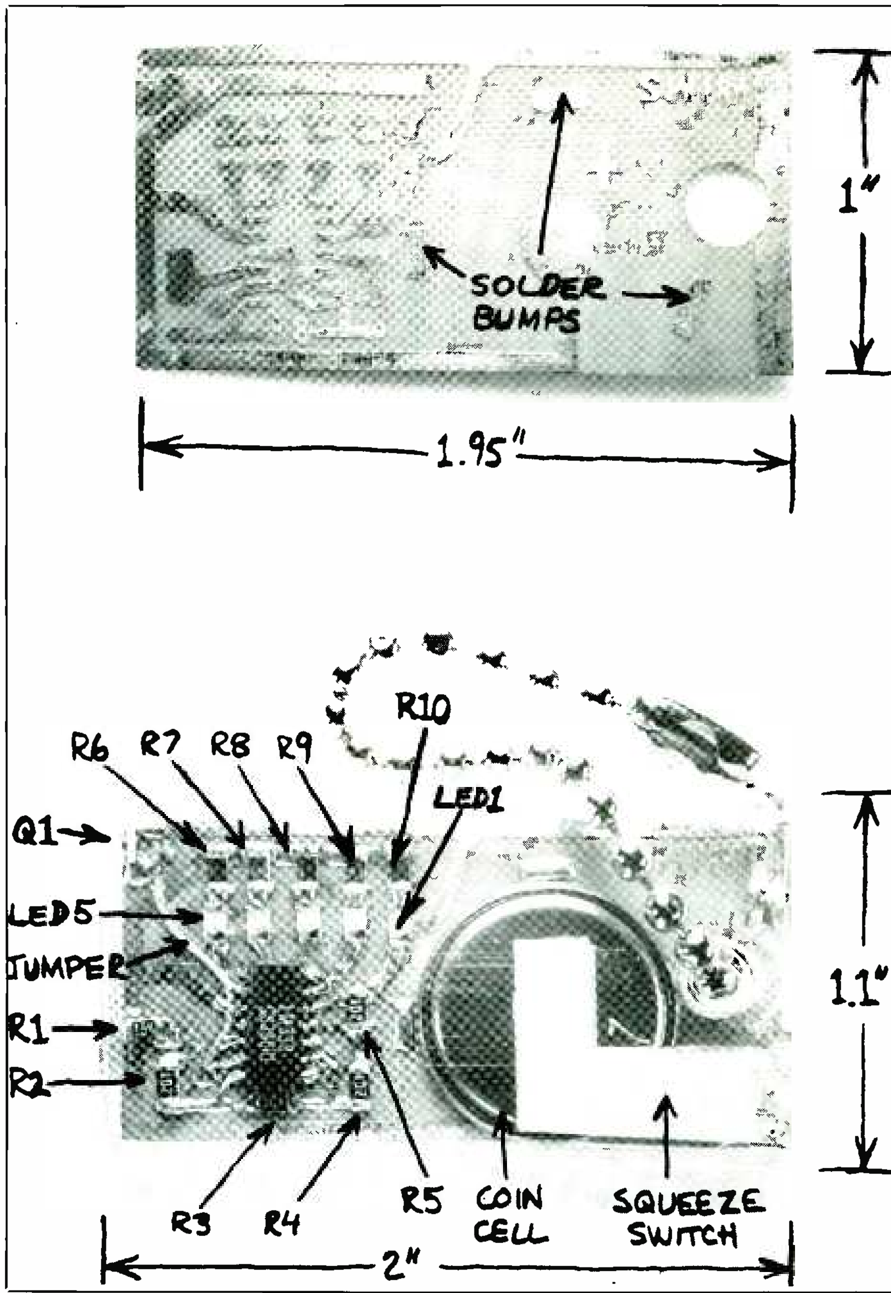


Fig. 3. Etched pc board for lightmeter circuit (upper) and hand-wired board using surface-mountable components (lower).

LED1 fails to glow, you will have to remove a slightly wider strip of tape from the end of the switch L. If *LED1* glows when the case is not squeezed, you must bend the end of the L upward slightly before reinserting the board in the case.

The end of the tag holder opposite the keychain holes has a small opening or slot that simplifies removing the board. Insert the end of a small screwdriver or similar implement into this slot and gently push the board out the opposite end until you can grasp it. Then pull the board from the case.

Chip resistors and the SO (small outline) version of the LM339 used in this

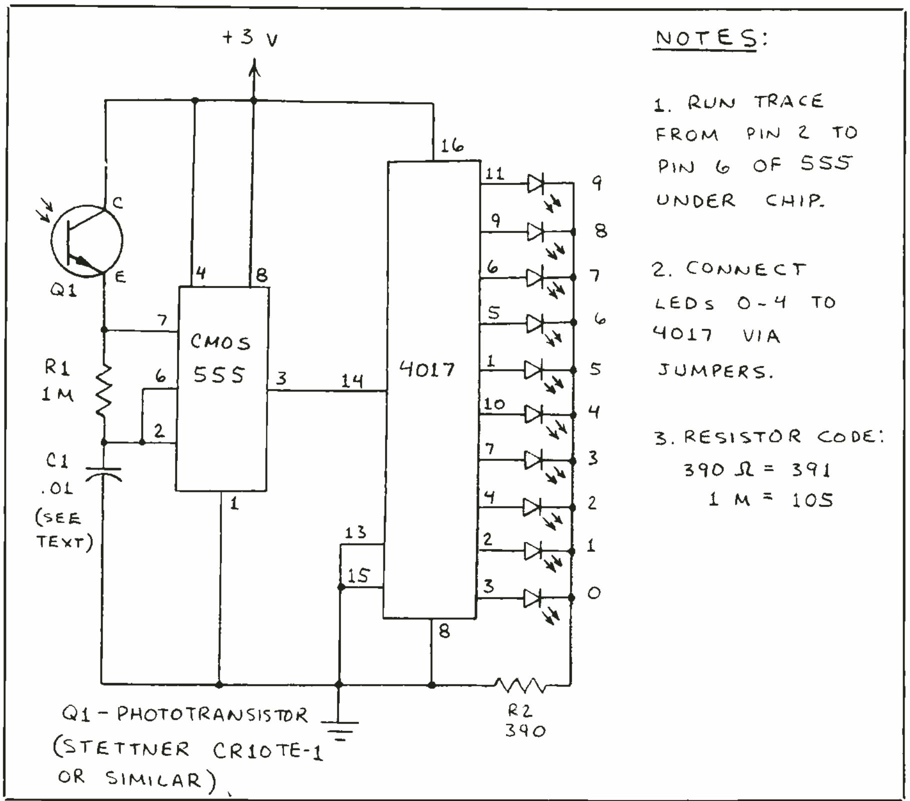


Fig. 4. A light sensor with a rotating LED ring display.

circuit can be obtained from Mouser Electronics and many other sources. The LEDs are Mouser Electronics No. ME351-2711 chip devices or equivalents. Phototransistor *Q1* is a Stettner Electronics No. CR10 TE-1.

Keychain Light Level Indicator

The keychain light meter described above indicates the light level with a bargraph readout. The circuit shown in Fig. 4 is less precise but more fun to build and use. It indicates the intensity of light by means of a ring of 10 LEDs that appears to rotate. The light intensity controls the apparent rotation speed.

A 555 oscillator and a 4017 counter/decoder are the main elements of this circuit. In operation, the 555 generates an oscillating signal whose rate is determined by the light level at *Q1*. For each pulse from the 555, the 4017 advances one step. When *Q1* is dark, the LEDs switch on in a slow sequence and the wheel "rotates" very slowly. When even a very low level of light reaches *Q1*, the ring begins to rotate more rapidly. Rotation rate continues to increase until the light level becomes so high that *Q1* is saturated and the 555 oscillator is disabled.

Before building a surface-mount version of this circuit, assemble a test version using conventional components and a solderless breadboard. This will allow you to select an appropriate value for *C1* that gives an optimum rotation rate for the light levels you want to monitor.

Figure 5 shows the completed keychain light sensor with rotating ring readout. The board for this circuit is laid out in the same fashion as that for the Fig. 1 circuit. The chief difference is that more jumpers are used. Compare the circuit diagram in Fig. 4 with the completed circuit in Fig. 5 and you can see that jumpers are used to connect *LED0* through *LED4* to the respective pins of the 4017.

A do-it-yourself squeeze switch identical to the one used in the Fig. 1 circuit is used for this new circuit. The SO version of the 4017 and all resistors and capacitors can be purchased from Mouser Electronics and many other sources. The SO 555, preferably the CMOS or low-power version, is available from Signetics, Exar and the SMD™ Technology Center. Transistor *Q1* is available from Stettner Electronics.

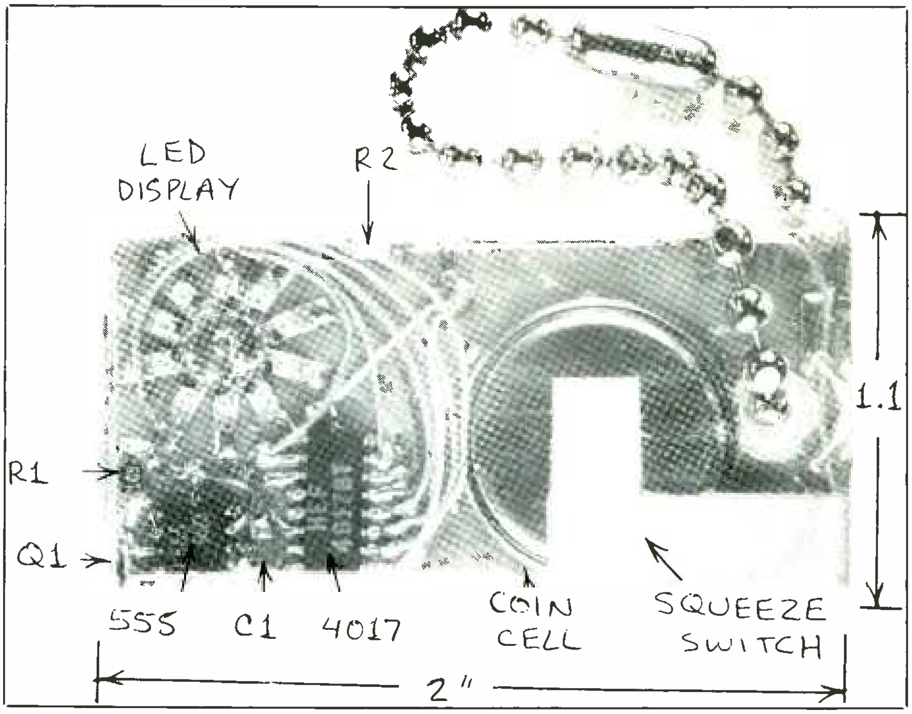


Fig. 5. Wired miniature SMT light sensor with rotating ring display.

Ultraminiature LED Pulse Transmitter

Regular readers of this column and my books may recognize the circuit at the left in Fig. 6 as one of my favorite LED pulse drivers. This simple circuit can drive an LED with a series of hefty pulses having an amplitude of hundreds of milliamperes and a duration of around 20 microseconds.

Though I have built many versions of this circuit, some quite small, availability of surface-mount components has allowed me to assemble the tiniest version yet. At the right in Fig. 6 is shown a photo of the result. The complete infrared pulse transmitter (less battery) measures only 8 mm × 9 mm and is just slightly over a millimeter thin. In other words, the entire circuit is smaller than the nail on your little finger.

I laid out the board for this circuit in the same manner as those described above. But because of its tiny dimensions, I did not trim the board to size until it was completed. In the meantime, it remained as a corner on a postage-stamp-size board.

Notice that the completed circuit includes a jumper wire. The jumper connects the positive supply lead (lower lead extending from board at right in Fig. 6) with the emitter terminal of *Q1*.

Resistors *R1* and *R2* and capacitor *C1* are available from Mouser Electronics. The infrared LED is a Stettner Electron-

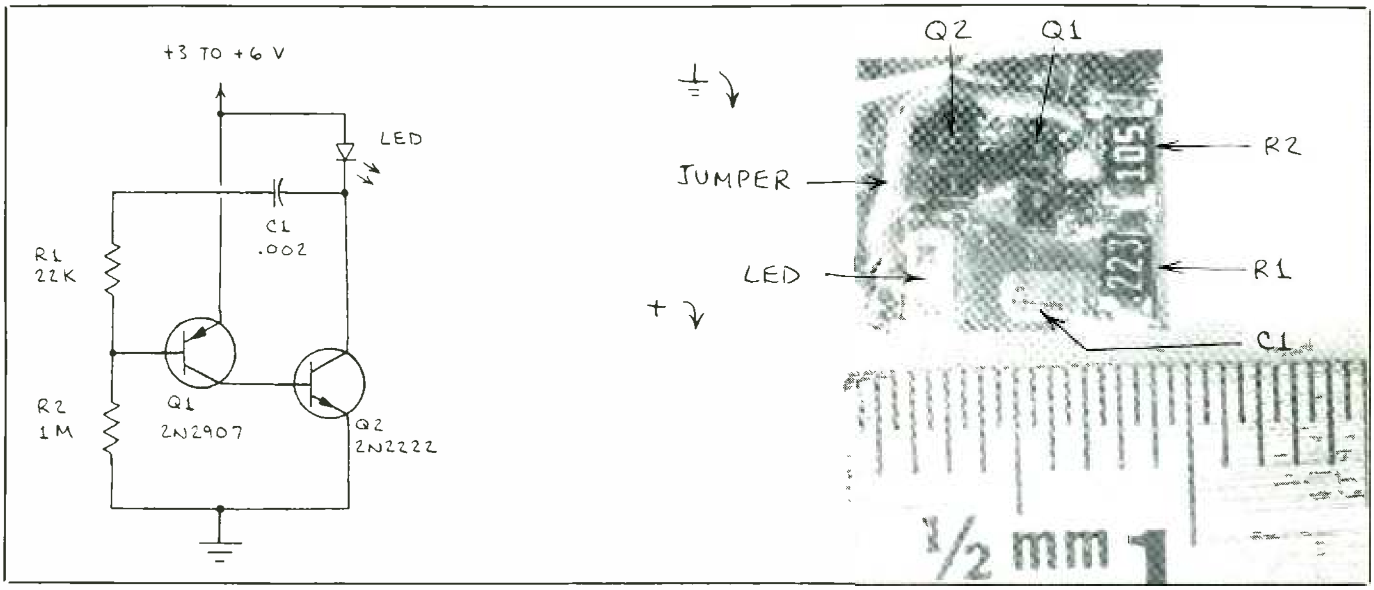


Fig. 6. A LED pulse transmitter (left) and SMT version of the circuit with scale (right).

ADDRESSES

Datak Corp.
3117 Patterson Plank Rd.
North Bergen, NJ 07047
201-863-7667

Edmund Scientific Co.
101 E. Gloucester Pike
Barrington, NJ 08007
609-573-6250

Mouser Electronics
2401 Highway 287 North
Mansfield, TX 76063
817-483-4422

SMD Technology Center
5855 North Glen Park Rd.
Milwaukee, WI 53209
414-228-7632

Stettner Electronics, Inc.
3344 Schierhorn Court
Franklin Park, IL 60131
800-251-4558 (toll free)

Vector Electronic Co.
12460 Gladstone Ave.
P.O. Box 4336
Sylmar, CA 91342
818-365-9661

ics No. CR10 IR. The SOT-23 transistors are available from many sources; the ones I used were purchased in 50-unit reels from the Surface Mount Technology Center.

Going Further

Each of the miniature circuits described here was built in less than three hours. That's certainly comparable with the time required to assemble much larger versions of the same circuits using conventional components. The only tools I used were an inexpensive handheld soldering iron, desoldering braid, tweezers and a magnifying loupe. In other words, surface-mount technology is well within the grasp and budget of most experimenters.

This came as quite a surprise to some of the surface-mount experts who examined these circuits at last fall's WESCON. Most of these engineers are so involved with highly sophisticated surface-mount soldering methods that they have overlooked the fact that simple tools will also work. Of course, specialized tools and equipment can simplify the assembly of surface-mount circuits. But not having access to such equipment doesn't prohibit access to the surface-mount age.

I hope you are by now as excited as I am by the prospects opened up by surface-mount technology. Since building the circuits described above, I have assembled a new family of miniature surface-mount projects without using a soldering iron. These new circuits illustrate more of the exciting possibilities that await those who join the surface-mount technology age. Since I think you will find them rather interesting, I'll describe them in a future column. **ME**

Troubleshooting, Servicing and Theory of AM, FM & FM Stereo Receivers, 2nd Edition, By Clarence R. Green & Robert M. Bourque. (Prentice-Hall. Hard cover. 556 pages. $29.95.)

This is as much a textbook that emphasizes the theory of AM, FM and FM-stereo receivers as it is a traditional troubleshooting manual. Taken in this vein, it can easily be used as the textbook in a classroom course on broadcast AM and FM theory whose ultimate aim is not to show the reader how to design this type of equipment, but to prepare him for efficient troubleshooting. It even has end-of-chapter summaries and questions (with selected solutions at the back of the book).

General circuit fundamentals are dealt with in the first eight chapters. Then comes the "troubleshooting" section in which tools, test equipment and basic procedures are introduced, followed in subsequent chapters with analyses of and troubleshooting procedures for specific pieces of AM and FM equipment. Within the troubleshooting section is more theory that focuses in detail on the specialty circuits used in AM and FM receivers, including both vacuum-tube and solid-state designs right on up to sophisticated PLL synthesized tuning and digital processing schemes.

All in all, this book should provide a good foundation for a career in servicing AM and FM receivers. Its general electronics section is a bonus that can serve as a basis for further preparation for other areas of servicing.

The Second Book of Modern Electronics Fun Projects. Edited by Art Salsberg. (Howard W. Sams. Soft cover. 8½" × 11". 183 pages. $12.95.)

This *Second Book of . . .* provides even more projects than the *First Book of . . .* that was also recently published. Like its predecessor, it consists of detailed electronics construction and design material that's logically divided into eight sections to reflect the category they're in: Intro to Electronic Projects, Home Electronics, Audio/Video Electronics, Security Electronics, Telephone Electronics, Computers, Test Equipment and Electronic Designing.

It, too, serves as a wide-ranging electronics educational tool that uses projects to build as the "hook." So whether you build all of them (more than 25 projects with complete plans) or not, you'll learn how the circuits and devices work.

Among the many construction projects included are a light controller to smoothly dim or brighten lamps, a digital humidity control, an automobile bargraph tachometer, a testbench audio amplifier, anti-theft car alarm installation, an electronic security alarm control center, a device to substitute up to 200 selectable musical tunes for your standard telephone ringer, an interface device to explore electronic music with a Commodore C-64 computer, and a host of test instruments. The latter selection includes a high-frequency ac probe/voltmeter that can measure rms volts to beyond 10 MHz, an impedance bridge, a true-rms adapter for a 3½-digit DMM, a high-frequency dual-pulse generator, a 16-bit logic analyzer, and precision voltage sources. The concluding section on electronic designing illustrates how to think out creating of digital circuits to culminate in a car-theft alarm and an EPROM

[redacted]

tester, as well as devising programmable timebase/dividers.

The projects are based on material that appeared in *Modern Electronics* magazine, with authors upgrading and refining their work. From easy-to-build to more complex ones, they'll provide readers and doers with many, many evenings and weekends of building fun and learning. Moreover, you'll be able to have many inviting electronic devices that you just can't buy anywhere while saving money at the same time.

NEW LITERATURE

SMD Catalog. A color catalog that covers the company's entire line of surface-mount devices is available from Sprague. It includes packaging and applications data on eight types of SMDs, including discrete semiconductors, sensors, interface and linear ICs, tantalum capacitors, multilayer ceramic capacitors, resistor networks, computer delay lines and inductors. Tables and graphs show device ratings and electrical characteristics. Component dimensions, tape and reel specifications, device orientation and quantities of parts per reel are given. Applications data includes mounting, soldering and board-cleaning recommendations, and standard layouts. For a copy of "Surface-Mount Components" (No. ASP-600A), write to: Sprague Electric Co., Technical Literature Service, P.O. Box 9102, Mansfield, MA 02048.

Resistor Networks Guide. "Designer's Guide to Resistor Networks" gives detailed information on a broad range of Bourns package styles in standard electrical schematics. It discusses a virtually limitless number of network options, including resistor/capacitor and capacitor-only networks. It also explains the advantages of surface-mount resistor networks over conventional through-hole devices, with illustrations that describe the recommended land patterns for surface-mount resistor networks. For a copy, write to: Bourns, Inc., 1200 Columbus Ave., Riverside, CA 92507.

[redacted]

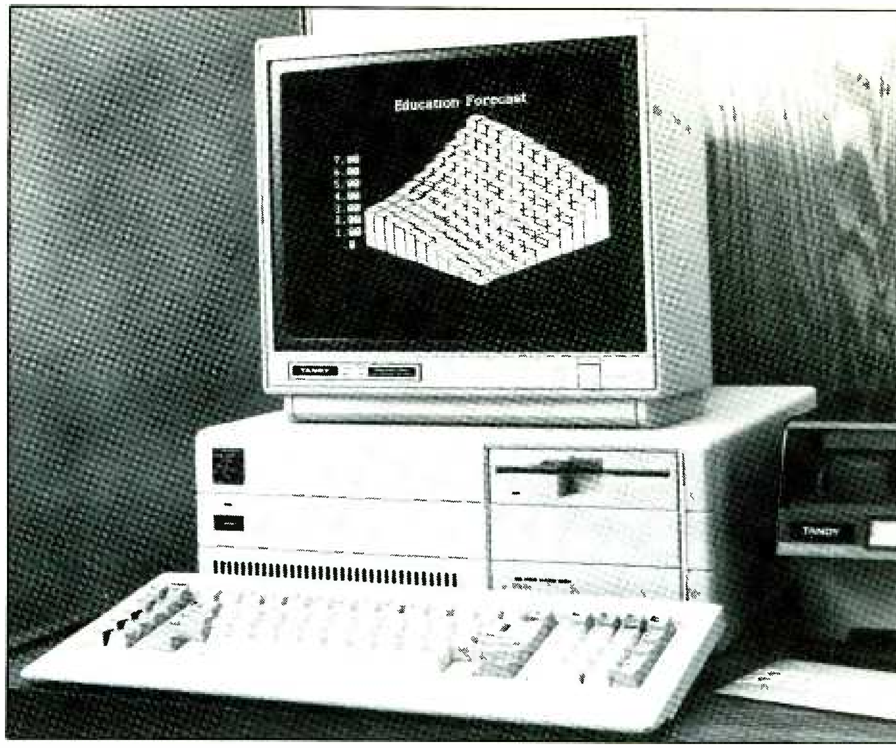
Two Hybrids: Tandy 3000 HL, Words & Figures

By Eric Grevstad

Maybe it's just that I don't like Las Vegas—everybody says it was a great show and a sign that the industry slump is over, but my favorite part of last November's Comdex/Fall was a visit to Hoover Dam. Probably I was put off by the sameness of it all; 100 hard-disk menu managers, so many under-$1,000 PC clones that I might have been at the Kitchen Appliance Expo, and, of course, desktop publishing, desktop publishing, desktop publishing . . . .

Still there were attractive trends. Datavue and NEC showed laptop portables with readable screens, 3.5-inch disks, and double (9.54-MHz) PC speed; NEC's MultiSpeed costs $1,995 with 640K, two drives, and 512K of SideKick-style ROMware, while Datavue's Spark will be a tempting $995 with 384K and one disk, though you'll want to add more RAM, a second drive, and maybe a backlit screen and a modem. Crowds surrounded IBM's PC Convertible, chanting "Woof, woof, arf, bow, wow."

And the 80386 chip is on the way, not waiting for an IBM standard or DOS 5.0. Compaq's Deskpro 386 found its way into a number of booths, software vendors trying to make buyers think their programs always run that fast, and 386 desktops and add-on boards were everywhere. In fact, there's a growing impression that 80286 micros like the AT will be bypassed, serving mostly as speedy XT equivalents while the future's multitasking software belongs to the 386. That's not necessarily a bad fate, judging from the crop of hybrid XT-AT machines lately. I've been testing just such a machine, using a program that's a hybrid of Lotus 1-2-3 and a word processor.



A fast runner without a huge footprint: Tandy's 3000 HL.

Speed & the Single User

The idea of an "ATjr," an XT-compatible system with the AT's swift 80286, isn't new. I think the ITT Xtra XP was the first; IBM sells an obsolete-parts clearinghouse called the XT-286, with an old 6-MHz CPU and a case that won't hold AT-size expansion cards. Now Tandy's made probably its best shot yet at corporate desks: the trim-sized 3000 HL.

Compared to the regular 3000, Tandy's bulkier AT clone, the HL has three fewer slots (three 8-bit and four 16-bit), comes with a 360K instead of 1.2M floppy drive (hooray!), can't expand past four megabytes of RAM, and can't run multi-user terminals under Xenix. As a single-user station, though, the HL offers good looks, a snappy AT-style keyboard, and the speed of an 8-MHz AT. It raced through BASIC benchmarks and Lotus sessions four times as fast as my XT clone, and the only software incompatibility I found was that the disk kept spinning while I played Ms. Pac-Man.

The price is right: $1,699 for the HL system with one drive, parallel port, and clock. Smart shoppers know, however, that Tandy's excellent prices for CPUs mask medium to steep tags for peripherals—MS-DOS 3.2 is a shameful $99.95 extra; the several video cards offered are all named "Deluxe," but you can do better for less with third-party items; and Tandy, which buys RAM chips the way Ford buys rivets, was too chintzy to put 640K instead of 512K on the motherboard sockets.

On the other hand, while the cost of Tandy's 40-megabyte hard disk is breathtaking ($2,199 with controller), so is its performance. I'd earlier scoffed at hot-rodders who say, "Oh, 30 instead of 90 milliseconds access time makes a big difference." It does. Tandy's 40MB drive, a Control Data Wren model, is a screamer. Between the hard disk and the 80286, going back to my old 1200 HD is no fun. Unless you're zealous for Xenix, or holding out for even more speed and eventual multitasking with the 386, the 3000 HL is really a prize.

1-2-3 Meets A,B,C

Lotus 1-2-3 Release 2 has seized control since I described Release 1A as the Classic Coke of the spreadsheet world (June 1986), but the 1A compatibles and enhancements keep coming. The newest, Lifetree Software's Words & Figures, strikes me as the best Lotus clone yet—and a ferocious argument against paying $495 for the original.

Like other clones, W&F is affordable ($195), not copy-protected, and ready to read existing .WKS files, macros, and templates or produce new ones. The screen display, slash commands, and separate graph-printing program are instantly familiar, with a few differences, such as pop-up menus instead of horizontal listings of files and ranges; where commands are slightly different, W&F adjusts when reading old macros.

There are worksheet enhancements, some familiar in Release 2 and some original: math coprocessor support, efficient memory management and expanded memory use up to 9,999 rows by 256 columns, the ability to hide cells or transpose a range from row to column (or vice-versa), three instead of two database sort keys, and an "audit" mode that instantly shows which cells hold values, formulas, and circular references or errors. Unlike many clones, W&F is as fast as 1-2-3 and sometimes faster—on my 8088 system, it did a 1,000-cell recalculations in 18 seconds compared to the 26.5 seconds for Release #2.

By the way, there's one feature here that Lotus lacks: The /T (Text) command turns W&F into a genuine word processor, controlled by similar slash commands (you press the slash key twice to type one in your document). You can flip between spreadsheet and text anytime with Alt-F10, and the same window command that lets you see two parts of a spreadsheet can split the screen between a spreadsheet and document.

Not bad, you say; I'll bet there's a cut-and-paste procedure to copy spreadsheet rows into text. No, there's a variation on the "insert lines" command that inserts a live worksheet window into your document, a frame behind which you scroll material vertically or horizontally and within which you have a working spreadsheet cursor with spreadsheet commands and recalculation. Changes appear in both the spreadsheet, which you can save separately as a .WKS file, and the combined document (.WAK) file.

You can make a .WAF file containing just text with no spreadsheet excerpts, though the word processor is the mildly disappointing part of a superb integrated program. Lifetree is careful to distinguish W&F from its popular Volkswriter line, calling it a word processor for users whose primary work is spreadsheets—the package calls W&F "The spreadsheet that lets you write about your numbers." The editor's automatic reformatting is quick, and I admire its handling of headers and footers and PFS-style page break display, but you'll miss features such as undelete, a delete word command as opposed to a block operation, or support for multiple margins or spacing within a document.

Nevertheless, if you want a first-rate spreadsheet that you won't have to leave to write a letter or memo, Words & Figures works wonderfully. If you disagree, there's a 60-day money-back guarantee. Seeing companies like Lifetree, I think "Lotus" stands for List-price vendor Opposed To Unprotection and Site licensing. ME

```
REBUTTAL.WAF       Page: 1     Line: 10
Global  Insert  Delete  Copy  Move  File  Print  Spreadsheet  Quit
Locate, Replace, Format, Window, Justify, Erase, Setting, Default
         A           B          C          D          E          F
7       Alaska    $211.00    $242.65    $279.05    $320.90    $369.04
8    N. Dakota    $490.00    $563.50    $648.03    $745.23    $857.01
9       Hawaii    $363.00    $417.45    $480.07    $552.08    $634.89
10     Indiana    $487.00    $560.05    $644.06    $740.67    $851.77
11    Michigan    $503.00    $578.45    $665.22    $765.00    $879.75
12 Connecticut    $472.00    $542.80    $624.22    $717.85    $825.53
13 W. Virginia    $360.00    $414.00    $476.10    $547.52    $629.64
14    Oklahoma    $409.00    $470.35    $540.90    $622.04    $715.34
       Looking at the initial returns, however, contradicts Smithers'
   bold assertion.  A few months' worth of figures should suffice:

                 Jan        Feb        Mar        Apr
   ------------------------------------------------------
          Maine  $387.00    $445.05    $511.81    $588.58
        Vermont  $410.00    $471.50    $542.23    $623.56
          Texas  $692.00    $795.80    $915.17  $1,052.45

   Clearly, the anticipated shortfall in profits has not occurred.
   Despite the naysaying of Smithers and his vile clique, it seems clear
```

A split screen shows Words & Figures' spreadsheet and word processor, which in turn has a spreadsheet window.

Names and Addresses

Tandy Corp./Radio Shack
1800 One Tandy Center
Fort Worth, TX 76102

Lifetree Software Inc.
411 Pacific Street
Monterey, CA 93940
408-373-4718

EDITORIAL... (from page 4)

Let's face it, playback-only equipment is not as attractive to users as playback-record equipment. Without a record function on VCRs, recordings sold and rented would doubtlessly be greatly reduced since much fewer pieces of equipment would be bought. Just take a look at the very low sales figures of video laser, disc equipment and recording sales to prove this, as well as the failure of RCA's playback-only video machine and accompanying recordings. VCRs, with their recording capability, easily won out here and, as a result of their high popularity, are spitting out huge sums of money from software sales to the very people who, in their greed, could kill their golden egg.

If you're as annoyed as I am about taking it on the chin as a consumer, why don't you write your congressman and tell 'em that you're against anticopying circuits in home entertainment equipment. At the same time, why not complain about the outrageous charges from the Bell Telephone companies since the Justice Department forced them to split up. This new freedom from a monopoly has resulted in us guys paying billions of dollars more every year to Bell (local phone rates have risen 30% to 40% in only a few years) yielding a greater profit to the phone companies than even the leading business corporations enjoyed this past year, while providing poorer service than ever to end users.

Art Salsberg

LETTERS... (from page 5)

bers. A 2.2-meg is "not available" according to them also.

The next step was to search the many catalogs I have acquired. None had any listing of the IC and only one showed a 2.2-meg pot for which they wanted about $8.00 and they do not do mail order.

Now I ask you, where do I go from here? Even if I were to find a mail-order source, they all have some minimum purchase requirement, and I have no intention of buying parts I don't need just to get those that I do.

I believe that if you are going to publish articles of this type, you also have some responsibility to either verify parts availability or list a source that will sell the parts without forcing the purchase of unwanted parts.

I do think your magazine is among the best of it's type. This complaint is not unique to you but it has prevented me from building a device which I had hoped would have helped my baby son sleep, which in turn would allow me to sleep! If you cannot suggest a source I must abandon this project.

Robert S. Heintz
Dumont, NJ

A 2.2-meg potentiometer shouldn't be difficult to find, especially through radio-TV distributors. Use a 2-meg one if you're having difficulty, which will work fine and give you just a slightly reduced range. The MM5837 IC is easily obtained, too. Digikey, one of our advertisers, for example, lists it in its catalog for $3.13. There's no minimum purchase requirement here, either. A 2-meg pot's price ranges from 99¢ to $1.20—Ed.

SMT Turn-On

• Thanks for your article on SMT in ME (Jan. '87). It's most timely since I'm trying to squash a servo control down to pea size for ultra mini R/C planes. Now there's a light at the end of the tunnel—you turned it on!

As a small gesture of appreciation I enclose a one-year subscription to Modern Electronics. It will enable me to follow Forrest Mims's SMT work. Once before—about 20 years ago—another man piqued my sense of gratitude. I wrote to Lou Garner to thank him for his work in transistor technology. Keep up the good work.

Daniel A. Hoffman, II
Springfield, PA

Lou Garner was the original "Solid State" columnist in Popular Electronics, *the latter now defunct. Forrest Mims was his successor there and continues his remarkable electronic experimenting in* Modern Electronics.*—Ed.*

to examine the plated media's tracks to see if any unused ones were bad, but they were all fine. So the shock mounting is obviously good.

Now to some test numbers. Average access time measured 88 milliseconds, which compares to an IBM XT drive's 93 ms when using Core International's test disk. Rotational speed of the drive is a hard disk's standard 3,600 rpm, while data transfer rate is also the standard 5 megabits/second. Maynard states that OnBoard draws only 4.5 watts of power.

In all, this hard-disk card has a lot of things going for it. Its list is a bit pricey, but the extra features and a name company behind it makes it a bit easier to take if dealer discounts are in order.

—*Art Salsberg*

Conclusions

If you do any serious work with your computer, as so many of you do, then you just have to upgrade to a hard-disk drive, just as early IBM PC owners moved to a higher disk-operating system version, such as DOS 2.1 and now DOS 3.1 or 3.2. Life is easier in the fast track.

There are certain caveats to look out for when buying a hard-disk kit. Be certain that the drive you buy can be booted up automatically as the default drive. Most can, but there are some that may not.

If you're adding a hard disk as your second one, be aware of some possible challenges. For example, should you decide to give up one of your full-height floppy-disk drives to make room for an internal hard-disk drive with separate controller, be sure that you don't remove the one that has a required terminating resistor pack on it (the other won't have one). So take out the drive that doesn't have this device. On IBM PCs, this usually means that you should remove the right-hand drive (but check it out).

Do read the instructions that come with your hard-disk drive very thoroughly before you lay a hand on your computer. In some instances, you might even have to *remove* a terminating resistor, for example, which is the case when adding OnBoard as a second hard drive in an IBM XT. Here, the resistor on the XT's drive has to be taken out, as well as its controller board.

Again, if you're adding a second hard-disk drive after you've already formatted one that you've been using, you'll have to reformat the first one so that the second one will be recognized by the system. You can avoid this only if you were installing both drives at the same time, which would allow you to configure the system for two hard disks when setting up your first one. If adding one later, you'll have to copy all your existing files onto floppies and reload them later. (There's a way around this through some trickery, though. See *PC Magazine*, March 25, 1986, page 191.)

If you're adding an internal hard-disk drive with a separate controller in an old model IBM PC, be sure to replace the computer's underpowered switching power supply. Exact replacement types, 135 watts or 150 watts, are cheap, and installation is a snap. Just remove a few screws, disconnect a few cables, and slide the old supply out. Reverse the procedure for installation of the new supply. In real life, you'll have to loosen a screw on a floppy drive frame to move it forward to get enough room to move the supply a little forward past the case's lip. Also, the original supply's screw threads might be different than the substitute's, which may not come with screws to secure it to the chassis. So a fast trip to a hardware store may be in order. Check this out *before* installing the new supply.

Chances are that you won't run into any difficulties at all in adding a hard disk since the procedures are quite simple and not time consuming. A typical charge for installing and formatting a hard-disk drive in the Northeast section of the country is $100, by the way. This is for a standard drive/controller (not a simple plug-in card) that's known to work with a particular computer. By doing it yourself, you save money, gain a sense of accomplishment and also have fun. **ME** carefully smooth the stub tips with a fine file.

Unlock the levers on *SO1*, *SO2* and *SO3* on the Programmer. Lower the add-on assembly onto the main board, aligning the pins protruding from the bottom of the former with the ZIF sockets in the latter. Everything should line up squarely, and there should be no need to force the assembly into place. Set the levers on the ZIF sockets on the Programmer to the lock position to secure the retrofit board in place.

Taking care to properly orient them, install *IC18*, *IC19*, *DIS6* and *DIS7* in their respective sockets. Your Programmer is now ready to program and read large-capacity EPROMs.

Checkout and Use

You can check out the Stand-Alone EPROM Programmer's retrofit expansion module in the same manner as you did for the basic unit, except

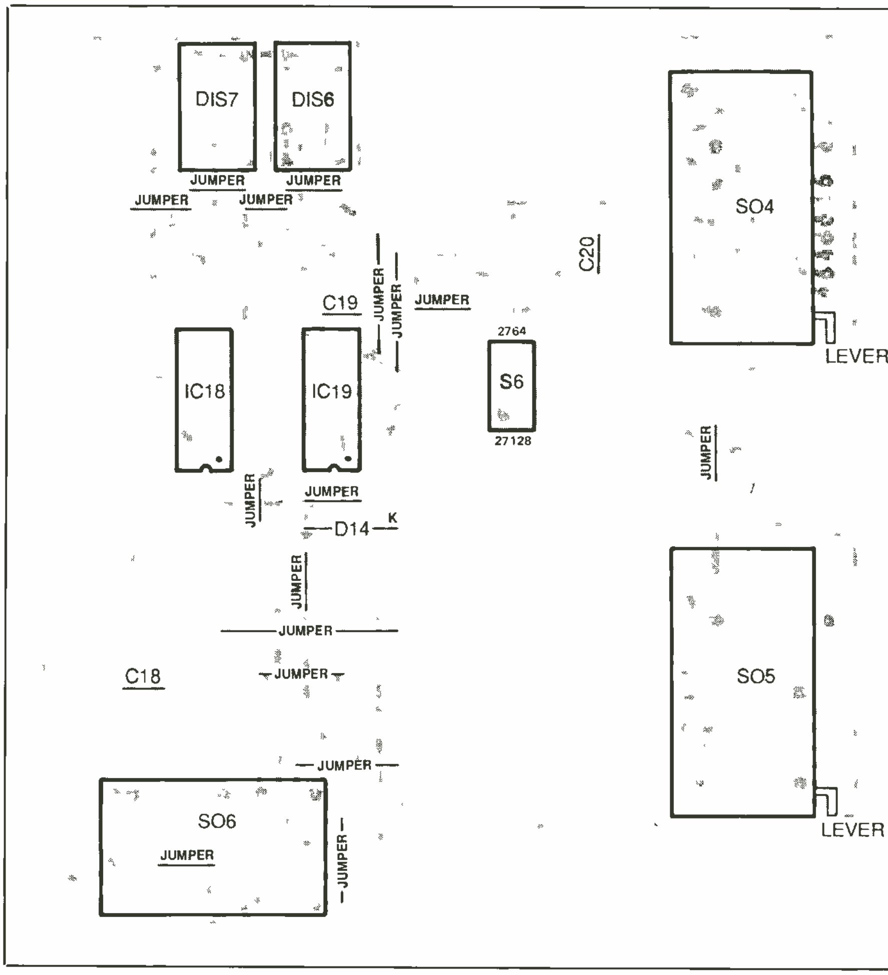


Fig. 11. Pc board wiring diagram.

that now you must use either 64K or 128K EPROMs and set switch *S9* accordingly.

With the addition of the expander module described here, you do not lose the ability to program the 16K and 32K EPROMs for which the Programmer was originally designed. Any time you wish to program, say, a 2716 or a 2732, simply remove the retrofit board and you are in business. **ME**

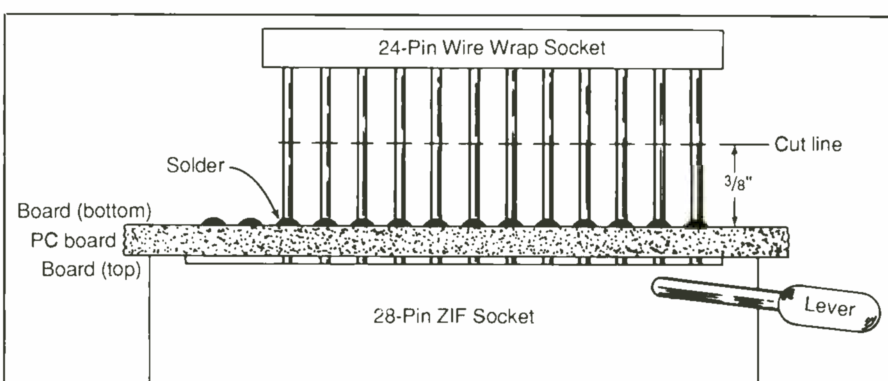
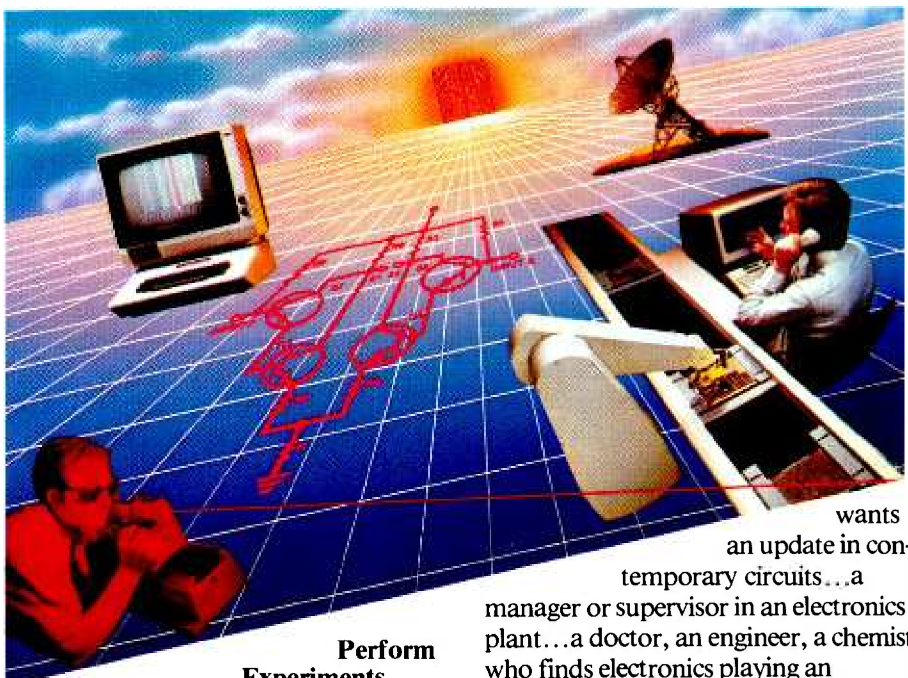


Fig. 12. Details for installing plug-in adapter socket pins that connect retrofit module to original EPROM Programmer's ZIF sockets.

MASTER THE NEW ELECTRONICS WITH McGRAW-HILL'S

Contemporary Electronics Series

The fast, easy and low cost way to meet the challenges of today's electronic innovations. A unique learning series that's as innovative as the circuitry it explains, as fascinating as the experiments you build and explore.

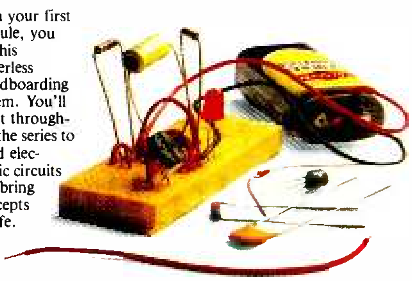


From digital logic to the latest 32-bit microprocessor, the McGraw-Hill Contemporary Electronics Series puts you into the electronic picture one easy step at a time. Fifteen unique Concept Modules, sent to you one every 4–6 weeks, give you a handle on subjects like optoelectronics, robotics, integrated circuits, lasers, fiber optics and more.

Each Concept Module goes right to the heart of the matter. You waste no time on extraneous material or outdated history. It's a fast, efficient, and lively learning experience...a non-traditional approach to the most modern of subject matter.

Unique Interactive Instruction

With each module, you receive a McGraw-Hill Action Audio Cassette. Each tape is a dynamic discussion that drives home the key facts about the subject. Your learning experience is reinforced through interaction with vividly illustrated text, audio cassettes, and actual electronic experiments. Indexed binders preserve backup material, notes, and tapes for convenient referral.



With your first module, you get this solderless breadboarding system. You'll use it throughout the series to build electronic circuits and bring concepts to life.

Perform Experiments in Contemporary Electronics

Throughout your series, laboratory experiments reinforce every significant point. This essential experience ...dynamic, hands-on demonstrations of theory in practice... will help you master principles that apply all the way up to tomorrow's latest VLSI (Very Large Scale Integrated) circuitry.

In your very first module, you'll use integrated circuits to build a digital oscillator, verifying its operation with a light emitting diode (LED). You'll learn to identify passive and active components, understand concepts common to all electronic circuits.

For Anyone Interested in Electronics

The Contemporary Electronics Series is designed for anyone from hobbyist to professional. It's for you if you're looking for new fields of interest...if you're a teacher who wants an update in contemporary circuits...a manager or supervisor in an electronics plant...a doctor, an engineer, a chemist who finds electronics playing an increasingly important role in your work. It's even for electronics engineers or technicians who feel their training needs freshening up. It's the quickest, most convenient, probably least expensive way to do it. And the only one that gives you hands-on experience.

15-Day No-Risk Trial

To order your first module without risk, send the card today. Examine it for 15 days under the terms of the order form and see how the Contemporary Electronics Series gets you into today's electronics. If card has been used, write us for ordering information.

McGraw-Hill
Continuing Education Center
3939 Wisconsin Ave.
Washington, D.C. 20016

Distribution Amplifier *(from page 42)*

for marking their mounting hole locations on the floor of the enclosure. Drill holes large enough to accommodate No. 6 machine screws for the transformer and No. 4 machine screws for the circuit-board assemblies at the marked locations.

Next, cut the slots for the input and output phono-jack assemblies in the enclosure's rear wall. The easiest way to do this is with a nibbling tool. If you do not have such a tool, drill a number of interconnected holes around the perimeter of the slots and use a file to square up the slots. Drill the line-cord entry hole (make it large enough for a small rubber grommet) and the bayonet-type fuse holder, as shown in Fig. 8. (If you prefer, you can mount an inexpensive chassis-mount fuse block inside the enclosure to the left of the power transformer and eliminate having to drill the large hole required for a bayonet fuse holder.)

Prepare the front panel as follows. First draw a light pencil line parallel to the bottom of the front panel 1⅛" to 1¼" up. Then measure about 2" in from both sides and strike short lines at these points across the first. These two points locate the centers of the holes that must be drilled for the GAIN controls. By mounting the controls in the holes drilled at these points, they will not interfere with the audio and video boards when the project is assembled.

Deburr all holes. Then use a dry-transfer lettering kit or a tape labeler to label the AUDIO GAIN and VIDEO GAIN controls and AUDIO and VIDEO INPUTS and OUTPUTS. If you use a dry-transfer lettering kit, protect the labels by spraying two or three *light* coats of clear acrylic over the front and rear panels. Wait for each coat to dry before spraying on the next.

Now mount all elements in place, starting with the power transformer. Before mounting the transformer, however, plug its secondary leads into the T1 Secondary holes in the power-supply board, solder into place and trim the excess lead lengths. Use 4-40 × ¾" machine screws for mounting the circuit boards and 6-32 × ¼" or ⅜" machine screws for the power transformer and rear-panel jack assemblies. Use 6-32 or 4-40 machine nuts and No. 6 or No. 4 lockwashers to secure all hardware, except screw an insulated standoff post onto the left screw end (viewed from the front of the enclosure) of the video jack assembly. Sandwich the No. 6 solder lug attached to the free end of the wire coming from the power-supply board between the spacer and floor of the enclosure at one corner of the power-supply board to ground it to the chassis.

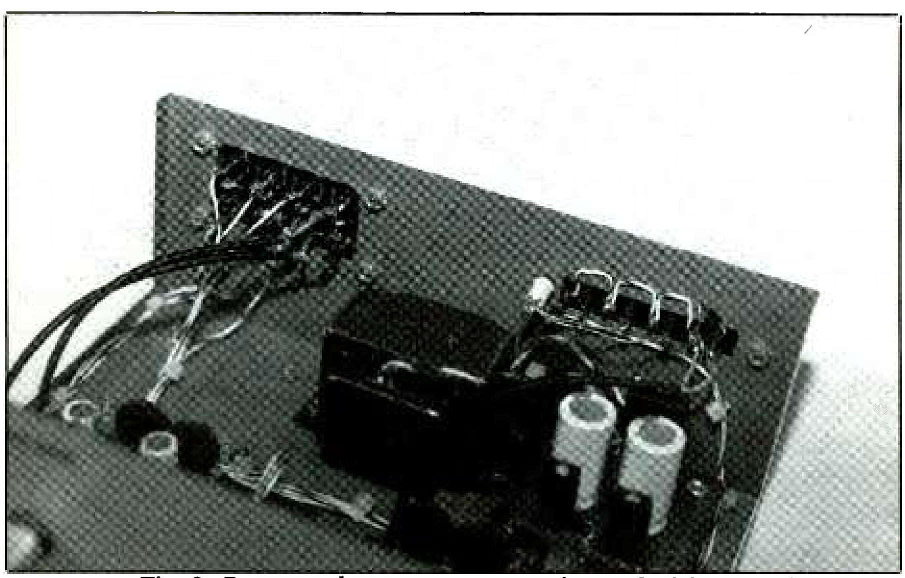


Fig. 8. Rear panel component mounting and wiring details.

Line the appropriate hole in the rear panel with a rubber grommet. Then trim ⅜" of insulation from both conductors at the free end of the ac line cord. Tightly twist together the fine wires in both conductors and sparingly tin with solder. Pass this end of the line cord through the rubber grommet into the enclosure and tie a knot about 4" from the prepared end inside the enclosure.

Mount the controls (and POWER switch, if you have decided to include it) on the front panel in their respective holes and the fuse holder on the rear panel (unless you have decided to use the internal fuse block). Now, referring to both the schematic diagrams and the wiring guides, interconnect all elements as shown.

One conductor of the ac line cord connects to one of the lugs on the fuse holder. Then one primary lead of the power transformer connects to one lug of the POWER switch, while a length of hookup wire interconnects the remaining lugs on both the POWER switch and fuse holder. When this has been done, wrap electrical tape over the contacts of the fuse holder and POWER switch's lugs to insulate the ac line from the rest of the circuit. Alternatively, you can slip over the whole rear portion of the fuse holder a 2" length of large-diameter heat-shrinkable tubing and shrink it into place to insulate this assembly.

You have two choices for wiring the other line cord to the other primary lead of the power transformer. The simpler method is to twist together the remaining ac line cord conductor and remaining primary lead of the transformer and screw onto the connection a wire nut. The alternative is to slip a 1" length of small-diameter heat-shrinkable tubing over one wire, twist together and solder the wires and shrink the tubing tightly over the connection so that it is fully insulated.

Referring back to Fig. 6, wire the GAIN controls to their respective boards, using the wires previously installed. Trim the wires to as short as needed before connecting and soldering them to the lugs of the controls.

One lead of resistors *R10*, *R11* and *R12* for the video circuit wires to the signal (center or "hot") lug of each of the VIDEO OUTPUT jacks. The other leads of these resistors tie together to form a common junction with the output wire from the video board. To make this connection, trim the resistor leads to length and wrap them around the post on the insulated standoff. Trim the output wire from the video board to length before wrapping it, too, around the post and solder the connection.

Connect and solder the free ends of the coaxial cables previously installed on the audio and video boards to the appropriate lugs of the remaining input and output connectors on the rear panel. Remember, the center conductors of these cables go to the signal lugs of the jacks, the shields to the ground lugs. Finally, interconnect all ground lugs on both jack assemblies, including the ground lugs to which the coaxial cables are connected. You can use bare solid wire to accomplish this, but make certain that no portion of the wire contacts the signal lugs of the jacks. Obviously, it would be safer to use insulated hookup wire.

Checkout and Use

With the ICs still not installed in the sockets on the audio and video boards, plug the line cord of the Distribution Amplifier into an ac outlet and, if you included it, set the POWER switch to ON. Use a voltmeter set to 20 volts dc or so full-scale to check for the presence of the proper voltages at the appropriate points in the circuit. All measurements should be made with reference to circuit ground (in this case, you can use the metal chassis of the project's enclosure). On the power-supply board, you should measure +12 and −12 volts at the + lead of *C3* and − lead of *C4*, respectively. You should also measure +12 and −12 volts at pin 7 and 4, respectively, of *IC1* on the video board. Finally, you should measure +12 and −12 volts at pins 8 and 4, respectively, of *IC1* on the audio board.

If you do not obtain the proper indications, power down the circuit and correct the problem before proceeding further. Start with the power-supply board. If you obtain the proper measurements, proceed to the video board. If you get just the reverse of the correct measurements, you cross-connected the power bus wiring; to correct this, simply transpose the two wires going to the video board. The same applies for the audio board. If the voltages are reversed on both the audio and the video boards, it is easier to transpose the wiring at the power-supply board.

Once you are satisfied that everything is working as it should, power down the project and pull the line cord from the ac receptacle. Now handling the ICs with the proper precautions for MOS devices, plug them into the sockets on the audio and video boards. Make sure you install the proper IC in each case, and make sure that no pins fold under the ICs or overhang their sockets.

Rotate the control shafts of the GAIN controls to determine where their midpoint settings are. Adjust each to its midpoint. Then carefully and without disturbing the settings, push a pointer-type or other indicating knob onto each pot shaft so that the indicator is pointing straight up. This is the unity-gain position for each control.

When the Audio/Video Distribution Amplifier is connected into your home-entertainment system and is powered up, turning any knob clockwise should increase the gain, while turning it counterclockwise should reduce the gain. If this is not the case with any given control, power down the project and transpose the two outer wires going to it.

The normal operating position for the GAIN controls should be straight up at the unity-gain setting. Whenever the GAIN controls are used, always be sure to make a test recording if one of the outputs is going to a VCR before making the actual recording. Check the test recording to make sure no stages of the VCR are being overloaded.

You should now have the makings of a fine-performing audio-visual home entertainment system. **ME**

MODERN ELECTRONICS MART

Classified Commercial Rates: 90¢ per word, 15-word minimum ($13.50) 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. 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.

Mart Display Rates: 1″ × 1 col., $120; 2″ × 1 col., $230; 3″ × 1 col., $330. Prepayment discount 5% for 6 issues; 10% for 12 issues prepaid at once.

(All advertisers with PO Box addresses must supply permanent address and telephone number. Copy is subject to publisher approval.)

Mailing Information: Copy must be received by the publisher by the 20th of the third month preceding the cover date. Send Advertising material with check or money order to: Modern Electronics, Classified Department, 76 N. Broadway, Hicksville, NY 11801.

VIDEO

PAY TV and Satellite Descrambling. 6 Ed. 100 pages covering 13 cable and 7 satellite systems. Schematics, bypasses, descrambler detection etc. Videocipher update (material not in the magazines) included. $14.95. MDS/MMDS Handbook. For microwave hackers $12.95. Cable TV. How systems work including two-way. $12.95. Experiments with Videocipher. Turn-ons $9.95. Build Satellite Systems under $600. $11.95. Any 3/$26. New catalog $1. Shojiki Electronics Corp., 1327M Niagara St., Niagara Falls, NY 14303. COD's 716-284-2163.

CABLE and SUBSCRIPTION TV secret manual. Build your own **DESCRAMBLERS**, converters. Instructions, schematics for: Sinewave, Inband/Outband Gated Sync Pulse, SSAVI - (HBO, Showtime, Cinemax, UHF, etc.) Send $8.95 to **CABLETRONICS**, Box 30502ME, Bethesda, MD 20814.

CABLE TV CONVERTERS. Scientific Atlantic, Jerrold, Oak, Zenith, Hamlin. Many others. Visa & M.C. accepted. Toll Free 1-800-826-7623 B&B Inc. 10517 Upton Circle, Bloomington, MN 55431.

SATELLITE DESCRAMBLING. Latest methods of digital scrambling of the audio in video cypherII satellite television transmissions. Covers Transmission format, key generation, and DES decoding. $10.95; **CABLETRONICS**, Box 30502ME, Bethesda, MD 20814.

DESCRAMBLING manuals. VIDEOCIPHER II-$24.95. ORION-$19.95. LSASE brings brochure. Satellite systems catalog $2.00 (refundable) **MICROTRONICS** Box 2517-M, Covina, CA 91722.

STRANGE Stuff. Plans, kits, items. Build Satellite Dish $69. Descramblers, bugs, adult toys. Informational photo package $3. Refundable. Dirijo Corporation, Box 212-M, Lowell, NC 28098.

CABLE TV Secrets - the outlaw publication the Cable Companies tried to Ban. HBO, Movie Channel, Showtime, Descramblers, Converters, etc. Suppliers list included. $8.95. Cable Facts, Box 711-ME, Pataskala, OH 43062.

CABLE and Satellite Descramblers. Major brands, Catalog 3.00. Cabletech 3310-10 W. Bell, Phoenix, AZ 85023.

ELECTRONICS

PROGRAMMABLE POWER SUPPLIES. Proven schematics and well written details are provided on several digitally programmable power supplies. Easy interface to PC and other devices or stand alone capability. $10PPD. J. BELL, 416 Dale Terrace, Clarksville, TN 37042.

LINEAR PARTS—Transistors: MRF454 $15, MRF455 $12, MRF477 $11, MRF492 $16.75, MRF421 $22.50, SRF2072 $13, SRF3662 $25, 3800 $18.75, 2SC2290 $19.75, 2SC2879 $25. **Tubes:** 6KD6 $10.50, 6LQ6 $9.75, 6LF6 $9.75, 8950 $16.75. Best Prices on Palomar Road Noise Mics, Ranger AR3300. New 16 page Catalog listing radio/amplifier tricks—Channel Modification, PLL-Sliders, Peaking for Range, Hard-to-Find Linear Parts—Mail $1.00 to: **RFPC**, Box 700, San Marcos, CA 92069. For Same Day Parts Shipment, Call (619) 744-0728.

HARDWARE, Software, Surplus Parts, Solar Energy, Much more. Free Catalog. GIL Electronics, Dept. 3, P.O. Box 1628, Soquel, CA 95073.

$$$$$ Super Savings $$$$$
on electronic parts, components, supplies and computer accessories. Free 40-page catalog for SASE. Get on our mailing list. BCD Electro, P.O. Box 830119, Richardson, TX 75083 or call 214-343-1770.

TOP QUALITY imported, domestic kits, surplus, discount electronics, computer components. Free catalog. **TEKTRASONIX**, 80-50 Baxter Ave., Suite 120, Elmhurst, NY 11373.

TUBES: 59¢. Year Guarantee. Free Catalog. Tube Tester $8.95. CORNELL, 4213-17 University, San Diego, CA 92105.

FREE RFI Technical Note tells how to keep RF out of TV's, telephones, etc. with ferrite beads. Palomar Engineers, Box 455, Escondido, CA 92025.

LASERS and Nightvision surplus components. FREE catalog, M.J. NEAL COMPANY, 6672 Mallard Ct., Orient, OH 43146.

COMPUTERS

BASIC Computers, 10 lesson correspondence course, $39.50. Certificate. Details free. AMERICAN TECHNICAL INSTITUTE, Box 201, Cedar Mountain, NC 28718.

FINAL Closeout of new, Surplus, MS-DOS Software, and Manuals!! 10% Off with this ad. Free Catalog. GIL Electronics, Dept. 2, P.O. Box 1628, Soquel, CA 95073.

TI-99/4A Software/Hardware bargains. Hard to find items. Huge selection. Fast Service. Free Catalog. TYNAMIC, Box 690, Hicksville, NY 11801

ELECTRONIC KITS

Do It Yourself, HOBBY, EDUCATIONAL, PROFESSIONAL 100 KITS to Choose From

Don't miss out on the ultimate in hobby, educational, and professional high quality, functional kits.

*Light Dimmers	EPROM Programmers
Universal Timers	Audio Input Selectors
Power Amplifiers	Alarms
Pre-Amplifiers	Thermostates
Power Supplies	Thermometers
*Light Computers	AC Motor Controls
Electronic Ignitions	Geiger Counters
Infra-red Transmitters	Mother Boards
Infra-red Receivers	Extension Boards
*Stereo-Decoders	Interface Cards
AM/FM Tuners	Relay Cards
Door Bells	OPTO Input Cards
Power/Switch Dimmer	*Quad Triac Switch Card

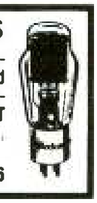
To receive your catalog, send $3.00 to

HOBBY
ELECTRONIC
P.O. Box 1339, Claremont, NH 03743
or call (603) 543-0033

NEW 20-PAGE CATALOG FREE

7 MILLION TUBES

Includes all current, obsolete, antique, hard-to-find receiving, transmitting, industrial, radio/TV types. **LOWEST PRICES.** Major brands in stock.
Unity Electronics Dept. M
P.O. Box 213, Elizabeth, N.J. 07206



COMMUNICATIONS

EXPERT EXPORT REPAIR. PLAIN 40'S TOO. MOBILES = $45.00, BASES = $55.00. PLUS $5.00 SHIPPING. LESCOM, 4445 OUTWOOD, LADSON, SC 29456.

VOICE DISGUISER, FM Transmitter, Telephone Transmitter and More! Catalog $1.00 (Refundable): XANDI, Box 25647, "F", Tempe, AZ 85282.

COMMUNICATIONS PLANS, BOOKS, KITS! AM/FM broadcasting (licensed/unlicensed), 1750 Meter transceivers, ham/CB amplifiers, surveillance bugs, more! FREE catalog. PAN-COM, Box 130-ME3, Paradise, CA 95967.

DIGITAL AUDIO

DIGITAL AUDIO RECORDER Commodore-64. Excellent Sound! Plans, P.C.B., & DRUM SOFTWARE: $19.95. KIT $49.95. PostPaid, ORDER NOW!! TAD PAINTER, P.O. Box 166055, IRVING, TX 75016.

COMPUTER ROBOTS

FISHERTECHNIK Robotic Computer Kits. Build ten different working models. Available for Apple, IBM and Commodore. Valley Computers, 613 N. Idlewild, Kaukauna, WI 54130. 414-766-3589. (Dealer and School PO's welcome).

EPROM PROGRAMMING

FREE catalog. Your software/data installed in (E)PROM of your choice. Fast, low cost service. Write/call: Romulus Microcontrol, Dept. C, Box 8669, Rockville, Maryland 20856; (301) 540-8863.

CABLE TV

CABLE TV converters and descramblers. Low prices, quality merchandise, we ship C.O.D. Send $2.00 for catalog. Cabletronics Unlimited, P.O. Box 266-M, S. Weymouth, Mass. 02190 (617) 871-6500.

INVENTORS

INVENTORS! Have idea for product or invention, don't know what to do? Call AIM we present idea's to manufacturers - Toll Free 1-800-225-5800.

INVENTORS

INVENTORS! Can you profit from your idea? Call AMERICAN INVENTORS CORPORATION for free information. Over a decade of service, 1-800-338-5656. In Massachusetts or Canada call (413) 568-3753.

MISCELLANEOUS

LEARN MORSE CODE IN 1 HOUR. Amazing new easy technique. Moneyback guarantee. $5. Bahr, 2549 Temple, Palmbay, FL 32905.

APEX® Screwdriving Bits: Phillips, Slotted, Square Tip, Clutch Head, Reed-Prince, Torx, Pozidriv, Tri-wing and much more. Made in the USA. Precision machined, heat treated tool steel. Complimentary list. Don Shockey, 5841 Longford Road, Dayton, Ohio 45424-2940.

ASIAN LADIES want correspondence for friendship, marriage. SUNSHINE INTERNATIONAL, Dept. TW, Box 260, North Hollywood, CA 91603.

IPC SALES

A Division of LJM TECHNOLOGIES INC.
PO Box 1540
Haverhill, MA 01831
Telephone AC (617) 373-7750

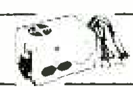
MasterCard VISA

40 CHARACTERS 5X7 DOT MATRIX SORRY, NO COO'S

IEE 40 CHARACTER VACUUM FLOURESCENT DISPLAY MODULES. Display is blue-green. .24" high 5 x 7 dot matrix. ASCII coded for alphanumerics. On-board microprocessor. Interfacing includes 8-bit bidirectional bus and TTL serial (or jumper selectable RS 232 for model 3601) at 1200 baud. Requires only + 5 VDC. Size: 10.75"L x 3"W x 1"D. 26 pin conn.. 2' of cable. and 6 pgs. of data included.

Model # 3600	$ 30.00 Each	10 & up	$ 25.00 Each
Model # 3601	$ 40.00 Each	10 & up	$ 34.00 Each

IBM PC-XT COMPATIBLE 150 WATT Power Supply. Cooling by on-board DC fan. New. in cartons. SPECIAL SALE PRICE $ 89.00 Each



MC14011 CMOS Quad NAND Gate. 25pcs / Tube: 1-9 tubes $ 6 ea. 10 & up $ 5 ea

HITACHI HD68B09 MICROPROCESSOR. CPU with 2 MHZ Internal Clock. 2 for $ 6.00 Per Sleeve (9 pcs) 1-9 $ 23 / Sleeve 10 & up $ 18 / Sleeve

SPECTRA-STRIP 30 Conductor Ribbon Cable. # 111-2213-030. 22 Ga. stranded (7/30) color coded cable. 100 ft. Rolls. in original cartons. List $ 110.00/ Roll. SPECIAL SALE PRICE $ 20 / Roll 5 & up $ 18 / Roll

SOLID STATE DIFFERENTIAL PRESSURE TRANSDUCER. MICRO SWITCH # 143PC02. ± 2.5 psi range. Supply range 7 to 16vdc. 1 to 6vdc output at 8vdc supply. Measures gage. absolute. and differential pressure. Usable range ± 7.5 psi. Built in signal conditioning and temperature compensation. Data included. List price over $ 65. YOUR PRICE $ 35 Ea. 5 & up $ 30 Ea

POWER MOSFETS AT SPECIAL PRICES — LIMITED QUANTITIES

Part No.	Quantity	Vds	Id @25°C	Rds (on)	Case Style	Price Each 1-9	10-49	50 & up
BUZ 21	1000	100	19.0	0.10	TO-220	9.50	8.50	7.50
BUZ 60	200	200	5.5	1.00	TO-220	6.00	5.40	4.80
BUZ 46	80	500	9.6	0.60	TO-3	13.75	12.00	10.60
BUZ 64	200	400	10.0	0.40	TO-3	14.80	13.00	11.40
BUZ 84	500	800	5.3	2.00	TO-3	21.50	18.90	16.60
2N6764	50	100	38.0	0.055	TO-204	22.00	19.25	16.75

ALL PRICES INCLUDE UPS or USPS Shipping Within Continental USA
QUANTITIES ARE LIMITED. Phone in your order to insure availability
SEND FOR OUR FREE CATALOG of Electronic & Hardware Bargains

CIRCLE 66 ON FREE INFORMATION CARD

★QUALITY PARTS ★DISCOUNT PRICES ★FAST SHIPPING!

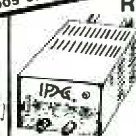
SEND FOR FREE CATALOG... 48 PAGES!

ALL ELECTRONICS CORP.

905 S. VERMONT • P.O. BOX 20406 • LOS ANGELES, CA 90006

10 AMP SOLID STATE RELAY
CONTROL 3 - 32 vdc
LOAD: 140 vac 10 amp
SIZE: 2¼" x ¾" x ⅞"
$9.50 EACH 10 FOR $90.00

13.8 VDC REGULATED POWER SUPPLY

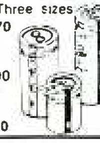


These are solid state, fully regulated 13.8 vdc power supplies. Both feature 100% solid state construction, fuse protection, and L.E.D. power indicator. U.L. listed.
2 amp constant, 4 amp surge $20.00 each
3 amp constant, 5 amp surge $27.50 each

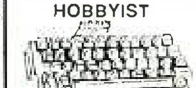
RECHARGEABLE NI-CAD BATTERIES

AAA SIZE	1.25V 500mAH	$1.85
AA SIZE	1.25V 500mAH	$1.85
AA with solder tab		$2.00
C SIZE	1.2V 1200mAH	$3.50
SUB-C SIZE	solder tab	$3.50
D SIZE	1.2V 1200mAH	$3.50

PHOTO-FLASH CAPS
170 mf 330v 75¢ ea. Three sizes
CAT# PPC-170
400 mf 330v 1.00 ea.
CAT# PPC-400
800 mf 330v 1.35 ea.
CAT# PPC-800



48 KEY ASSEMBLY FOR COMPUTER OR HOBBYIST



NEW T.I. KEYBOARDS Originally used on computers, these key boards contain 48 S.P.S.T. mechanical switches. Terminates to 15 pin connector. Frame 4" x 9"
CAT # KP-48 $3.50 each
10 for $30.00

8 OHMS 15 WATTS
EXTRA SPECIAL VALUE

C.T.S. MODEL 8B3079
8" LOUDSPEAKER
8 OHMS COIL 100 - 10,000 HZ
Power rating 15 watts max
3.0 oz ferrite magnet
Typical response range
CAT3# SK-815 $3.50 each
case of 8 $25.00
96 pcs @ $2.75 each.

FLASHER LED
5 volt operation
red jumbo T 1¾ size $1.00 each
NEW GREEN FLASHER
CAT # LED 4G $1.00

XENON FLASH TUBE
3/4" long X 1/8" dia. Flash tube designed for use in compact camera flash units. Ideal for experimentors.
CAT# FLT-1 2 for $1.00

MINIATURE TOGGLE SWITCHES
S.P.D.T. (on-on) Solder lug terminals $1.00 each 10 for $9.00
S.P.D.T. (on-off-on) Solder lug terminals $1.00 each 100 for $80.00

ULTRA-MINIATURE 5 VDC RELAY
Fujitsu # FBR211NED005M20
High sensitivity
COIL 120 ohms $1.25 each
CONTACTS: 1 amp 10 for $10.00
Mounts in 14 pin DIP socket

D.P.S.T. LIGHTED ROCKER SWITCH
115 vac lighted rocker snap mounts in ⅞" x 1⅛" hole
Orange lens 16 amp contact $1.50

TOLL FREE ORDERS
• 1-800-826-5432
(IN CA: 1-800-258-6666)
INFO • (213) 380-8000
TWX - 5101010163 ALL ELECTRONIC

• QUANTITIES LIMITED
• MINIMUM ORDER $10.00
• USA $3.00 SHIPPING
NO C.O.D.!
• FOREIGN ORDERS INCLUDE SUFFICIENT SHIPPING
• CALIF. RES. ADD 6 1/2

MINI-PUSH BUTTON
S.P.S.T momentary normally open ¼" bushing
Red button 35¢ each 10 for $3.00

CIRCLE 17 ON FREE INFORMATION CARD

Logic Signal Measurements *(from page 21)*

within circuit amplitude limits, beware of overshoot. Momentary hard saturation caused by pulse overshoot can still extend device storage time.

Overshoot can do even worse things to voltage-sensitive devices. Perhaps you'll have the opportunity to experiment with high-speed CMOS devices. The tendency here is to tweak circuits for the highest slew rate (risetime) pulses possible as part of milking more speed out of the circuit. But fast slew rates often cause overshoot. In CMOS circuits, exceeding logic swing limits with overshoot can result in latchup, which causes the circuit to burn out.

Triggering Tricks

Making any of the above measurements or waveform observations presumes you can get the digital signal displayed on the scope screen. Sometimes that's easy. Sometimes it's not.

When problems arise, it's generally because a stably triggered display cannot be achieved. Signal noise or jitter are causing the trigger point to jump around on the signal. Thus, the signal jumps around on the display.

Most triggering problems can be solved if the scope has some reject modes provided in the triggering section. For example, display drift caused by 60-Hz interference from lights can be eliminated by using a low-frequency reject mode. A high-frequency reject mode is useful for eliminating interference from local radio stations. A noise reject mode emphasizes the peak-to-peak amplitude of the signal coupled to the triggering circuit and improves triggering on signals in the presence of electrical noise.

If your scope does not have these convenience features, you can sometimes emulate them with external filtering. For example, if 60-Hz interference is bothering your measurements, you can build a 60-Hz filter and use it at the channel-1 scope input. You'll need to set the scope for a dual-trace display with triggering on channel 1 and the unfiltered version of the signal fed to channel 2. The filtered channel-1 waveform serves only as a triggering device, and actual measurements must be done on the channel-2 display of the unfiltered version of the waveform.

Such external filtering for a stable trigger signal can get you by in some cases. But it does require building a special filter for your particular needs. It also uses up one of your scope inputs just for triggering purposes. For more widespread measurement needs, it is far more convenient to have a selection of measurement modes and triggering features built into the scope. This allows you to spend more time on your project and less time fiddling with the scope.

** 2 CENTS PLAIN **

That's about all it costs subscribers for each page of editorial matter in ***MODERN ELECTRONICS . . .*** every month. No charge for informative advertisers' messages. Or for free information requested on our bound-in postpaid Free Information Service card.

A bargain? You bet! ***MODERN ELECTRONICS*** is a veritable one-stop source of "hard" information for enthusiasts whose interests spread across the entire spectrum of electronics and computers for work and play. The latest technical information and news written by a galaxy of authoritative writers—Forrest Mims on "Experimenting," Don Lancaster on "Hardware Hacking," Stan Prentiss on "Video," Len Feldman on "Audio," Glenn Hauser on "Communications," and Eric Grevstad on "Personal Computers," to name a few authors who share their specialized experiences with readers every month.

This neat package keeps everyone abreast of the important developments in electronics and computers. From new devices and circuits to useful construction projects to evaluations of the latest products. Both "how to do" and "how it works" information increases your technical competence every page of the way. Two cents a shot. And hands-on product evaluations make you a wiser buyer, whether it's on a test instrument or a video recorder. So whether you're a service technician, an engineer, a budding one in a technical career path, or an active electronics enthusiast, ***MODERN ELECTRONICS*** will serve you well. Subscribe and be sure to get every information-packed issue delivered to you every month. It's important reading you can't afford to miss!

Just fill out the coupon and mail with your check, money order or credit-card information (Visa or MasterCard) to enter your subscription. Do it today to ensure earliest delivery!

MODERN ELECTRONICS
76 North Broadway, Hicksville, NY 11801

Please send me Modern Electronics for ☐ 3 Years ☐ 2 Years ☐ 1 Year

Name ______________________

Street ______________________

City ______________________

State ______________ Zip __________

Charge My Order To: Payment Enclosed $ __________

☐ MasterCard — **3 Years (36 issues) . . . . $48.00** ☐

2 Years (24 issues) . . . . $33.00 ☐

☐ VISA — **1 Year (12 issues) . . . . $17.97** ☐

Account Number

[ ] - [ ] - [ ] - [ ]

MODERN ELECTRONICS

76 N. Broadway, Hicksville, NY 11801

FREE INFORMATION SERVICE

For further information on products, dealers, or literature in this issue, circle the appropriate numbers below. Be sure to include your name and address before mailing.

1	2	3	4	5	6	7	8	9	10	11	12
13	14	15	16	17	18	19	20	21	22	23	24
25	26	27	28	29	30	31	32	33	34	35	36
37	38	39	40	41	42	43	44	45	46	47	48
49	50	51	52	53	54	55	56	57	58	59	60
61	62	63	64	65	66	67	68	69	70	71	72
73	74	75	76	77	78	79	80	81	82	83	84
85	86	87	88	89	90	91	92	93	94	95	96
97	98	99	100	101	102	103	104	105	106	107	108
109	110	111	112	113	114	115	116	117	118	119	120
121	122	123	124	125	126	127	128	129	130	131	132
133	134	135	136	137	138	139	140	141	142	143	144
145	146	147	148	149	150	151	152	153	154	155	156
157	158	159	160	161	162	163	164	165	166	167	168
169	170	171	172	173	174	175	176	177	178	179	180

Insert issue date here ______ ______
(month) (year)
(must be completed to process)

Name ______________________

Company Name ______________________

Address ______________________

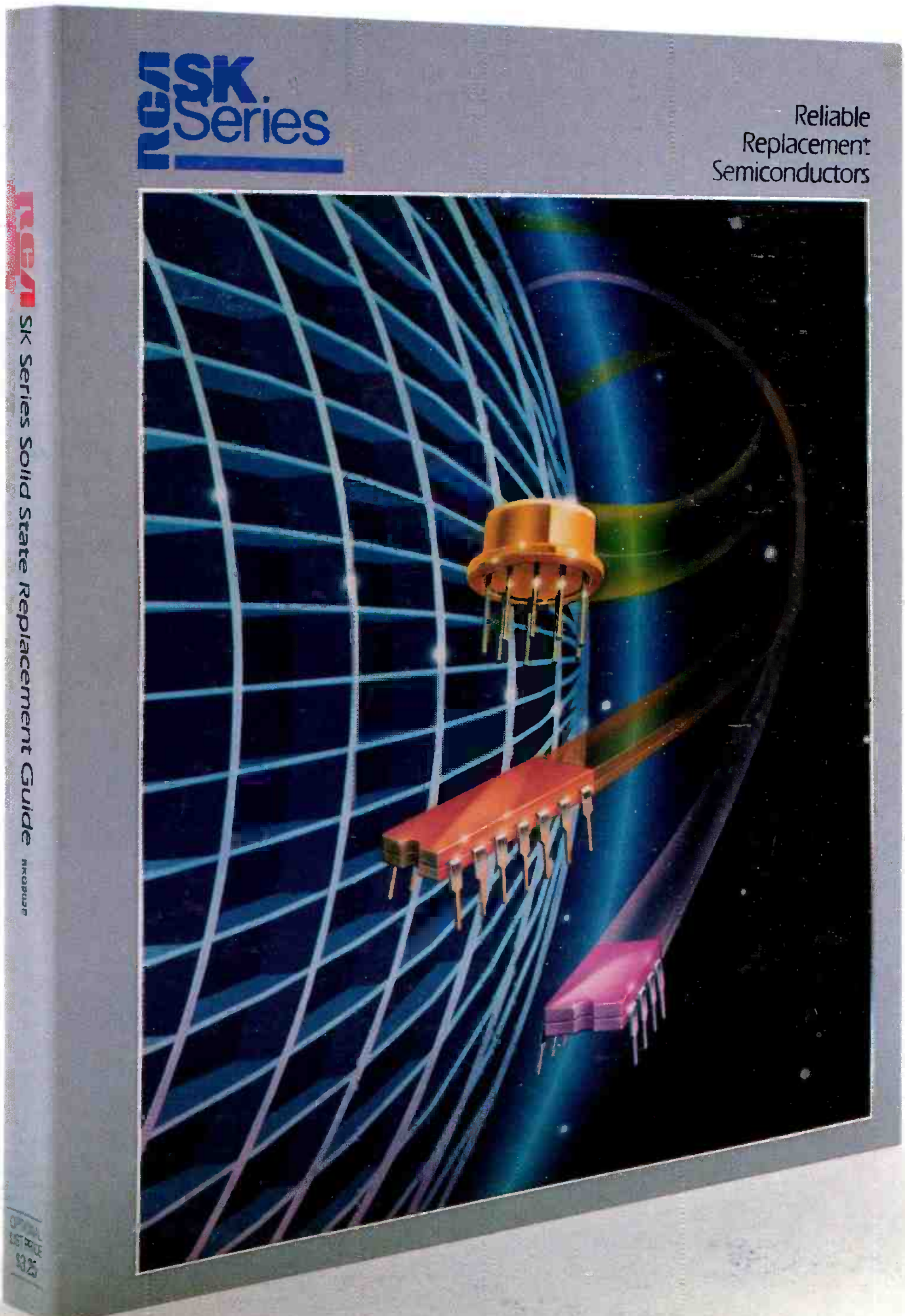
City ______________ **State** __________ **Zip** ________

Phone ______________________

USE YOUR FREE INFORMATION CARD

ADVERTISERS' INDEX

INTRODUCING THE REPLACEMENT FOR OUR REPLACEMENT GUIDE.



RCA's new SK Guide gives you fast, accurate solid state replacements.

In the world of semiconductor replacements, no one outperforms RCA's engineering excellence. We're in the business of manufacturing semiconductors, so you can depend on our reliability.

Our new, expanded RCA SK Guide to Reliable Replacement Semiconductors lists more than 2,900 SK and KH types that replace over 214,000 industry types. And, for the first time, QMOS logic devices and an extensive line of RF types are included.

The new RCA SK Replacement Guide (SKG202E). It's the only solid state replacement source you need. For a copy, see your RCA SK Distributor. Or mail a check or money order for $3.25 to RCA Distributor and Special Products Division, Box 597, Woodbury, New Jersey 08096-2088.

RCA SK Replacement Solid State

CIRCLE NO. 138 ON FREE INFORMATION CARD