Popular Electronics®

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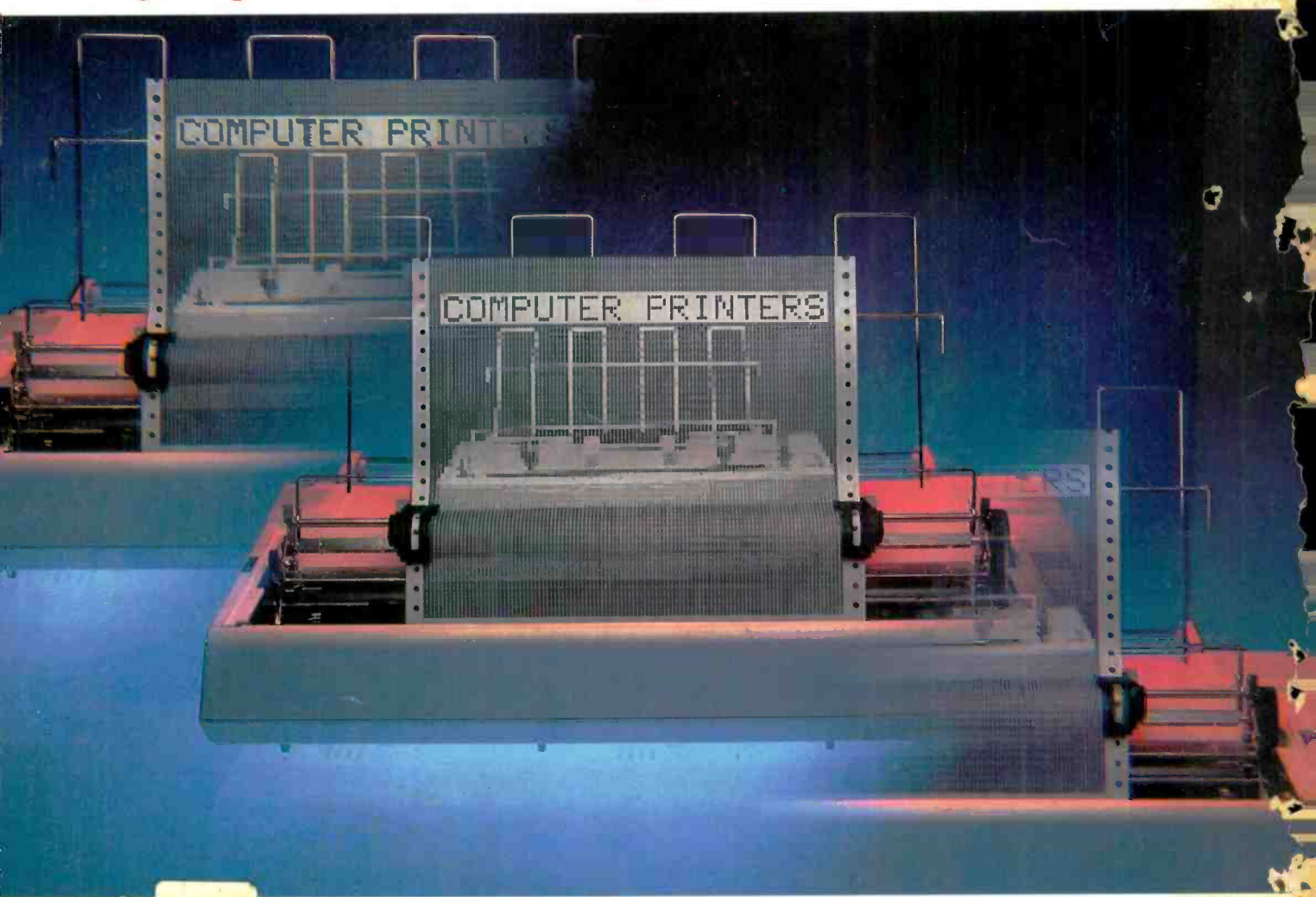
THE ELECTRONIC WORLD

Enhancing Stereo Sound with Signal Processors

Portables for all Electronic Tastes:

ZENITH'S 5" TV/AM-FM COMBO • MICROTAPE MACHINES FOR MUSIC • SINCLAIR'S NEW 12-Oz. ZX81 MICROCOMPUTER

Buying Guide to Computer Printers



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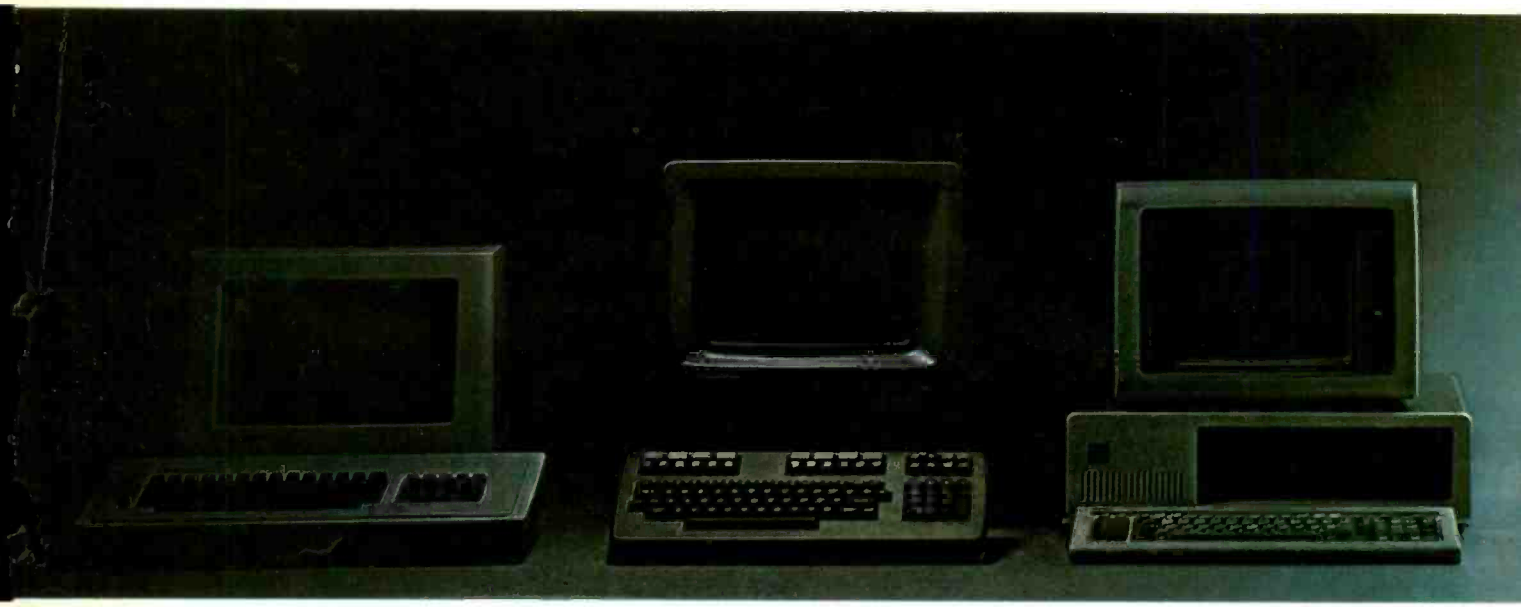
Heath IO-4550 Dual-Trace Oscilloscope

NOW THAT YOU
FIRST GEN
TAKE A LOOK



Welcome to a tour of the biggest Apple.

The Apple® III Personal Computer—the most powerful machine in its class.

Because it's the only personal computer that lets you add up to 256K RAM, hang on a full complement of peripherals, and still have four expansion slots left for future growth. (Unlike some micros which become woefully "slot-bound" when upgraded to maximum memory.)

Because it's the only machine now using 64K RAM chips to keep 256K tidy on a single board.

And because it's the only machine that gives you the help of SOS.

THE MOST SOPHISTICATED OS.

SOS is the Apple III's Sophisticated Operating System, an elegant software interface that frees you from most system control tasks. It features a hierarchical file system, device- and user-level interrupt capabilities, a device-independent file system and memory management capability.

Since all Apple III languages use SOS, they share a common disk format. So Apple III programs can merge and communicate—a Pascal application program can directly access a BASIC text file, for example.

Xerox 820	Hewlett-Packard 125—Model 10	IBM Personal Computer	Apple III
Standard Memory			
64K	64K	64K	128K
*Maximum Memory when fully configured**			
64K	64K	192K	256K
Expandability			
No expansion slots	No expansion slots	No extra expansion slots in fully configured* 192K system	4 extra expansion slots in fully configured 256K system*
Diskette Storage (per drive)			
92K	256K	160K	140K
Mass Storage (per drive)			
—	1.16 megabyte Floppy Disk	—	5 megabyte Hard Disk
Display Graphics Capability			
High resolution B/W	High resolution B/W	High resolution B/W or 4-color (color requires additional card)	High resolution B/W or 16-color
Software Available			
Word Processing Super Calc® — Communications — CP/M® library	Word Processing VisiCalc® 125 Business Graphics Communications — CP/M® library	Word Processing VisiCalc® — Communications — CP/M® 86 programs	Word Processing VisiCalc® III Business Graphics Communications Apple II software library CP/M® library (available Spring, 1982)

*"Fully configured" means system includes, at minimum, monitor, printer, 2-disk drives and RS-232 communicator. NOTE: Chart based on manufacturer's information available as of December, 1981.

VE SEEN THEIR ERATION AT OUR THIRD.

SOS allocates system resources to make the most of dynamic memory, simplifies programming with standard device and file interfaces for all languages, and speeds software development by reducing program size and complexity.

OUR NEW PROFILE.

ProFile™ is Apple's new personal mass storage system—a quick, quiet 5MB hard disk ideal for software development or any mass storage application. Shown above twixt monitor and console, it comes with everything you need to get up and running, including interface card and driver software.

The III's standard built-in drive is a 140-K floppy that can be daisy-chained with three additional drives through a back panel connector. Which leaves you plenty of expansion slots for things like our new Universal Parallel Interface Card or our OEM Prototyping Card.

CHANGE KEYS.

The 128-character ASCII-encoded keyboard happens to be fully-programmable. So you can (with SOS) do neat things like remap it into DVORK. Or create armies of special function keys. Or teach your Apple to write Chinese.

Its own languages already include Business BASIC, UCSD Pascal,™ Assembly and, soon, a powerful new COBOL—and, in emulation mode, most languages available for Apple II.

Look up from the keyboard and you'll see our standard Monitor III green phosphor display (80 char. x 24 lines, u/l). It can show you some of the highest resolution graphics available—560 x 192 in 16 gray scales. Or choose a color monitor, and you could be seeing 16-color graphics in high 280 x 192 resolution.

HIT LIST.

We have a new edition of that monster hit, VisiCalc® with more modeling space than any other version. Plus AppleWriter III, a powerful new word processing package. Plus a new Business Graphics package. Plus a new Mail List Manager.

Plus a Pascal Utility Library that lets you take full advantage of all UCSD Pascal features.

Plus Access III—sophisticated smart terminal software to access mainframes with asynchronous communications up to 9600 bps.

Plus Apple II emulation to access that vast software library.

Plus, soon, a CP/M® card to access that other vast library.

Even with all this, the Apple III's potential remains essentially untapped.

So we're offering improved documentation, new programmer's aids, expert hotline counseling and an open channel to the industry leader in software publishing. Us.

See your Apple dealer for more information and, perhaps, a little comparison shopping.

We're sure you'll find that between our third generation and their first, there's quite a gap.

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MARCH 1982 VOLUME 20, NUMBER 3

Popular Electronics

WORLD'S LARGEST-SELLING ELECTRONICS MAGAZINE

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 Popular Electronics (ISSN 0032-4485) March 1982, Volume 20, Number 3. Published monthly by Ziff-Davis Publishing Co., at One Park Ave., New York, NY 10016. Richard P. Friese, President; Selwyn Taubman, Treasurer; Bertram A. Abrams, Secretary. One year subscription rate for U.S. and Possessions, $15.00; Canada, $20.00; all other countries, $23.00 (cash orders only, payable in U.S. currency). Second Class Postage Paid at New York, N.Y. 10016 and at additional mailing offices. Authorized as second class mail by the Post Office Dept., Ottawa, Canada, and for payment of postage in cash. POPULAR ELECTRONICS including ELECTRONICS WORLD, Trade Mark Registered. Indexed in the Reader's Guide to Periodical Literature. Ziff-Davis also publishes Boating, Car and Driver, Cycle, Flying, Popular Photography, Skiing, Stereo Review, Electronic Experimenter's Handbook, and Tape Recording & Buying Guide. Forms 3579 and all Subscription Correspondence: POPULAR ELECTRONICS, Circulation Dept. P.O. Box 2774, Boulder, CO 80302. Please allow at least eight weeks for change of address, enclosing, if possible, an address label from a recent issue. Permissions.

The $149.95 personal computer.

Introducing the Sinclair ZX81

If you're ever going to buy a personal computer, now is the time to do it.

The new Sinclair ZX81 is the most powerful, yet easy-to-use computer ever offered for anywhere near the price: only $149.95* completely assembled.

Don't let the price fool you. The ZX81 has just about everything you could ask for in a personal computer.

A breakthrough in personal computers

The ZX81 is a major advance over the original Sinclair ZX80—the world's largest selling personal computer and the first for under $200.

In fact, the ZX81's new 8K Extended BASIC offers features found only on computers costing two or three times as much.

Just look at what you get:

- Continuous display, including moving graphics
- Multi-dimensional string and numerical arrays
- Mathematical and scientific functions accurate to 8 decimal places
- Unique one-touch entry of key words like PRINT, RUN and LIST
- Automatic syntax error detection and easy editing
- Randomize function useful for both games and serious applications
- Built-in interface for ZX Printer
- 1K of memory expandable to 16K

The ZX81 is also very convenient to use. It hooks up to any television set to produce a clear 32-column by 24-line display. And you can use a regular cassette recorder to store and recall programs by name.

*Plus shipping and handling. Price includes connectors for TV and cassette, AC adaptor, and FREE manual.

If you already own a ZX80

The 8K Extended BASIC chip used in the ZX81 is available as a plug-in replacement for your ZX80 for only $39.95, plus shipping and handling—complete with new keyboard overlay and the ZX81 manual.

So in just a few minutes, with no special skills or tools required, you can upgrade your ZX80 to have all the powerful features of the ZX81. (You'll have everything except continuous display, but you can still use the PAUSE and SCROLL commands to get moving graphics.)

With the 8K BASIC chip, your ZX80 will also be equipped to use the ZX Printer and Sinclair software.

Order at no risk**

We'll give you 10 days to try out the ZX81. If you're not completely satisfied, just return it to Sinclair Research and we'll give you a full refund.

And if you have a problem with your ZX81, send it to Sinclair Research within 90 days and we'll repair or replace it at no charge.

**Does not apply to ZX81 kits.

NEW SOFTWARE: Sinclair has published pre-recorded programs on cassettes for your ZX81, or ZX80 with 8K BASIC. We're constantly coming out with new programs, so we'll send you our latest software catalog with your computer.

ZX PRINTER: The Sinclair ZX Printer will work with your ZX81, or ZX80 with 8K BASIC. It will be available in the near future and will cost less than $100.

16K MEMORY MODULE: Like any powerful, full fledged computer, the ZX81 is expandable. Sinclair's 16K memory module plugs right onto the back of your ZX81 (or ZX80, with or without 8K BASIC). Cost is $99.95, plus shipping and handling.

ZX81 MANUAL: The ZX81 comes with a comprehensive 164-page programming guide and operating manual designed for both beginners and experienced computer users. A $10.95 value, it's yours free with the ZX81.

The $99.95 personal computer.

Introducing the ZX81 kit

If you really want to save money, and you enjoy building electronic kits, you can order the ZX81 in kit form for the incredible price of just $99.95†. It's the same, full-featured computer, only you put it together yourself. We'll send complete, easy-to-follow instructions on how you can assemble your ZX81 in just a few hours. All you have to supply is the soldering iron.

How to order

Sinclair Research is the world's largest manufacturer of personal computers.

The ZX81 represents the latest technology in microelectronics, and it picks up right where the ZX80 left off. Thousands are selling every week.

We urge you to place your order for the new ZX81 today. The sooner you order, the sooner you can start enjoying your own computer.

To order, simply call our toll free number, and use your MasterCard or VISA.

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CALL 800-543-3000. Ask for operator #509. In Ohio call 800-582-1364. In Canada call 513-729-4300. Ask for operator #509. Phones open 24 hours a day, 7 days a week. Have your MasterCard or VISA ready.

These numbers are for orders only. For information, you must write to Sinclair Research Ltd., 2 Sinclair Plaza, Nashua, NH 03061.

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ZX81	$149.95		
ZX81 Kit	99.95		
8K BASIC chip (for ZX80)	39.95		
16K Memory Module (for ZX81 or ZX80)	99.95		
Shipping and Handling	4.95		$4.95
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EDITORIAL

Whose Time Has Come?

Hindsight is marvelous. But how many people can recognize a development whose time has come when it's only in the embryonic marketing state? Western Union didn't when it had a chance to get Alexander Bell's telephone. After all, the telegraph was master, wasn't it? At one time, IBM and Remington Rand ignored computers that didn't fill whole rooms. So two engineers from MIT started a minicomputer company called Digital Equipment Corp., in which a venture capitalist invested $70,000 for 78% ownership. (DEC registered over $3-billion in sales in 1981.)

What's on the horizon that will make inroads into our technological industry? Perhaps it will be fiber optics. It's only a $65-million business now, but it's been predicted that it will hit close to $1-billion by 1990.

How about microcassette car audio systems? It's not here now, but Matsushita Electric, parent company of Panasonic, Technics, and Quasar, will be marketing it in Japan next year.

Will video-game parlors give way to computer parlors? Or will some far-sighted computer company open non-selling computer centers in key cities to spread the gospel? It would not be a completely magnanimous gesture to do so if the company already has a substantial share of the market; creating a larger pool of buyers would benefit the company if it maintained only its present share.

If this sounds far fetched, you should know that Hitachi, Ltd. opened up a "mycom" (the Japanese shorthand name for a microcomputer) center called GAIN in the Akihabara section of Tokyo in 1977. It's a favorite hangout for teenagers, and has working micros equipped for all levels of computer literacy, including instructing newcomers. The center, with 10 a.m. to 7 p.m. hours, has 500 to 600 visitors a day.

With desktop computers perhaps sounding a death knell for intelligent terminals, or so it seems, will companies leap-frog to 32-bit CPUs instead of moving from 8-bit to 16-bit machines? Motorola's 68000 16/32-bit CPU is pointing the way. Even though software hasn't caught up to 16-bitters yet, the future of super-number crunchers with Unix or Unix look-alike operating systems for 32-bit micros seems bright. To draw an analogy, the U.S. could have moved more quickly past the A-bomb once it was developed to a thermonuclear device since the latter was to be its strategic successor anyway. Dr. Edward Teller was indeed chomping at the bit in an effort to do so, but the more idealistic and charismatic Dr. J. Robert Oppenheimer won the day. (The only reason the U.S. did move forward with dispatch about four years later was due to the Soviet Union detonating its first super bomb, a half-year before us.)

High-resolution TV, with 1150 lines, is a reality today. One hangup is standards. Will the world settle on 1150 or will countries follow the path taken for standard TV, which has a few different systems? Furthermore, will stereo-TV sound systems be available in the U.S. as they are in Japan? I understand that a different system is being toyed with here.

And finally, will digital very-large-scale ICs (VLSI) be used to advantage to bring us digital TV receivers? The technology is already here, and it would mean lower manufacturing costs, better TV performance, and an extension of these advantages to video cassette recorders (digital, of course). ICs for this purpose have already been fabricated in West Germany by the ITT Semiconductors Group, with a sampling kit of six VLSI and two LSI chips reportedly available. Which TV maker will pick up the gauntlet?

Art Salsberg

Popular Electronics

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Radio Shack - The Leader in Small Business Computers Also Has Computers for Your Home!

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Radio Shack now offers disk drives for our popular TRS-80 Color Computer. Now you can have superb high-resolution color graphics and fast, "on-line" access to large amounts of data.

Only $1198 for a 1-Drive System. Our new $599 disk drive makes our TRS-80 Color Computer—complete with 16,000 characters (16K) of internal memory and Extended Color BASIC language—a versatile, **low-cost** computing system that's ready to attach to your own TV receiver.

Stores 156,000 Characters! Just plug in the Program Pak™ controller to add disk storage to the Color Computer. The Disk Operating System is completely contained in the Program Pak, so you get a full 156K-bytes of on-line storage. The Program Pak also includes Color Disk BASIC—an enhanced version of the Color Computer's programming language.

Easy to Use. The 16K TRS-80 Color Computer lets you create sophisticated color diagrams, business charts and even simple animation—using just a few simple one-line commands! This gives experienced programmers **incredible power**, yet makes it easy for beginners, too. We take you from the ground up with over 500 pages of easy-to-read documentation.

Instant Fun and Games. And just for fun, you can also use any of our plug-in game cartridges. Battle starships in outer space, conquer dinosaurs from a prehistoric world, or just brush up on your chess.

Expandable, too. Your TRS-80 Color Computer Disk System can expand with up to four drives for over **626,000** characters of storage! And the additional drives are only $399 each. Add up to 16K more memory, a printer and other accessories anytime.

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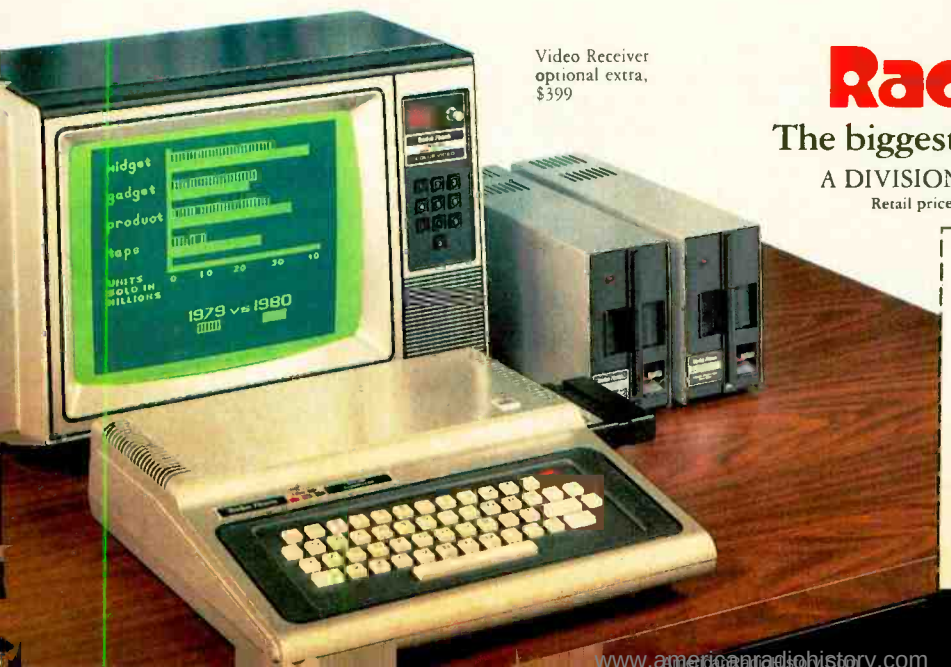

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ZIP PHONE

LETTERS

A Vote for the Current Convention

I was extremely pleased to see, in his first "Fundamental Facts" column (December 1981), that Walter Buchsbaum used conventional "positive current" notation in choosing the directions of the branch and loop currents in his analyses. The matter of current convention is of concern to me because it is so fundamental to the way a person learns to conceptualize circuit operation (as opposed to using electron flow). A great many schools train electronic technicians to use the electron-flow idea. One of the most frustrating consequences of this arises when an engineer and a technician, both of somewhat limited experience, sit down to analyze a circuit and each concludes the other is ignorant of basic circuit functions.—*Lucias B. Day, Jr., Lakewood, CO.*

Automatic Dialer Erratum

Enjoyed your article on automatic telephone dialers in the February issue. I note, however, that there are some errors in the Table for Webcor's ZIP 757. The following features were omitted: redials number automatically when there's a busy signal, and has programmable chained memory locations for automatic redialing of MCI and SPRING systems. Also, the suggested retail price is $129.95, not $150.00.—*Nancy S. Joseph, Webcor Electronics, Inc., Plainview, NY.*

Liquid-Crystal Displays

The December "Solid-State Developments" column showed how to generate the 30-Hz ac needed to drive an LCD using two gates of a CD4011. I have experimented with this and similar circuits for the same purpose and found some startling differences in current consumption. If the old CD4011A is used, it will draw as much as 9 mA. Either of the newer CD4011B or CD4011C units draws only 3 mA. The same circuit using a CD4093 Schmitt trigger NAND gate will draw only 0.3 mA. And a CD4047 low-power oscillator pulls only 0.05 mA. Also, the latter contains a flip-flop to produce the perfect 50% duty-cycle square wave needed to avoid the destruction of the LCD display. With this circuit, it is possible to build CMOS-LCD circuits with a battery life of thousands of hours.—*D. J. Salomon, Montreal, Can.*

Computer Language Popular

Your last article on computer language (December 1981) was great for me. I am a draftsman in an electrical engineering firm, and I noticed that the computer engineers in our company kept the article for about three weeks when it first came out.—*R. M. Holberg, Lansing, MI.*

Source for PC Boards

I read with great interest the article, "Electronic Bass Boost for Woofers," in your November 1981 issue. Unfortunately, no pc board pattern was published and since I have limited ability in setting up a circuit board, I am at a disadvantage when it comes to building such a project. Please publish pc board patterns as often as is practically possible, or list a source where such a board can be obtained at a reasonable cost.—*S. B. Roy, Boston, MA.*

As stated in the article, this circuit was simple enough that we felt most readers would prefer to construct it on perf board. A pc board could, of course, be designed; but in this case it would not be practical for us to find a source for the board (which we normally do for projects of sufficient complexity).—Ed.

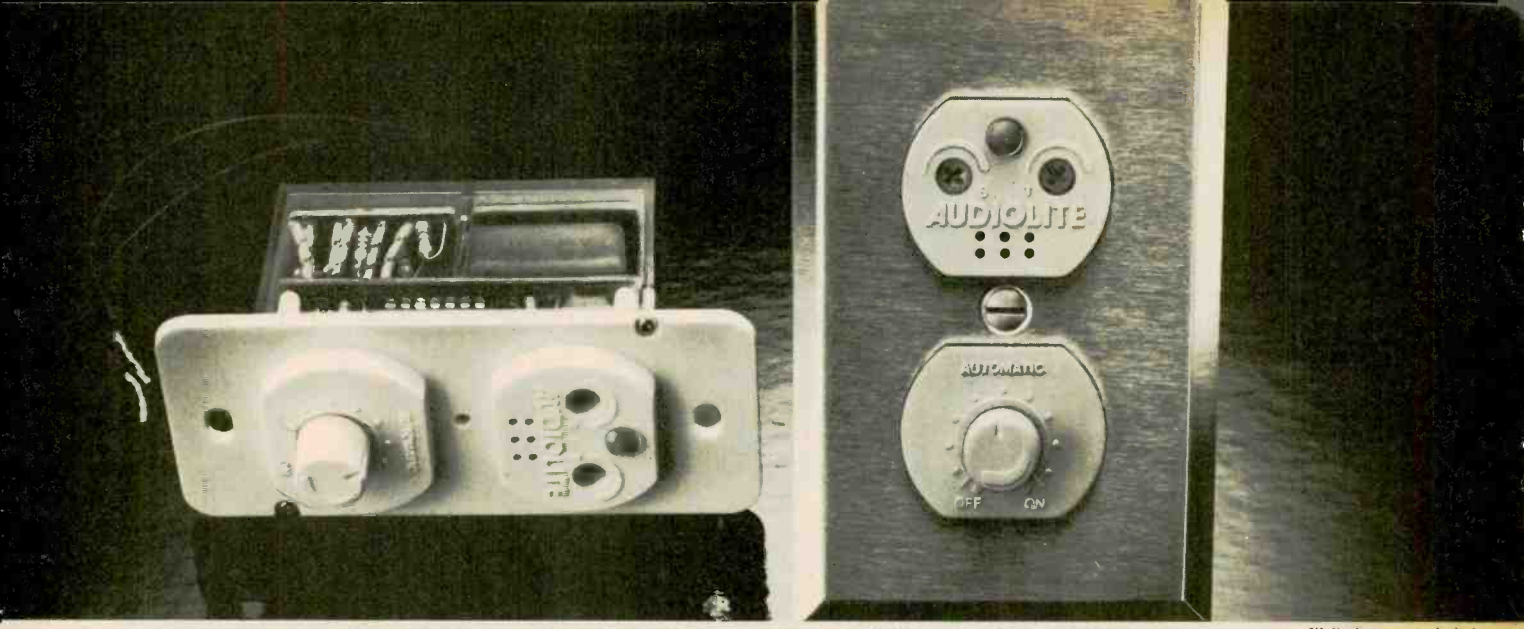
OUT OF TUNE

In "Build a Diode Temperature Probe" (February 1981), the value of *R2* to give Celsius readings should be 120 kilohms in the Parts List, as it is on the schematic. Also, in the schematic, the bottom of the bridge should be connected to the negative side of 1.35 V.

In "Electronic Bass Boost for Woofers" (November 1981), in the schematic, the lower end of *R5* should be connected to the circuit ground instead of the negative supply.

In "Fundamental Facts" for December 1981 ("The Basic Network Laws"), in Fig. 3, *R1* should have been given as 27 kilohms, not 2.7. This results in a base bias of 1.7 V, and collector and emitter voltages of 2 and 1 V respectively. The collector current is then 10 mA, base current is 0.13 mA and emitter current is 10.13 mA.

In "Add a Safe, Convenient Shutoff to Smoke Detectors" (January 1982), *LED1* is shown in the schematic with its polarity reversed.



Wall plate not included.

NEWEST THIEF STOPPER. A LIGHT SWITCH WITH EARS.

Imagine entering a darkened room that lights up at the sound of your footsteps. A room that's also 'smart' enough to flick off lights when it's empty.

Imagine too, an intruder attempting to pry open your window at midnight. Suddenly, room lights are ablaze, frightening him off—and your home and family remain untouched.

And who's your fearless protector? A light switch named AudioLite.

An invention that offers security and remote convenience straight from the pages of science fiction.

A slave to your every move.

AudioLite is also a wall switch you never have to touch—because it's sound activated. It turns on lights the second someone enters a room and turns them off when they leave (works outside too—in driveways, patios, porches).

How much sound does it take? You can adjust AudioLite's sound sensor to precisely any level. At high sensitivity even the clicking of a key in a lock or the opening of a door will turn on the lights. You can also lower its sensitivity so an extremely loud verbal command or noise will be required. Or choose an infinite number of adjustments in between.

Once activated, lights remain on for the time duration you set, anywhere from 7 seconds to 7 minutes.

Don't worry about lights going off when you need them. Each time AudioLite hears a new sound, it resets and begins counting over—keeping lights on without interruption. For quiet reading, simply use the manual On/Off override. Easily adjustable timer and sensitivity controls are recessed and child proof.

Save money in more ways than you'd think.

Hall lights usually left on for hours are now on only when you need them. Likewise bathrooms, closets, garages and patios. You'll find about half the light usage in such areas is saved—lowering your utility bill accordingly.

Because AudioLite is also a full range dimmer, you use exactly the amount of light you need—as well as extend bulb life by 15 times or more.

And you needn't turn AudioLite off during the day—a daylight-sensitive photocell assures no unnecessary lights get turned on during daytime hours.

Turn on lights with the snap of your fingers—even the creaking of your footsteps.

Magic that won't fade.

From the first snap of your fingers, AudioLite will be a constant source of amazement to you and your friends. And because it's solid state electronics—with few moving parts to wear out—it will outlast conventional light switches by many years. Its microcomputer circuitry is so reliable there's a one year total replacement warranty: should anything go wrong, the manufacturer will send you a new one, free of charge. After a year, prompt service is available by mail—but it's unlikely you'll ever need it.

AudioLite replaces your present light switch in minutes. All you need is a screwdriver. Works with any incandescent bulb up to 300 watts.

As soon as you try one, you'll want to replace all your conventional wall switches with AudioLite. That's why there's a special price if you order four at a time—$99. (For one only, the price is $34.)

However, you may order four on trial. If not perfectly satisfied after trying one, return them all within 30 days for a prompt, courteous refund. You're protected by The Sharper Image guarantee of satisfaction.

Call now toll-free, and protect your home with this newest brainchild of remote control technology. Be among the first to own a light switch with ears, eyes and brains.

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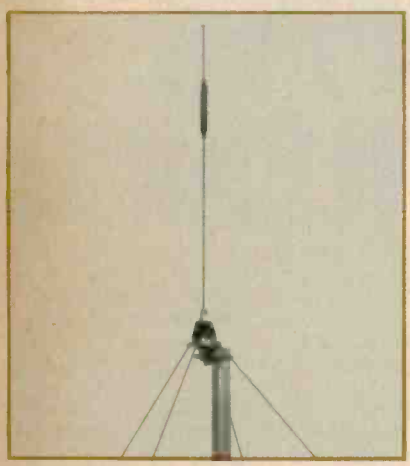
Additional information on new products covered in this section is available from the manufacturers. Either circle the item's code number on the Free Information Card or write to the manufacturer at the address given.

Lightweight Base Antenna



The MON-38 rooftop antenna from the Antenna Specialists Co. covers all of the popular scanner low-band, vhf, uhf, and T-band frequencies. The antenna weighs 1 lb and is said to be simple to assemble and install—mounting on any pipe or tubing up to 1¼" dia. The MON-38 terminates in an SO-239 recepticle (cable not provided). $20.95.

CIRCLE NO. 88 ON FREE INFORMATION CARD

Tubeless TV Camera

Hitachi has introduced what it claims is the first solid-state color video camera for the consumer market. Called the VK-C1000, the camera uses a single-chip CCD MOS image sensor instead of a vidicon tube. The system also features four additive complementary color filters, NTSC compatibility, internal sync, and an f 1.4 C-mount lens with automatic iris and 6X zoom capability. Also, a unidirectional (up to 30° to either side of the camera), boom-type electret condenser microphone; and a 1½" black-and-white electronic viewfinder. The CCD image sensor is said to eliminate the light-lag and burn-in that often result when a video camera is pointed at a bright light, i.e., exposure response is almost instantaneous. The on-wafer color filters are claimed to achieve high resolution (260 horizontal lines) while suppressing fixed-pattern noise. Other specs: video S/N, 46 dB; sensitivity, 100–100,000 lux; mic input, −67 dB; power requirement, 12 V dc; power consumption, 5.3 W; dimensions, 2½" x 4½" x 6" without viewfinder or lens; weight, 3.96 lb. The VK-C1000 is compatible with all VCRs. $2000.

CIRCLE NO. 91 ON FREE INFORMATION CARD

Digital Tuner

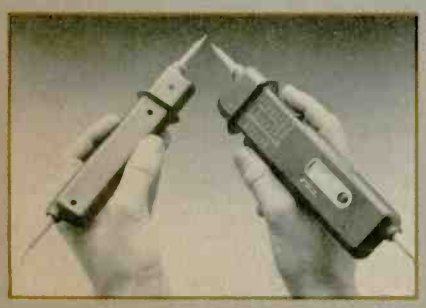
The GFT-1 AM/FM digitally synthesized quartz tuner from ADCOM is claimed to have a tuning accuracy of 0.00025%. It can program up to 12 stations (six AM; six FM) for instant retrieval. A five-stage LED indicates the strength of incoming signals. A built-in record oscillator delivers a 400-Hz test tone, at 50% FM modulation, for setting tape deck levels for off-the-air recordings. Additionally, the GFT-1 features a high-blend switch to reduce out-of-phase high-frequency noise, and a muting switch to suppress inter-station noise. Specs: THD, 0.22% (stereo at 1 kHz); S/N, 70 dB (stereo); alternate channel selectivity, 70 dB; antenna impedance, 75 or 300 ohms; power requirements, 17 W. $375.

CIRCLE NO. 87 ON FREE INFORMATION CARD

Color Printer

The Prism Printer from Integral Data Systems uses a four-band ribbon (cyan, magenta, yellow and black) to produce eight colors in a dot matrix format. The printer employs a nine-wire print head with two staggered rows of print needles for creating vertically overlapping dots in a single pass. Claimed to be well-suited for graphics, the unit features proportional spacing, horizontal and vertical tabbing, and reverse paper feed. Other capabilities: semi-automatic cut sheet feed, bold text printing, print densities of 10, 12, or 16.7 cpi, adjustable pitch for line lengths up to 220 columns on standard EDP paper, automatic text justification, and fine-positioning of characters to tolerances of 1/120 inch. Speed is selectable: In the high density mode (24 x 9 dots per character), the print rate is 150 cps; in the standard mode, over 200 cps. The Prism Printer uses the usual ASCII upper- and lower-case 96-character set. Up to four different such sets can reside in the unit at one time, for foreign language or custom character printing. Microprocessor controlled, the printer uses a standard RS-

Probe DMM



The 3½-digit hand-held multimeter from Steinel, called "Digi-Check," differs from other hand-held or pocket DMMs by utilizing two probe tips interconnected by one-meter cable. The probes, slightly longer than conventional test probes, contain the LCD display, range and function selector slide switches, NiCd storage batteries, and an integral battery charger. No other cables, clips, or test leads are said to be required. Five ac and dc voltage ranges cover potential from 200 mV to 500 V with a basic accuracy given as ±0.3% dc and ±1.0% ac. Resistance is measured in six ranges from 200 ohms to 20 megohms with an accuracy of ±0.5%. All ranges are protected against overload. A push-button memory permits the user to store a specific reading. The Digi-Check is claimed to have an operating life of 12 hours per charge. Recharging is accomplished from any ac outlet. $169.

CIRCLE NO. 89 ON FREE INFORMATION CARD

Save on Scanners! NEW Rebates!

Communications Electronics,™ the world's largest distributor of radio scanners, celebrates 1982 with big savings on *Bearcat* scanners. Electra Company, the manufacturers of *Bearcat* scanners is offering consumer rebates on their great line of scanners, when purchased between February 1 and March 15, 1982.

With your scanner, you can monitor the exciting two-way radio conversations of police and fire departments, intelligence agencies, mobile telephones, energy/oil exploration crews, and more. Some scanners can even monitor aircraft transmissions! You can actually hear the news *before* it's news. If you do not own a scanner for yourself, now's the time to buy your new scanner from **Communications Electronics**. Choose the scanner that's right for you, then call our *toll-free* number to place your order with your Visa or Master Card.

We give you excellent service because **CE** distributes more scanners worldwide than *anyone* else. Our warehouse facilities are equipped to process thousands of scanner orders every week. We also export scanners to over 300 countries and military installations. Almost all items are in **stock** for **quick shipment**, so if you're a person who prefers fact to fantasy and who needs to know what's *really* happening around you, order your scanner today from **CE**!

NEW! Bearcat® 350

The Ultimate Synthesized Scanner!

List price $599.95/**CE price $399.00/$50.00 rebate**
Your final cost is a low $349.00

7-Band, 50 Channel • Alpha-Numeric • No-crystal scanner • AM Aircraft and Public Service bands. • Priority Channel • AC/DC

Bands: 30-50, 118-136 AM, 144-174, 421-512 MHz.

The new *Bearcat* 350 introduces an incredible breakthrough in synthesized scanning: Alpha-Numeric Display. Push a button—and the Vacuum Fluorescent Display switches from "numeric" to word descriptions of what's being monitored. 50 channels in 5 banks. Plus, Auto & Manual Search, Search Direction, Limit & Count. Direct Channel Access. Selective Scan Delay. Dual Scan Speeds. Automatic Lockout. Automatic Squelch. Non-Volatile Memory. Order your *Bearcat* 350 today!

Bearcat® 300

List price $549.95/**CE price $349.00/$50.00 rebate**
Your final cost is a low $299.00

7-Band, 50 Channel • Service Search • No-crystal scanner • AM Aircraft and Public Service bands. • Priority Channel • AC/DC

Bands: 32-50, 118-136 AM, 144-174, 421-512 MHz.

The *Bearcat* 300 Is the most advanced automatic scanning radio that has ever been offered to the public. The *Bearcat* 300 uses a bright green fluorescent digital display, so it's ideal for mobile applications. The *Bearcat* 300 now has these added features: Service Search, Display Intensity Control, Hold Search and Resume Search keys, Separate Band keys to permit lock-in/lock-out of any band for more efficient service search.

NEW! Bearcat® 350

FREE Bearcat® Rebate Offer

Get a coupon good for a $50 rebate when you purchase a *Bearcat* 350 or 300; $25 rebate on model 250 or 20/20; $15 rebate on model 210XL; $10 rebate on model 160 or 4-6 Thin Scan. To get your rebate, mail rebate coupon with your original dated sales receipt and the *Bearcat* model number from the carton to Electra. You'll receive your rebate in four to six weeks. Offer valid only on purchases made betwen February 1, 1982 and March 15, 1982. All requests must be postmarked by March 31, 1982. Limit of one rebate per household. Coupon must accompany all rebate requests and may not be reproduced. Offer good only in the U.S.A. Void where taxed or prohibited by law. Resellers, companies, clubs and organizations–both profit and non-profit–are not eligible for rebates. Employees of Electra Company, their advertising agencies, distributors and retailers of *Bearcat* Scanners are also not eligible for rebates. Please be sure to send in the correct amount for your scanner. Pay the listed **CE** price in this ad. *Do not* deduct the rebate amount since your rebate will be sent directly to you from Electra. Orders received with insufficient payments will not be processed and will be returned. Offer subject to change without notice.

Bearcat® 250

List price $429.95/**CE price $279.00/$25.00 rebate**
Your final cost is a low $254.00

6-Band, 50 Channel • Crystalless • Searches Stores • Recalls • Digital clock • AC/DC Priority Channel • 3-Band • Count Feature.

Frequency range 32-50, 146-174, 420-512 MHz.

The *Bearcat* 250 performs any scanning function you could possibly want. With push button ease you can program up to 50 channels for automatic monitoring. Push another button and search for new frequencies. There are no crystals to limit what you want to hear. A special search feature of the *Bearcat* 250 actually stores 64 frequencies and recalls them, one at a time, at your convenience.

NEW! Bearcat® 20/20

List price $449.95/**CE price $289.00/$25.00 rebate**
Your final cost is a low $264.00

7-Band, 40 Channel • Crystalless • Searches AM Aircraft and Public Service bands • AC/DC Priority Channel • Direct Channel Access • Delay

Frequency range 32-50, 118-136 AM, 144-174, 420-512 MHz.

The *Bearcat* 20/20 automatic scanning radio replaces the *Bearcat* 220 and monitors 40 frequencies from 7 bands, including aircraft. A two-position switch, located on the front panel, allows monitoring of 20 channels at a time.

Bearcat® 210XL

List price $349.95/**CE price $229.00/$15.00 rebate**
Your final cost is a low $214.00

6-Band, 18 Channel • Crystalless • AC/DC

Frequency range: 32-50, 144-174, 421-512 MHz.

The *Bearcat* 210XL scanning radio is the second generation scanner that replaces the popular *Bearcat* 210 and 211. It has almost twice the scanning capacity of the *Bearcat* 210 with 18 channels plus dual scanning speeds and a bright green fluorescent display. Automatic search finds new frequencies. Features scan delay, single antenna, patented track tuning and more!

Bearcat® 160

List price $299.95/**CE price $194.00/$10.00 rebate**
Your final cost is a low $184.00

5-Band, 16 Channel • AC only • Priority Dual Scan Speeds • Direct Channel Access

Frequency range: 32-50, 144-174, 440-512 MHz.

The *Bearcat* 160 is the least expensive *Bearcat* crystalless scanner. Smooth keyboard. No buttons to punch. No knobs to turn. Instead, finger-tip pads provide control of *all* scanning operations.

NEW! Bearcat® 100

The first no-crystal programmable handheld scanner.

Allow 30-120 days for delivery after receipt of order due to the high demand for this product.

List price $449.95/**CE price $299.00**

8-Band, 16 Channel • Liquid Crystal Display Search • Limit • Hold • Lockout • AC/DC

Frequency range: 30-50, 138-174, 406-512 MHz.

The world's first no-crystal handheld scanner has compressed into a 3" x 7" x 1¼" case more scanning power than is found in many base or mobile scanners. The *Bearcat* 100 has a full 16 channels with frequency coverage that includes all public service bands (Low, High, UHF and "T" bands), the 2-Meter and 70 cm. Amateur bands, *plus* Military and Federal Government frequencies. It has chrome-plated keys for functions that are user controlled, such as lockout, manual and automatic scan. Even search is provided, both manual and automatic. Wow...what a scanner!

The *Bearcat* 100 produces audio power output of 300 milliwatts, is track-tuned and has selectivity of better than 50 dB down and sensitivity of 0.6 microvolts on VHF and 1.0 microvolts on UHF. Power consumption is kept extremely low by using a liquid crystal display and exclusive low power integrated circuits.

Included in our low **CE** price is a sturdy carrying case, earphone, battery charger/AC adapter, six AA ni-cad batteries and flexible antenna. For earliest delivery from CE, reserve your *Bearcat* 100 today.

TEST ANY SCANNER

Test any scanner purchased from **Communications Electronics™** for 31 days before you decide to keep it. If for any reason you are not completely satisfied, return it in original condition with all parts in 31 days, for a prompt refund (less shipping/handling charges and rebate credits).

CIRCLE NO. 1 ON FREE INFORMATION CARD

Bearcat® Four-Six ThinScan™

List price $189.95/**CE price $124.00/$10.00 rebate**
Your final cost is a low $114.00

Frequency range: 33-47, 152-164, 450-508 MHz.

The incredible, *Bearcat* Four-Six Thin Scan™ is like having an information center in your pocket. This four band, 6 channel crystal controlled scanner has patented Track Tuning on UHF. Scan Delay and Channel Lockout. Measures 2¾ x 6¼ x 1." Includes rubber ducky antenna. Order crystal certificate for each channel. Made in Japan.

Fanon Slimline 6-HLU

List price $169.95/**CE price $109.00**

Low cost 6-channel, 3-band scanner!

The *Fanon* Slimline 6-HLU gives you six channels of crystal controlled excitement. Unique Automatic Peak Tuning Circuit adjusts the receiver front end for maximum sensitivity across the entire UHF band. Individual channel lockout switches. Frequency range 30-50, 146-175 and 450-512 MHz. Size 2¾ x6¼ x 1." Includes rubber ducky antenna. If you *don't* need the UHF band, get the **Fanon model 6-HL** for $99.00 each, and save money. Same high performance and features as the model HLU without the UHF band. Order crystal certificates for each channel. Made in Japan.

OTHER SCANNERS & ACCESSORIES

NEW! **Regency† t D810 Scanner**	$319.00
NEW! **Rgency† D300 Scanner**	$219.00
NEW! **Regency† D100 Scanner**	$169.00
NEW! **Regency† H604 Scanner**	$129.00
Regency† M400 Scanner	$259.00
Regency† M100 Scanner	$199.00
Regency† R1040 Scanner	$149.00
SCMA-6 Fanon Mobile Adapter/Battery Charger	$49.00
CHB-6 Fanon AC Adapter/Battery Charger	$15.00
CAT-6 Fanon carrying case with belt clip	$15.00
AUC-3 Fanon auto lighter adapter/Battery Charger	$15.00
PSK-6 Base Power Supply/Bracket for SCMA-6	$20.00
SP50 *Bearcat* AC Adapter	$9.00
SP51 *Bearcat* Battery Charger	$9.00
SP58 *Bearcat* 4-6 ThinScan™ carrying case	$12.00
MA506 *Regency* carrying case for H604	$15.00
FB-E Frequency Directory for Eastern U.S.A.	$12.00
FB-W Frequency Directory for Western U.S.A.	$12.00
FFD Federal Frequency Directory for U.S.A.	$12.00
TSG "Top Secret" Registry of U.S. Government Freq.	$10.00
ASD Frequency Directory for Aircraft Band	$10.00
B-4 1 2 V AAA Ni-Cad batteries (set of four)	$9.00
A-135cc Crystal certificate	$3.00

Add $3.00 shipping for all *accessories* ordered at the same time.

INCREASED PERFORMANCE ANTENNAS

If you want the utmost in performance from your scanner, it is essential that you use an external antenna. We have six base and mobile antennas specifically designed for receiving all bands. Order **#A60** is a magnet mount mobile antenna. Order **#A61** is a gutter clip mobile antenna. Order **#A62** is a trunk-lip mobile antenna. Order **#A63** is a ¾ inch hole mount. Order **#A64** is a ⅜ inch snap-in mount, and **#A70** is an all band base station antenna. All antennas are $35.00 and $3.00 for UPS shipping in the continental United States.

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To ***get the fastest delivery from CE*** of any scanner, send or phone your order directly to our Scanner Distribution Center.™ Be sure to calculate your price using the CE prices in this ad. Michigan residents please add 4% sales tax. Written purchase orders are accepted from approved government agencies and most well rated firms at a 10% surcharge for net 10 billing. All sales are subject to availability, acceptance and verification. All sales on accessories are final. Prices, terms and specifications are subject to change without notice. Out of stock items will be placed on backorder automatically unless CE is instructed differently. Most products that we sell have a manufacturer's warranty. Free copies of warranties on these products are available prior to purchase by writing to CE. International orders are invited with a $20.00 surcharge for special handling *in addition* to shipping charges. All shipments are F.O.B. Ann Arbor, Michigan. No COD's please. Non-certified and foreign checks require bank clearance. Minimum order $35.00.

Mail orders to: **Communications Electronics,™** Box 1002, Ann Arbor, Michigan 48106 U.S.A. Add $7.00 per scanner or phone product for U.P.S. *ground* shipping and handling, or $14.00 for faster U.P.S. *air* shipping to some locations. If you have a Visa or Master Card, you may call anytime and place a credit card order. **Order toll free** in the U.S.A. Dial 800-521-4414. If you are outside the U.S. or in Michigan, dial 313-994-4444. **Dealer inquiries invited.** Order without obligation today!

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232C serial interface, as well as a Centronics-compatible parallel interface. Serial transmission rates from 300 to 9600 baud are switch selectable. $1995.

CIRCLE NO. 92 ON FREE INFORMATION CARD

Desktop Computer With Full Graphics

Northstar Computers has an integrated desktop stand-alone system offering minicomputer-grade graphics. Called the Advantage, it includes a 12″ display, two 5¼″ high-capacity floppy-disk drives, an 87-key Selectric-style keyboard, and a wide range of operating and applications software. The unit is built around a 4-MHz Z80A and 60K bytes of RAM. It features a 12″ bit-mapped CRT display that produces bar charts, pie diagrams, plotted graphics, and 3D visuals. It can be operated as a 1,920-character display (24 lines by 80 characters wide), or in a 240 × 640 pixel bit-mapped format. In addition to the double-sided, double-density floppy disks, the chassis contains six slots for plug-in options. Dimensions are 19″ × 20″ × 12½″. Weight is 43 lb. $3,999.

CIRCLE NO. 93 ON FREE INFORMATION CARD

Vacuum-Disc Turntable

The Luxman PD-300 is a double-insulated, two-speed, belt-driven turntable that uses a brushless, slotless dc servo motor. The unit features a system that literally vacuums the air from between the record and the high-inertia platter via grooves and a relief hole on the platter's surface; thereby, it is claimed, reducing wow and flutter (0.03%) and eliminating low-frequency rumble completely. A lever on the front of the turntable activates and deactivates the vacuum. The PD-300 has a unified chassis insulated with natural rubber from the cabinet. The legs, too, have sub-insulators. A stroboscopic quartz oscillator fine-tunes the platter, and a heavy arm-base, made of planed aluminum, is available as an option. S/N is given as 72 dB. The turntable weighs 39.9 lb. $1000.

CIRCLE NO. 94 ON FREE INFORMATION CARD

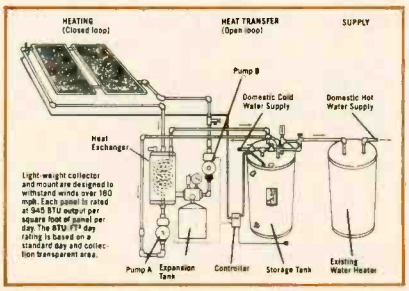
Car Equalizer

Radio Shack is offering a 40-W Graphic Equalizer/Booster, the Realistic Model 12-1864. The unit connects between the speakers and the output of most car stereos and tape players. It is claimed to boost

the power of an existing system by as much as 20 W/ch. The equalizer section is comprised of five audio bands centered around 60, 250, 1000, 3500, and 12,000 Hz. Each slide-action control provides a +12-dB adjustment. THD is given as 1% at 30 W. A front/rear fader control is included for four-speaker systems. Dimensions: 1¼″ x 5½″ x 6½″. $70.

CIRCLE NO. 95 ON FREE INFORMATION CARD

Solar Water Heater



Designed to augment your existing water heater, the NS-1100 from Heath is said to be able to save 50 to 80 percent of the hot water costs for an average home. Lightweight solar collectors (claimed to withstand winds over 180 mph and rated at 945 BTU per square foot of panel) mount on the roof, while the heat exchanger mounts on the outside of the water tank to reduce weight. The closed-loop system ensures that the working fluid does not contact the water being heated, i.e., the risk of freezing and corrosion is reduced. The NS-1100 is a kit whose assembly time is projected to be "from two to three weekends," according to Heath. The kit comes with the components needed for installation, except for the ¾″ copper pipe and insulation. Tax credits for purchasing the unit are available from the Federal Government and from many states. $2840.

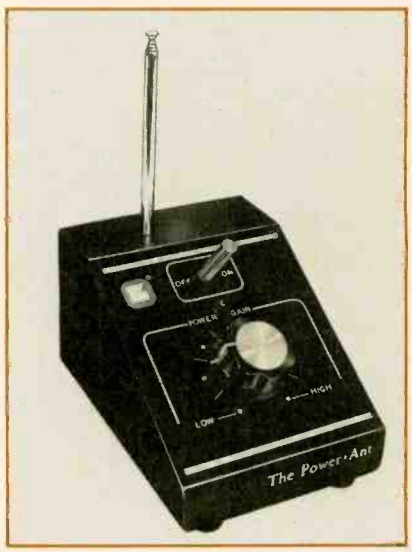
CIRCLE NO. 90 ON FREE INFORMATION CARD

Record Cleaner

The Allsop 3 Orbitrac Record Cleaning System uses a dual-disc cleaning action that is claimed to make record cleaning simple and thorough. According to the manufacturer, the cleaning pad's soft fibers align with the record grooves when the pivot arm is placed into the record spindle hole. The cleaning disc, attached via an internal bearing to a control disc, is spun around the record by the user. Thus, the cleaning pad remains in contact with the record grooves while the disc pivots freely with the motion of the user's hand. The Orbitrac comes with storage case, anti-static mat, convertible pivot point, solution spray dispenser bottle, and pad cleaning brush. $25.

CIRCLE NO. 96 ON FREE INFORMATION CARD

Scanner Gain Booster



The Power Ant from Grove Enterprises increases the gain from a scanner or shortwave antenna, and allows a user to vary the strength of the signal. Equipped with a telescoping whip, the unit may be used in conjunction with another antenna or in a stand-alone mode as the sole antenna for scanner and shortwave frequencies. The Power Ant is said to cover the entire spectrum between 30 and 960 MHz. A gain of 25 dB is claimed for low and high band, 15 dB at uhf, and 10 dB at 800 MHz. It is designed for mobile, portable, or base operation; housed in an all-metal cabinet; and weighs less than 1 lb. It comes with a 12 V dc/ac adapter, and all interconnecting cables.

CIRCLE NO. 97 ON FREE INFORMATION CARD

Logic Monitor

The LM-4, a 40-channel logic display designed to monitor up to 40 pins of a DIP IC, has been introduced by Global Specialties Corp. Compatible with any device using TTL or CMOS, the monitor has an LCD screen that is said to instantly display the logic status of each pin in a

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The Fox BMP 10/60 is the smallest, lightest base station on the market today.

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Because it's pre-programmed to the 60 hottest police, fire, mobile phone and other frequencies, even beginners are surprised how easy the BMP 10/60 is to operate. Just as soon as the Fox is out of the box, it has its ear tuned to the action.

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*Some states may prohibit use of scanners in mobile or portable applications. Check your local laws.

CIRCLE NO. 19 ON FREE INFORMATION CARD

ROM, RAM, microprocessor, or MSI/LSI chip. The LM-4 can also be used for comparison testing when wired into a computer bus fitted with two optional 16-pin IC test clips. Another use for the device, according to the manufacturer, is as a clip-on display during testing and troubleshooting. The 40-conductor input cable has an impedance of one megohm. An optional Universal Cable Kit is available for special interfacing requirements. $199.

CIRCLE NO. 98 ON FREE INFORMATION CARD

Interface Board for Printers

The Integrator from Intek is a Z80-based interface board that connects most popular printers to any computer via an RS-232 or Centronics parallel I/O port. The unit features 24 switch-selectable functions, auto bi-directional printing, sheet-feeder and graphics modes, auto proportional spacing and tab setting, complete word-processing features, and 1K of RAM with an optional expansion to 16 or 48K RAM. Baud rate accommodation ranges from 50 to 19,200 baud. $650. **Address:** Intek Manufacturing Co., 780 Charcot Ave., San Jose, CA 95131.

Double-Density Disk Controller

The Percom Data Company announces availability of a double-density, four-drive mini-disk controller for the Heath/Zenith H/Z-89 computer. The controller, designated the ZFD-C, allows a user to add approximately 1.5M bytes to an on-line storage system. The ZFD-C works in conjunction with the Heath minidisk controller—the Heath unit handling the hard-sectored diskettes, and the Percom handling the soft disks. This scheme is said to permit the user to mix diskettes and drives; the system will automatically select the right controller. The ZFD-C includes an on-card parallel port for interfacing dot-matrix printers, and a diskette that includes software to modify the H/Z-89 operating system. $250.

CIRCLE NO. 99 ON FREE INFORMATION CARD

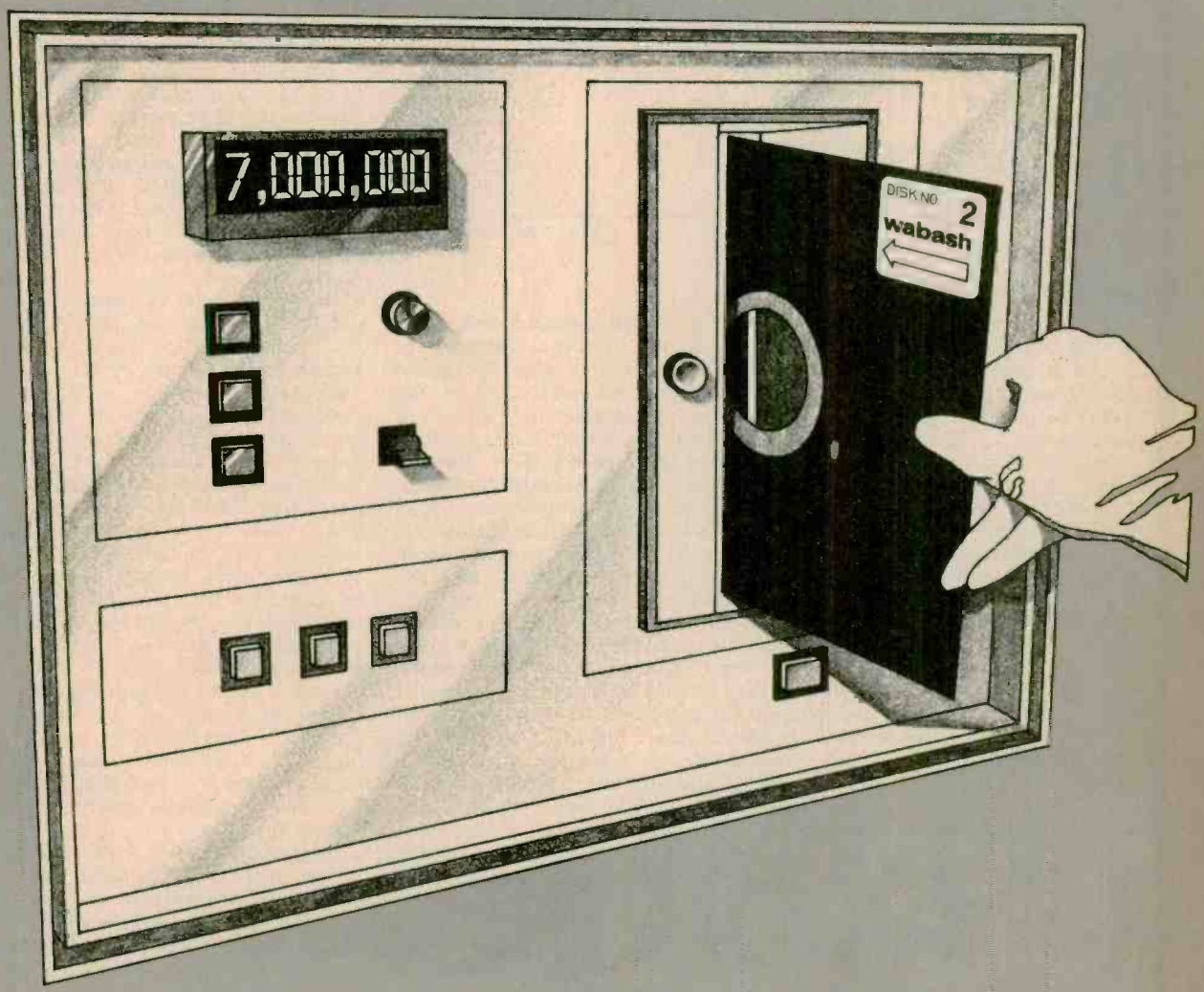
DMM Kit

Tomar Ltd. announces the availability of its 3½-digit multimeter in kit form. Intended for field and laboratory use, the DMM813 is designed around the industry-standard ICL7106 A/D converter IC from Intersil. Readout is LCD, and includes parameter and polarity indication, and low-battery warning. A diode-transistor network protects against overload. Dc voltage range is from 2 V (1 mV resolution) to 1999 V (1 V resolution), with 0.8% accuracy. Ac voltage is measured to the 500-V level at 1 V resolution, with accuracy to 1%. Resistance measurement range is from 2 kilohms to 2 megohms (1 ohm to 1 kilohm resolution), with accuracy to 0.5%. Dc amperage is measured over a range from 200 μA to 200 mA, with a resolution from 100 nA to 100 μA, at an accuracy of 1%. Power source is one 9-V battery. $50 ($55 fully assembled).

CIRCLE NO. 100 ON FREE INFORMATION CARD

Electronic Dipstick

An electronic probe can be used to replace a conventional dipstick, according to Levelonics, manufacturer of the Model S1. A solid-state display installed in a standard mounting panel or in the dash flashes yellow or green—yellow for ADD, green for OK—depending on the level of oil in the crankcase. An ON/OFF switch permits either instantaneous or continuous reading. The stick can also be read manually in the usual way (stick length is adjustable). If the lead wire breaks or shorts out, the display will indicate an "attention needed" condition. $34.50. **Address:** Levelonics, 2623 Virginia, P.O. Box 5667, Everett, WA 98201.



Seven Million Test Passes Later...

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It takes a lot to be a winner in the computer industry these days. When it comes to magnetic media it takes a successful magnetic coating formulation and expert manufacturing skills. It takes steady performance in critical applications, and endurance over the long run.

Wabash MAXI-MYTE™ 8″ diskettes and MINI-MYTE™ 5¼″ diskettes are a quality buy no matter what your criteria. In standards testing performed by 25 prestigious drive manufacturers (including the world's largest) Wabash diskettes emerged a sure winner. . . with the papers to prove it.

The fact is, Wabash quality is unsurpassed in the industry, with a five year usage warranty that will keep your customers satisfied for years to come.

So the next time you're faced with a purchasing decision, don't take chances. Any way you look at it, Wabash diskettes are your best bet for the long run.

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CIRCLE NO. 50 ON FREE INFORMATION CARD

ENTERTAINMENT ELECTRONICS

By Ivan Berger

Microtape and Music

FOR MONTHS, now, I've been walking around with a complete stereo system in my pocket: Sony's M-1000 portable stereo microcassette recorder. I haven't been using it for music, though—just speech.

A stereo recorder makes a great dictating machine. That's chiefly due to a side benefit of stereo: directional microphones. And directional microphones can make a major difference in sound clarity when you're recording in noisy surroundings.

There are times when I do take direct advantage of the M-1000's stereo capability, even in recording speech. When I'm taping meetings or conversation under very noisy conditions, it's much easier to tell who's saying what if I listen in stereo through headphones. (Sony supplies a pair with the M-1000.) Even though I didn't buy the M-1000 as a music machine, Sony seems to have that possibility in mind. Besides its headphone and a case, the M-1000 kit includes a patch cord for taping music from a stereo system. The cord has phono plugs at one end, a 3.5-mm stereo miniphone plug at the other (to fit the recorder's MIC input), and an attenuating resistance somewhere in between, so the line-level signal from the stereo system won't overload the mike-level input.

I never put much credence in that cord. I've used the same arrangement with standard-cassette portables, and I've never been entranced by the results. But that's not the only way to tape music onto microcassettes these days. You can tape live or off the air with an FM/AM/micro portable. (Aiwa, Fisher, Panasonic and Sanyo make mono or stereo FM/AM/Microcassette ones.) And you can tape from a stereo system with Fisher's CR-M500 deck. The latter is as state-of-the-art as it could be, considering it was first shown over a year ago. It has Dolby HX and the ability to record on metal tape.

Fisher's deck gave me an idea. If I could make good tapes on it to play back through the Sony, I'd be able to carry my favorite music with me just by slipping a few tiny cassettes and a pair of headphones into my pockets. So I borrowed the Fisher deck to try the idea.

The M500 causes lots of double-takes. It's styled to look like any other cassette deck, so it sometimes takes a moment to realize that it's built on a much smaller scale ($2\frac{3}{4}'' \times 8\frac{3}{4}'' \times 9\frac{3}{4}''$). For all its tiny size, there's not much missing. As on most full-sized cassette decks, the POWER and TIMER STANDBY switches are on the far left, together with the counter and the headphone jack. Just to the right is the tape compartment and seven feather-touch, solenoid logic control buttons for the tape transport. Further to the right is a 13-LED peak level indicator that covers the range from −20 to +6 dB; below that are the buttons for EJECT, DOLBY ON/OFF, METAL/NORMAL tape select, MIC/LINE select, and the coaxial INPUT LEVEL controls.

The only features to strike me offhand as different about the deck were that the MIC inputs were at the rear (which makes the MIC/LINE switch a necessity) and that there was no memory rewind on the counter. Since it's hard to tell from a distance what that tiny tape is doing, I also appreciated the mode indicators next to the recording-level display. They light up green for PLAY, red for REC and PAUSE, and flashing red for REC MUTE (which records blank spots on the tape, for editing or just for silence between tunes).

The deck's performance is like a full-sized tape deck's, too—but a deck from the days before Dolby and CrO_2 tape. Specifically, I compared the CR-M500's recording/playback performance (using TDK "MA" metal microcassette tape and Dolby HX) to the Akai GX-F95's (using a very old Sony normal-bias cassette, and no Dolby), and got nearly the same results—equally low distortion, equally high hiss, equally compressed dynamic range, and almost equal frequency response (the micro had noticeably more high-end response). When I switched to a more modern normal-bias cassette (TDK "D" Dynamic), the Akai gave me less compression and more even frequency response than the micro deck.

If Dolby HX and metal only bring microcassette performance up to the level of normal cassettes without Dolby, then microcassettes don't pose too much of a threat to the manufacturers of regular-cassette tapes and players (especially as the same manufacturers, by and large, make both). That's not the Fisher's fault, but the medium's. When you run tape at half the already-low speed of a standard cassette, getting good sound becomes a major challenge. On the other hand, the cassette probably seemed just as idle a threat to the open-reel market ten years back. I was able to get quite listenable results from the Fisher by switching in my Carver preamp's Autocorrelator (which got rid of most hiss) and Peak Unlimiter (which got rid of much compression). All it would take to make microcassettes really popular as a mass-music medium, I suspect, would be a hotter grade of tape than today's metal formulations, and a more potent form of noise reduction—Dolby "C", perhaps, or more likely dbx. That would bring microcassette quality to about where most home compact-cassette systems (with Dolby B and non-metal tape) are now.

But who needs it? People who want maximum portability, that's who. So far, the portables are lagging behind the Fisher deck since they lack metal-tape equalization and have no Dolby NR. (Dolby IC's available so far require higher power-supply voltages than microportables provide.) As a result, metal Dolby tapes made on the deck sound over-bright and super-hissy on my little Sony. Non-Dolby tapes made on normal-bias TDK and Olympus tapes with the Fisher deck gave far better results on the M-1000 than the metal HX recordings did, though still too hissy for me. And tapes made on the Sony itself, with its patch cord, fell right in the middle as far as hiss and sound quality were concerned. There was also some apparent loss of dynamic range when recording on the Sony, mainly due to the portable's automatic recording-level control. There was some apparent high-frequency loss, too.

So the only tapes I could enjoy listening to on the Sony portable were those made without Dolby, on standard tape, with the Fisher deck. (I suspect I could have done still better with Panasonic's metal-deposited, normal-bias Angrom tape, but my one Angrom cassette seems to have disappeared.) If it weren't for the hiss problem, I could live happily with this combination as a way of adding music to my travels. And if Dolby isn't available on a suitable low-voltage chip, National Semiconductor's LM1894 DNR noise reducer IC can operate on voltages as low as 4.5 V, about the highest voltage available from a compact battery supply. I expect microcassette portables with DNR will be coming in the next year or two.

Meanwhile, there is some definite news of what's to come in micro music machines. Prerecorded micro tapes are already available in Japan. Cetec Gauss has just announced metal-capable microcassette duplicating equipment here. And Matsushita last year made two micro-music announcements in Japan: first, a tape deck combining both standard and microcassette transports; then a set of three micro components that included a player with FM and AM reception for car dashboards, an under-dash player, and a home system with FM, AM and micro recording deck. Fisher is now advertising a portable in Japan that can play and record regular and microcassettes. If microcassettes gain any popularity for musical use here, we'll probably be offered the same products. ◇

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CP-203C

Audio Product of the Month

CHOSEN BY THE EDITORS OF POPULAR ELECTRONICS

Crown State-of-the-Art SL2 Preamplifier

THE Crown "Straight Line Two" is a compact, full-featured preamplifier whose size and style match those of companion Crown power amplifier and tuner components. The Straight Line Two (SL2) is only 1¾ inches high, and has a rack mounting (19-inch wide) panel fitted with handles. It is 11½ inches deep and weighs approximately 11 pounds. The SL2 can be installed in an optional walnut-finish wooden cabinet, or in a common cabinet with the other two units to form a functional "receiver" of exceptional quality. Suggested retail price is $479.

General Description. Published specifications of the Crown Straight Line Two are unusually detailed, including graphs covering frequency response, crosstalk, and phase response over a range far exceeding the audio frequency band. Harmonic distortion is rated at less than 0.009% from 20 to 20,000 Hz at the rated ouput of 2.5 V. The output impedance of 600 ohms makes the SL2 compatible with the input of any power amplifier. Its audio outputs are muted by a relay for 7 seconds after power is turned on to prevent any turn-on transients from reaching the power amplifier and speakers.

According to the block diagram of the preamplifier, the overload warning circuits monitor voltage levels at a number of points in the signal path, including immediately following the phono preamplifier, between the FILTER and the LEVEL controls, and immediately following the tone control circuits. Thus, the warning function takes account of any tone-control response modifications, phono preamplifier overload, or excessive LEVEL settings. The signal presence indicators and the rumble indicator monitor levels at the output of the preamplifier's active circuits.

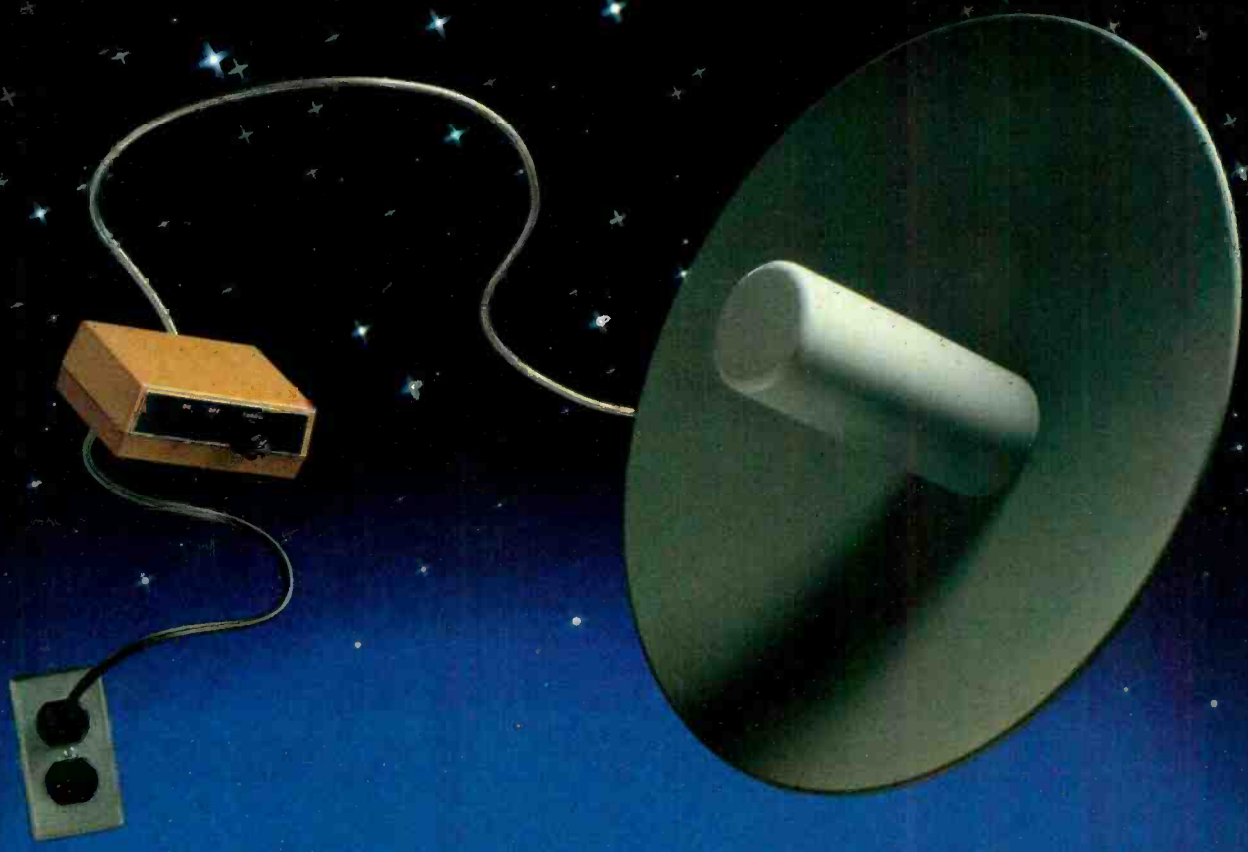
Laboratory Measurements. The output of the Crown SL2 was terminated in an IHF standard load of 10,000 ohms in parallel with 1000 pF. At 1000 Hz the output clipped at 11.0 V (the OVLD light came on at 10.2 V). At a maximum LEVEL setting, an input of 48 mV at a high level input, or 0.45 mV at the PHONO input, was required for a reference output of 0.5 V. The unweighted hum and noise in the output was below our 100-μV measurement threshold, which corresponds to 74 dB below 0.5 V, or 88 dB below the preamplifier's rated 2.5-V output. It seems highly probable from these measurements that the SL2 can meet its ratings of A-weighted S/N of 103 dB (high level) or 93 dB (phono), although a meter capable of measurement in the sub-microvolt range would be needed to verify them.

We measured the phono gain with the factory-set values, and they should be quite satisfactory for almost any situation. To adjust the gain through the access holes in the rear of the preamplifier requires a screwdriver with a very narrow and long blade. No screwdriver in our collection was both narrow enough and long enough for this purpose.

The phono preamplifier overloaded at 105 mV at 1000 Hz and 106 mV at 20 Hz (the latter referred to the equivalent 1000-Hz reading). It was only slightly lower at 20,000 Hz, where it measured

SATURN V

STATE-OF-THE-ART



The latest in micro-stripline design and the highest quality materials modern technology can provide are utilized to their greatest advantage in the manufacture of the Saturn-V downconverter. System gains and noise figures approaching the theoretical limit have been achieved with this fully integrated frequency agile microwave receiver. Advanced microstrip antenna techniques have allowed the full integration of the receiver-antenna into a sealed injection molded RF probe securely mounted in the focus of a parabolic dish with adjustable polarization. Matched diodes quiet a high-conversion mixer fed by a low phase-noise precision voltage-controlled oscillator coupled between an ultra-low-noise analyzer-matched RF front and a high gain IF amplifier impedance matched to drive one or more televisions or communication receivers.

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CIRCLE 9 ON READER SERVICE CARD

OPERATING FEATURES (Front Panel)

KNOB CONTROLS

COPY	Controls signal fed to one or two tape decks. In NORMAL, the selected input program can be heard or recorded. In PHONO, a record can be recorded while listening to any other source. The two remaining positions are for dubbing tapes from one deck to another.
INPUT	Selects program source. Positions for PHONO, TUNER, AUX 1, AUX 2.
BASS	32-position detented tone control.
TREBLE	32-position detented tone control.
BALANCE	Center-detented control.
MODE	MUTE silences audio outputs. STEREO is normal operating condition. REV interchanges left and right channels. MONO sums left and right channels and supplies sum signal to both outputs.
LEVEL	32-position detented volume control.

PUSHBUTTON CONTROLS

POWER	Controls preamplifier and five rear outlets.
TAPE	Two buttons for monitoring or playback from either tape deck.
ACTUATE	Small button between controls. When depressed, inserts tone-control circuits in signal path.
LOUDNESS	Adds bass boost at low volume control settings.
FILTER	Inserts an 18-dB/octave rolloff below 33 Hz.
MONITOR	Stereo headphone jack.

LIGHTS

POWER	Orange pilot light.
ACTUATE	Yellow light between tone controls. Indicates when controls are in circuit.
SPI	Signal Presence Indicator. Two green lights above LEVEL control to show presence of signal greater than 0.6 volts RMS at outputs.
OVLD	Overload Indicator. Two red lights above LEVEL knob to indicate overload in any stage of the preamplifier.
RUMBLE INDICATOR	A yellow light above FILTER button that shows presence of sufficient rumble to require use of FILTER.

OPERATING FEATURES (Rear Apron)

PHONO JACKS	For all INPUT sources.
PHONO JACKS	For TAPE 1 and TAPE 2 Input and output
PROCESSOR LOOP	Input and output phono jacks, joined by removable links. For connecting an external device such as equalizer or expander into signal path.
GAIN	Two screwdriver adjustments for phono preamplifier gain (20 dB range).
GND	Binding post.
OUTLETS	Six convenience outlets, five of them switched. Total power cacacity 1200 watts.

94 mV. The measured phono input impedance was 33 kilohms in parallel with 50 pF. Lacking a schematic, we could not account for the lower than rated phono input resistance (it is specified as 47 kilohms).

The RIAA phono equalization was unusually accurate, measuring well within ±0.5 dB from 20 to 20,000 Hz. When measured through the inductance of typical magnetic phono cartridges, the high-frequency phono response fell off very slightly, dropping about 0.5 dB between 4000 and 20,000 Hz.

Tone controls had a maximum boost or cut of ±14 dB at 20 and 20,000 Hz. The bass turnover frequency varied from lower than 200 Hz to a maximum of 500 Hz, depending on the control setting. The treble curves were hinged at about 1500 Hz. The loudness compensation, which follows the Robinson-Dadson criteria instead of the older Fletcher-Munson equal loudness contours, boosts only the low frequencies as the LEVEL is reduced, with a maximum boost of about 14 dB at 20 Hz, and a turnover frequency that moves between 60 and 200 Hz as the LEVEL setting is reduced. The FILTER has no effect on the response above 50 Hz, but cuts it rapidly at lower frequencies to −3 dB at 34 Hz and −13.5 dB at 20 Hz.

We measured the "response" of the rumble indicator circuit to see how it responded to different frequencies. Since 70 Hz was about the highest frequency that could make the rumble light come on, we used that level as our 0 dB reference. The indicator sensitivity increased 8 dB at 40 Hz, 18 dB at 20 Hz, 26 dB at 10 Hz, and 31.4 dB at 5 Hz (the lowest frequency obtainable from our signal generator). According to Crown, the signal presence lights require at least 0.6 V rms at the preamplifier outputs to turn them on.

The 1000-Hz harmonic distortion was 0.0003% (our measurement residual) for outputs from 1 to 10 V, increasing to 0.002 to 0.003% in the 0.1-to-1-V range. Harmonic distortion was also measured at 15,000 Hz, where it was from 0.0016 to 0.002% between 0.3 and 10 V output, and 0.009% at 0.1 V output.

User Comment. It should hardly be necessary to say that the Crown SL2 is a superb control center. Its electrical characteristics are nearly ideal, and it both looks and feels like the precision instrument it is.

Reassuring as the various warning lights may be, we never managed to get an indication from the rumble indicator when using a reasonably good turntable (and anything less than that would be unworthy of this preamplifier, in our view). The signal presence lights could only be lit at very high levels, corresponding to more than 100 W from the power amplifier we were using, which made the indication rather superfluous. It was not possible to overload the preamplifier with available signal sources (program) and with the amplifier and speakers on hand.

Still, these features *do* work and very well at that. With a less sensitive amplifier (such as one of those having an input level control) it is conceivable that the preamplifier could overload before the rest of the system, and the lights could then serve as a visual backup to the listeners' ears (which might be in a state of paralysis by that time!). Without complicating or confusing the operation of the SL2, Crown has made it nearly impossible to operate it incorrectly (unknowingly).

The silence of the SL2—its total lack of audible noise, either steady state or transient—was soon very apparent. Every possible switching transient has been eliminated at its source or otherwise suppressed. Even the loudness compensation is highly listenable, so much so that its presence was never detectable except by an A-B comparison between the in and out position of its button.

Our only reservations, which developed early in our acquaintance with the Crown SL2, concerned the row of control knobs, identical in size, shape, and color, that occupy most of its front panel. At first, it was necessary to look closely to find a specific control, since they are not distinguished by size, shape, or color. Fortunately, that procedure soon became unnecessary as I grew familiar with the control placement. In compensation, the "feel" of the knobs was excellent, with opposing flat surfaces that gave both a visual and tactile sense of their settings.

The "bottom line" in our evaluation of this product is that the Crown Straight Line Two, though not inexpensive, is representative of the state-of-the-art in its performance. It does everything most people would ever require, and it does them in a near-ideal manner. It is about as compact as such a versatile product can be, and its trim appearance would complement any system or home decor, especially if it were mounted in a common cabinet with the similarly-styled Crown amplifier and tuner.

Not only can we not find any significant criticism of the Straight Line Two, but our extended use of it leaves us with overwhelmingly positive feelings. It would be hard to surpass for its intended application.—*Julian D. Hirsch*

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Popular Electronics Tests

Zenith Explorer TV/AM/FM Clock Radio

IMAGINE (in one component) a 5" picture that's sharp as one could wish, an AM/FM radio, a liquid-crystal clock with snooze control and alarm, an earphone jack, and an audio system with nice performance. That's the Zenith monochrome portable for 1982, the NO52S Explorer.

Measuring 7¼"H x 6 ¾"W x 11¼"D (weight is 6 lb) and encased in an oblong silver cabinet with black accents, the Explorer has a rectangler screen; lighted, continuous-tuning uhf/vhf and AM/FM dials; and a telescoping antenna. Using 12 volts (battery-operated or isolated from the ac line by a stepdown transformer and full-wave bridge rectifier), the set delivers a full 4 MHz of baseband video to the picture tube, with quality in both TV and radio that's surprising for a receiver this size. Suggested retail price is $200.

General Description. The radio and clock circuits for the Explorer are fairly straightforward. In addition to the modular tuner circuits, it uses only three ICs and 16 transistors—and most of the latter are in the power-supply regulators.

The signal from the antenna is used for both the AM/FM and uhf/vhf tuners. The sound from the different channels is eventually switched by the master SELECTOR switch and applied through the VOLUME control to the loudspeaker. The VOLUME control is of the loudness variety, making possible treble and bass boost without overload at high frequencies, as well as loudness tone compensation at lower levels. There is a final audio amplifier IC between the control and the 3.5" 8-ohm speaker.

The uhf/vhf tuners are a miniature, fully transistorized matched pair. Varactor controlled, they are bandswitched for low/high vhf and uhf. Both tuners have 26 dB gain, and noise figures of 8 dB and 10 dB, respectively.

The power supplies provide +6.5, +9.5, and +12 V dc. They operate on the ac line, through a 12-volt converter, or on a rechargeable battery or six D cells.

The LCD clock is supplied by a separate 1.5-V AA battery. Mode switches select the timing alarm or snooze functions. The alarm is a series of pleasant, low-frequency tone bursts. Or the radio can be used as an alarm.

The Micromax IC. The large-scale integrated circuit (Fig. 1) that is the heart of the receiver represents a significant first in the area of the total signal and sync processing. Intercarrier 4.5-MHz sound (the beat difference between audio and video carriers) is heterodyned and transmitted to the sound detector. Automatic gain control is derived after video detection; sync countdown produces both vertical and horizontal drive; and a luminance signal stripped of sync is routed to the video output and then the cathrode ray tube.

Differential inputs that minimize external electric fields enter the video i-f block and untuned four-stage differential feedback amplifier, of which two stages are sequentially gain controlled for minimum noise and a gain reduction of 50 dB. Our measurements showed 57 dB before sync or white/black-level clipping.

Demodulation of i-f intelligence occurs in a current drive-balanced low-level detector that, according to Zenith, minimizes harmonic and intermodulation distortion. Outputs go to the sound demodulator, video processor, and agc loop that controls both i-f and r-f gain. Keyed agc action results from noise-gated composite sync and flyback pulses ANDed for minimum strobe pulse width. Should extraordinary noise pulses cause noise canceller lockup, internal logic defeats the combined gated system, permitting only regular flyback pulses to flow. The noise processor

(continued on page 30)

Improve your video image

Does what looked good on two-hour look not-so-good on six? Or what looked great on your original videotape end up hard-to-look-at when you dub a copy? Maybe the picture's a little soft; or smeary; lacks contrast; or the color's a little off. You may not even be sure what it is — it's just not up to snuff.

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The Proc Amp is another example. It gives you the ability -electronically- to regulate chroma level and phase, and overall luminance level. This means you can correct color saturation and hue for greater color accuracy. And adjust overall video signal level for optimum contrast and brightness. Not simply upon playback - where it may be too late - but in making the recording itself.

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Features include center-detent controls, a luminance level meter, and a four-output distribution amplifier.

A bypass feature is also provided - both on the Proc Amp and Detailer II - to give you instant picture-before and picture-after comparisons. So you can accurately judge the results.

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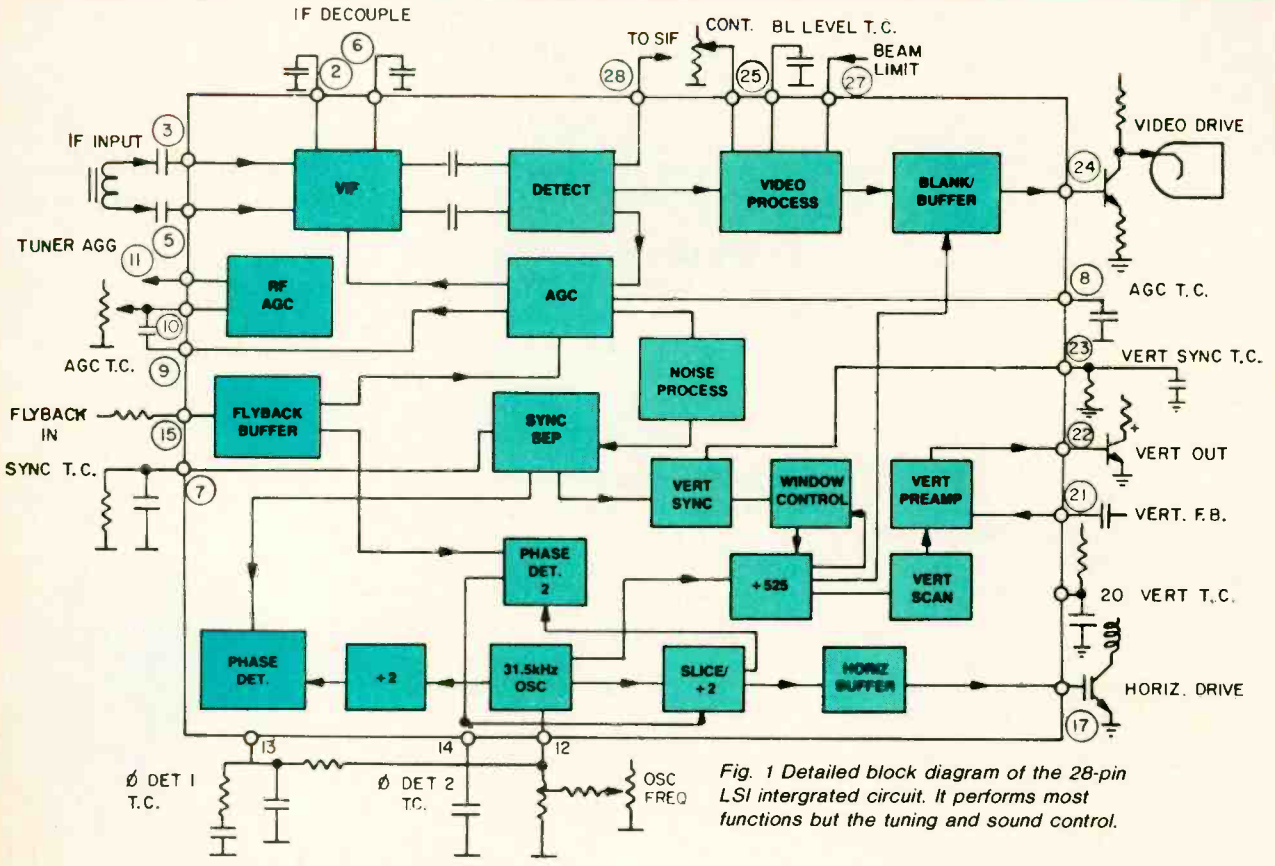
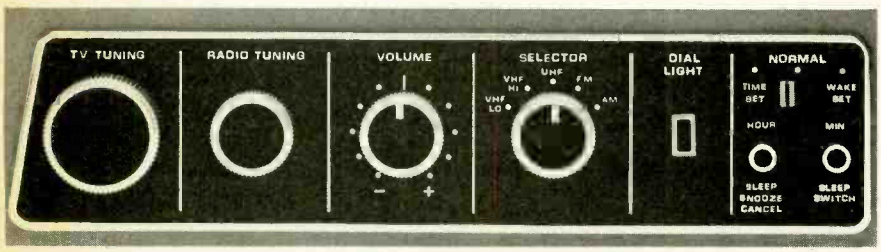


Fig. 1 Detailed block diagram of the 28-pin LSI intergrated circuit. It performs most functions but the tuning and sound control.



Controls for the TV and radio tuning, volume and function selections are on the side of the cabinet.

Pushbuttons control the alarm functions on the front of the cabinet and the dials and clock are just below the CRT.

removes video passing into the sync separator above a certain level. Normal sync pulses are then separated and routed to both vertical and horizontal circuits.

According to Zenith, video demodulation is synchronous, but without the usual carrier coil. About all that's visible in the video area of the chip are several filter capacitors and a dc contrast control. Small i-f signals, however, keep beat products to a minimum; e.g., 920 kHz, i-f harmonics, and intercarrier spikes. These low-level voltages are then substantially amplified within the chip, so that overall video output gain amounts to 74 dB. Our examination of the video signal shows it to be both clean and linear.

Should excessive beam currents threaten, the large IC has a sensing port from a turn on the flyback transformer's secondary—reducing any overdrive to a manageable amount. Thereafter, the back porch of the horizontal sync pulse is clamped at a fixed level and vertical and horizontal blanking becomes part of the video signal in the blanking buffer before it enters the final video driver. Coupling is dc to and through the single-stage video output and into the cathode ray tube.

The sync chain is formed at 31.5 kHz from a programmed current source, a 50-pF nitride capacitor and internal oscillator. A frequency divider drops this to the black and white line rate of 15,750 Hz, while dual phase detectors keep the horizontal oscillator in sync via feedback from the horizontal output. Because of this dual phase comparison, a traditionally integrated sawtooth from the flyback is not used.

Pulses from the horizontal oscillator drive both the discrete transistor horizontal output as well as internal chip 546-count logic, which then becomes a control system for all vertical circuits. Divided by 525, the 31.5-kHz oscillator produces 60 fields, or 30 frames per second, and retrace is triggered directly by received sync pulses through gating cir-

ZENITH NO52S B & W TV/CLOCK/RADIO LABORATORY DATA

Parameter	Measurement
Tuner/receiver sensitivity (min. signal for snow-free picture):	vhf (Ch. 6): −5 dBmV uhf (Ch. 30): −3 dBmV
Voltage regulation w/signal input (line varied from 100 to 130 VAC)	Low voltage: 6-V supply—99% 12-V supply—99% High voltage: 7-kV supply—99%
Video bandpass at CRT:	Over 4 MHz
S/N ratio at CRT:	38 dB
Horizontal overscan	17%
AGC response (before sync clipping or black level shift):	57 dB
Dc restoration:	83.7%
Auxiliary earphone audio output Z:	8 ohms
Ac power requirement (signal applied):	12.6 W

NOTE: Test instruments used in these measurements are: Tektronix 7L12 spectrum analyzer; Tektronix/Telequipment D67A oscilloscope; Winegard DX-300 vhf amplifier; Sadelco FS-3D-VU f/s meter; Data Precision 245 and 1750 multimeters; Sencore PR57 variable power supply; and Tektronix C5-A and Minolta XD-11 cameras.

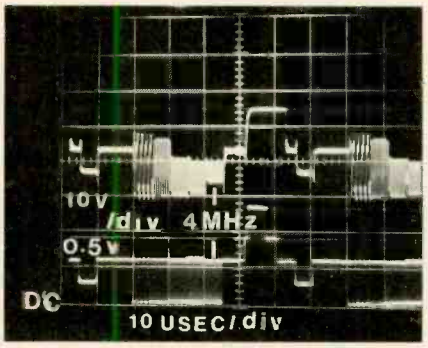


Fig. 2. Multiburst pattern from 0.75 to 4 MHz shows wide bandpass at CRT.

cuits in the countdown network. Initially dividing by 386, a wide gate opens thereafter, at which time the count down, now triggering on sync, continues to 546 and then self-triggers. With sync present, the gate count stops between 514 and 526. Should sync become lost, auto triggering goes beyond the count of 526 for eight fields, at which point the counter reverts to the wide gate and customary countdown.

The vertical output consists of a pair of complementary push-pull, class B discrete transistors, with driver, feedback and dc-coupling to the vertical deflection coils. Ramp drive voltage for the output is traditionally capacitor-generated and amounts to approximately five volts.

The usual tuning, volume and function settings are on the side, while black level and contrast controls are on the back.

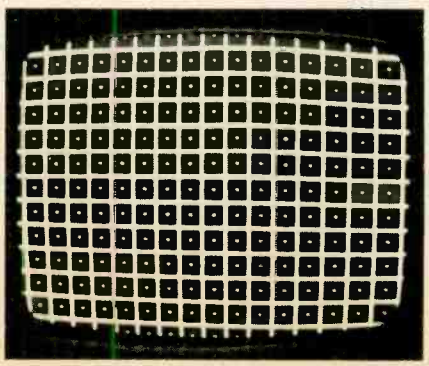


Fig. 3. Bow at top of dothatch pattern will be corrected by new speaker design.

User Comment. Waveforms and raster display (Figs. 2 and 3) show the bandpass and linearity of the receiver. The nonlinearity at the dothatch's top results from the prototype speaker's magnetic pull, but this will be changed to Alnico 5 material in the production runs. Multiburst directly out of the signal-injecting test equipment (bottom trace) at 0.5 V/div. and the resultant through the receiver (top trace) at 10 V/div are shown in Fig. 2. In each instance, a full 4 MHz is evident and horizontal blanking is a clean 10 μs, as it should be. Multiburst begins on the left at 0.75 MHz and extends, via the fifth oscillation, to 4.08 MHz. With an extended voltage frequency, the set might even be able to produce a bit more.

Contrast is good; the 7 kV of brightness in the CRT drive is satisfactory; and the diode-switched varactor tuning is broad and sufficient. The FM radio gives the 3.5″ speaker all the sound it can handle. The picture is steady, and raster size remains constant between ac power input swings of 100 to 130 V.

When all's said and done, you will find a great deal of innovative engineering in this one, making the unit ideal for anyone who wishes to watch TV at the beach, on a boat, in a trailer, or in a small vacation cottage. Add AM-FM radio and a clock with alarm provisions, and you have a handy entertainment radio-TV package that's truly portable.

—Stan Prentiss

CIRCLE NO. 103 ON FREE INFORMATION CARD

Popular Electronics Tests

Sinclair ZX81 Personal Computer

THE very small Sinclair ZX80 computer introduced a year ago cost $200 and had some 21 chips, 1K of user RAM, and a 4K ROM incorporating the operating system and BASIC. It had some drawbacks, low price notwithstanding, as observed in our report last year (August 1981). Now we have the Sinclair ZX81 for $149.95 and a kit version for $99.95.

This updated version of the ZX80 has 8K of ROM that allows some 30 additional BASIC functions to be included. (The 8K BASIC chip is also available to update the older ZX80.) It also has an expansion bus for the ZX printer (soon to be available), 16K RAM plug-in modules, and implementation in only four (yes, 4) chips! Eighteen of the ZX80 chips are replaced by a single custom chip made by Ferranti (England). The other three chips are the Z80A CPU operating at 3.5 MHz, the ROM and the RAM. A built-in r-f modulator having switch-selectable outputs for either channel 2 or 3 is provided, and its predecessor's RFI problem seems to have been overcome. Numbers are stored as five data bytes in a floating-point format, with a range of $3x10^{-39}$ to $7x10^{38}$, accurate to better than nine decimal digits. The BASIC now includes full log, trig, and inverse trig functions, and has the ability to handle multi-dimensional numeric and string arrays. No color facilities are provided.

Description. The ZX81 is even a little smaller than its older brother, measuring 6½" W x 6¾" H x 1½" D (at the thickest point at the rear), and weighing only 12 ounces.

The underprinted plastic membrane keyboard features only 40 keys, but has a total of 151 different functions, of which 55 are single-stroke BASIC statements, while 12 keys have five functions each. Color-coding and a change in cursor identification keeps things in line.

There are several physical differences between this new keyboard and the older ZX80. The black ABS plastic case is hard instead of the soft white plastic of the ZX80, and there is a bus connector accessible via an opening at the rear. The left side supports the cassette EAR and MIC connectors, the 9-V power plug, and an RCA jack for r-f output. The underside contains a channel selector switch (2 or 3).

The computer requires an external TV receiver for use as a video monitor, and a cassette recorder for mass storage. The TV screen displays 24 lines of 32 characters each (upper case only), but the display is limited to 22 lines. The lower two lines are used for inputting commands and data, program lines, and for displaying what Sinclair calls "reports." The graphics mode uses discrete points in a 44 by 64 matrix. Some 20 graphics and 54 inverse characters can be called.

The "reports" previously mentioned appear on the bottom line of the display after a program is run. There are 15 such report codes (0 through F), each having a particular meaning as explained in the manual. For example, report "0" means successful completion of a "run;" "3" stands for a subscript out of range; "7" means no corresponding GOSUB for a RETURN statement; etc. Each report is followed by a slash and the number of the last BASIC line executed. The BASIC is also syntax edited as it is entered (like the Apple) and cursor movement keys allow editing a wrong line. A special cursor symbol indicates where the problem is. Programs are saved and loaded from the cassette by name, and the ZX81 will search the tape for a named file.

The 8K BASIC is remarkably complete (see the Table). Besides a full complement of commands, it includes such features as LLIST, LPRINT, and COPY (for the upcoming printer with COPY printing an image of the video screen), PAUSE, PLOT, UNPLOT, SCROLL, and two functions called SLOW and FAST.

In the FAST mode, the video display makes the screen flicker like the old ZX80, but the system operates at high speed. The SLOW mode keeps the screen refreshed all the time, making the display easy to read. The SCROLL feature removes the top line and moves each line

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Personal Computer Comparison Chart

Product Features	Commodore VIC-20	Atari 400	TI 99/4A	TRS-80 Color Computer
Price*	$299.95	$399.95	$525.00	$399.50
Total Memory Standard (ROM & RAM)	25K	26K	42K	12K
Memory (RAM) Expansion to...	32K	Not Available	Not Available	32K
Keyboard Style	Full-Size Typewriter Style	Flat Plastic Membrane	Half-size Typewriter	Calculator Style
Programmable Function Keys	4	0	0	0
Basic Language	Microsoft Basic	$59.95 Extra	TI Basic	Radio Shack Basic
Upper/Lower Case Characters	Yes	Yes	No	No
RS232 Interface	$49.95	$219.95	$225.00	$19.95
Number of Keys	66	57	40	53
Graphic Symbols on Keyboard	62	0	0	0
Displayable Characters	512	256	64	256

*Manufacturers suggested retail price September 1, 1981

A computer like this would have been science fiction a few years ago. Now it's a reality. It's the new VIC-20 by Commodore, a full fledged expandable color computer that costs little more than video games. And it's so easy to use you can be writing your first program in 15 minutes!

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BASIC TABLE FOR SINCLAIR ZX81

Functions

ABS	ACS	AND	ASN	ATN
CHR$	CODE	COS	EXP	INT
INKEY$	LEN	LN	NOT	OR
PEEK	PI	RND	SGN	SIN
SQR	STR$	TAN	USR	VAL

Binary Operations

\+ - * / **(raise to a power)

= > < <= >= <>

Statements

All statements except INPUT can be used as commands.

CLEAR	CLS	CONT	COPY	DIM
FAST	FOR..TO (STEP)		GOSUB	GOTO
IF..THEN	INPUT	LET	LIST	LLIST
LOAD	LPRINT	NEW	NEXT	PAUSE
PLOT	POKE	PRINT(TAB)		RAND
REM	RETURN	RUN	SAVE	SCROLL
SLOW	STOP	UNPLOT		

up. Without this command, the display freezes when the bottom line is displayed. The PLOT and UNPLOT functions are for the graphics mode (entered by operating the GRAPHICS key) and allow use of 44 by 64 screen elements, each one-quarter the size of a normal character. SAVE and LOAD commands are used for the cassette recorder. When saving or loading a program, the screen display changes to a series of slanting lines to let you know that data is flowing. All the trigonometric functions are in radians and the PI key inserts 3.14159265 in the program. Unfortunately, there are no DATA or READ instructions.

String variable names are limited to A$ through Z$ and a character string of any length can be used, providing it starts with a letter. String and numeric arrays are limited by free memory.

Machine-language code can be entered using the USR, PEEK, and POKE functions.

Comments. We were surprised at the amount of computing power that Sinclair packed into such a small computer (you can carry this little wonder in a jacket pocket without making a bulge). The BASIC is as good as anything around in small computers, and has commands that others do not have. One has to get used to the single-keystroke BASIC entries, but through familiarity eventually it becomes easy to use. Sinclair even includes automatic spacing for "pretty printing," so even sloppily entered programs look good when listed.

You should recognize that the keyboard's small membrane keys are excellent for small fingers, but in no way can a touch typist work them. So forget about word processing for a secretarial operator. The ZX81, however, is a "hunt and peck" typist's dream. Getting used to the multi-function keys takes a bit of practice, of course. The block cursor changes its internal reverse letter depending on the function, and this makes life easier.

The 164-page manual is one of the best we have seen, and assumes that the reader knows almost nothing about computers or the BASIC language. There are many typically British expressions, but most readers will readily understand them.

Since our offices are located in midtown Manhattan, just a couple of blocks away from TV transmitters that put out many megawatts of power, any system we test that uses a TV receiver as a video display invariably displays heavy moiré patterns due to primary and adjacent channel breakthrough. This is usually heavy enough to make even an excellent system look bad. Therefore we test in a suburban area where the r-f at TV frequencies is greatly reduced. Although the ZX81 looked bad in the office, in our suburban test site, on an unused TV channel, it looked rather good. This is a function of the TV receiver, which also determines video clarity, and how its contrast and brightness are adjusted.

The alphanumerics looked very good, while the block graphic symbols, like those of most other computers, need to be "assembled" in proper order to create the desired visual image. Sinclair provides a good assortment of graphic symbols, not very high in resolution, but useful for most learning experiences.

The Sinclair ZX81 looks like a winner for those who want a low-cost way to learn BASIC programming or a small, inexpensive, yet powerful computer to start out on. Accessories include a 16-K byte plug-in RAM module at $99.95 and a printer soon to be announced at a price of about $100.

Having the bus structure available (all signals are explained in the manual) could be the beginning of a "cottage industry" built on this bus. One simple extension would be as an EPROM burner module controller at a really low price. After all, most of us can use BASIC a lot more easily than we can machine language. There is no reason, either, why peripherals (how about a disk?) can't be attached—and with a Z-80 processor, why not CP/M?

Interestingly, the ZX81 is manufactured by the Timex Corporation of Scotland, the same people who make watches and the Sinclair miniature TV receiver. The old saw about good things coming in small packages is true in the case of the Sinclair ZX81. It's a big computer in a small package—at remarkably low cost. —*Les Solomon*

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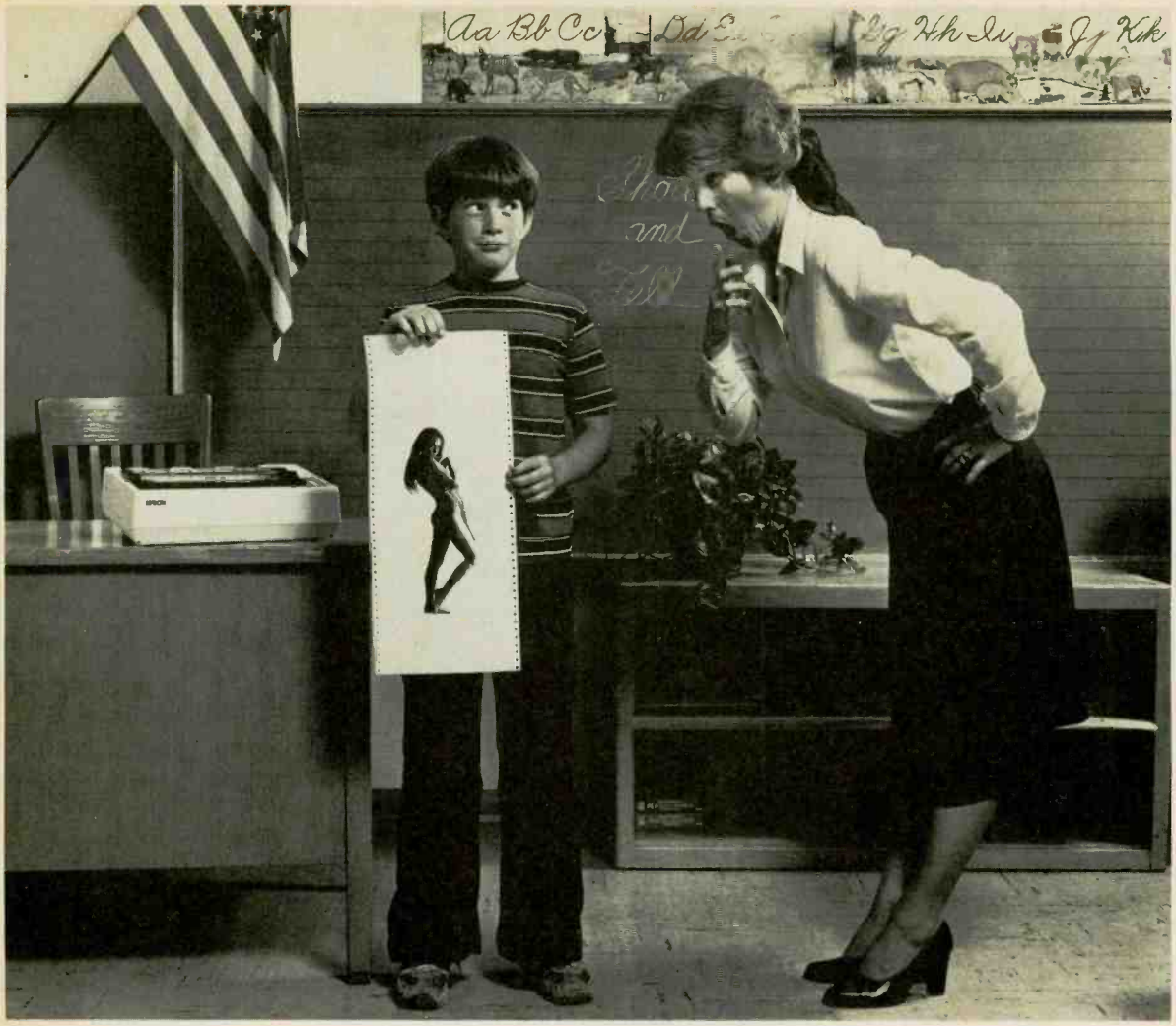

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CIRCLE NO. 16 ON FREE INFORMATION CARD

Popular Electronics
MARCH 1982

CHOOSING A PRINTER FOR A SMALL COMPUTER

How the different computer printer formats work and the advantages of each for different applications

BY ALEXANDER W. BURAWA

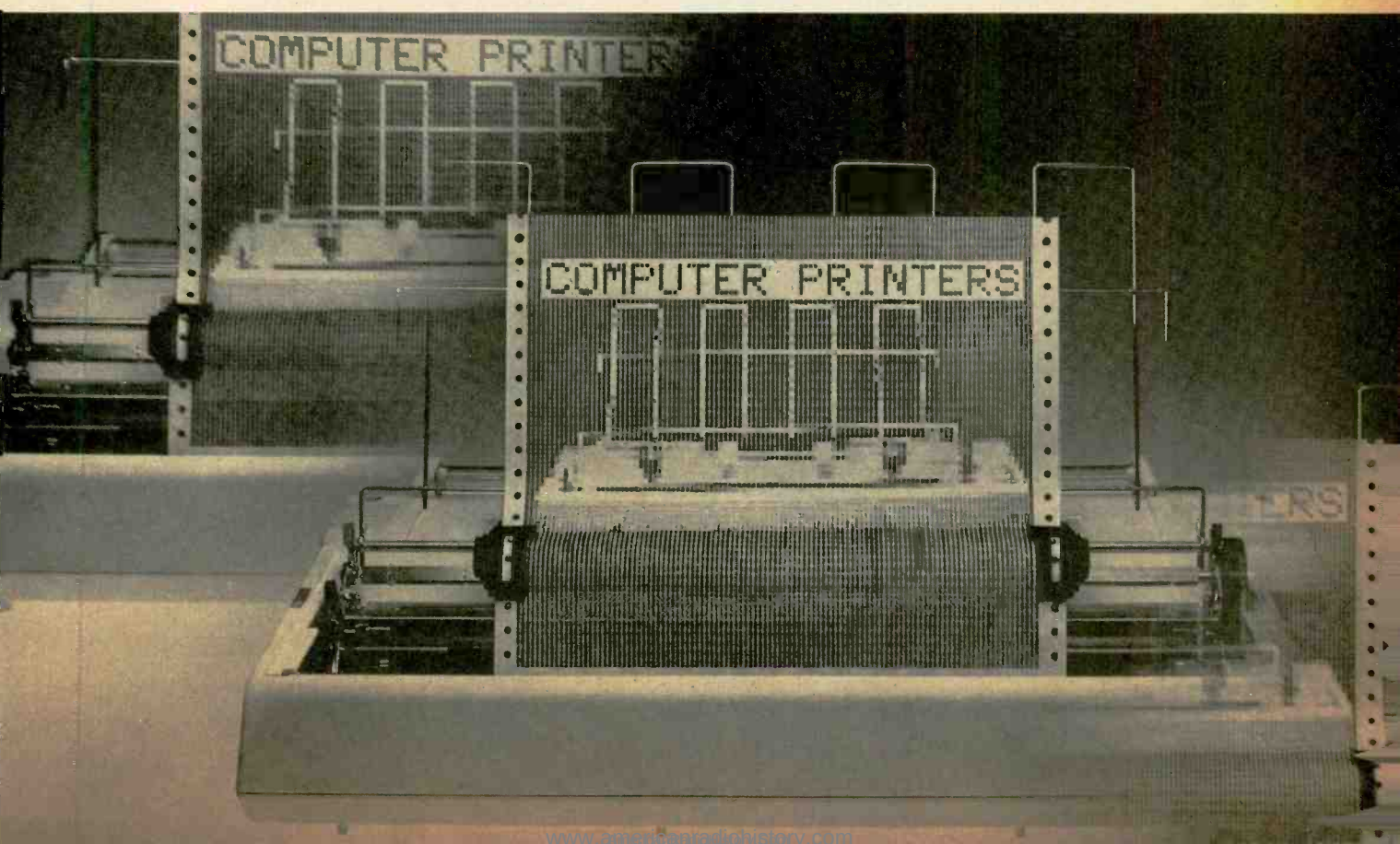
CHOOSING a low-to-moderate-priced printer for a small-business or home computer has become a relatively easy task. Now that the initial haste to supply printers to the budding small-computer market is over, manufacturers have settled down to providing logical designs that offer what users most want and need in a hard-copy computer printer.

With the weeding-out of exotic, expensive, or unreliable printers that use thermal, electrosensitive, ink-jet, and laser media from the low-end printer market, we see a bright new era in computer printers. Spurred on by the rapid growth of word-processing and business applications as the main use for the small computer, manufacturers have in recent years concentrated their design and marketing efforts on a hardy range of reliable and flexible impact printers. Except in very rare cases nowadays, electro- and thermosensitive paper is a thing of the past, and with it are the problems of expensive, fragile, and often poor-contrast print quality. Also, these "exotic" types of printers cannot make more than one copy at a time, while an impact printer can make several copies at one stroke.

Although the task of actually choosing a given make and model printer has been simplified, the choice must be based on intelligent weighing of all possibilities before making an actual purchase. A computer printer, after all, isn't a plug-it-in-and-turn-it-on appliance. It should be matched to your computer's hardware considerations and take into account demands of the software with which you'll be using it, as well as your intended and anticipated applications.

In this article, we'll explore the various aspects of modern computer printers, focusing our attention on only impact serial models that print character by character instead of a full line of type at a time.

Printing Approaches. There are basically two categories of impact printers—dot-matrix and formed-character.



In both types, print is transferred to paper in a manner similar to that used in a typewriter. That is, a slug or dot matrix for the desired character strikes through (impacts) an inked ribbon to deposit the character's impression on the paper.

By far the most popular type of printer available is the dot-matrix variety, due mostly to its low price and high speed when compared to formed-character printers. The dot-matrix printer is also potentially the most flexible. Many models are capable of producing compressed, standard, and expanded characters; standard and bold print; and a wide variety of graphics characters. Using appropriate software commands, it can even be used to create custom upper- and lower-case alphanumeric characters, punctuation, and foreign-language characters.

The only real drawback to the dot-matrix print is that character appearance (and sometimes legibility) is only fair to moderately good as compared to a conventional typewriter. With some models, characters may appear to be discontinuous or distorted. And although legibility can be vastly improved by overstriking and boldfacing, sharpness will never quite come up to the quality obtained from a formed-character printer.

Each character in a dot-matrix printer is created in a matrix of dot patterns. The per-character matrix in a given printer is fixed by the geometry of the printhead and is defined by the numbers of horizontal and vertical dots within the matrix. While the number of vertical dots is invariably fixed, the number horizontally can be varied to permit compressed and expanded characters. The matrix, therefore, defines the character field for a "standard" character. Typical matrix examples are 5 × 7, 7 × 9, 9 × 12, etc., as shown in Fig. 1A.

The dot-matrix printhead does *not* contain the full point-by-point matrix. Instead, it typically consists of a single vertical column of print pins that are selectively "fired" by solenoids, as illustrated in Fig. 1B. (Our example in Fig. 1B assumes a view through the paper, head travel from right to left, and a 5 × 9 standard matrix.) Hence, to print an entire character the print pins must be fired as many as five times as the printhead sweeps across the character field.

A matrix consists of columns and rows. A line of matrix print consists of continuous matrices arranged side by side. Therefore, a line of print can be viewed as a matrix of *y* number of rows (horizontally) and *x* number of columns (vertically). Viewed in this light, it's easy to see how the system knows exactly which print pins to fire in each column as the printhead sweeps across the page. In Fig. 1B, the numbers at the top of each column are the *row* numbers to be fired at each location.

The example shown in Fig. 1B demonstrates a simple single-strike character printing technique. To improve legibility, columns are often struck twice, with the printhead shifted slightly to allow the second strike to fill in the gaps between dots. The result is an apparently continuous character with rough edges. This is the technique used to obtain what is known as "correspondence-quality" printing.

If you need truly professional-quality printing, like that of a typewriter and the print used to compose this text, you have no alternative but to move up to a formed-character printer.

At this writing, there are basically two kinds of formed-character printers available at low to moderate prices. One is the "daisywheel" printer developed by Xerox and first used in that company's Diablo printers and printing terminals. The daisywheel, the actual printing element, gets its name from its resemblance to the daisy flower (Fig. 2A). Arranged radially around a solid hub are 96 or more spokes that resemble petals. At the end of each spoke is a single alphabetic, numeric, punctuation, or special symbol character that is unique to all other spoke characters. Hence, the daisywheel printing element can accommodate the entire 96 ASCII characters. Moreover, type faces can be easily changed by substituting from a wide range of 96-character elements.

If you look at the Sampler Table of Printers presented in this article, you will note that almost every manufacturer of formed-character printers uses the daisywheel printing element approach. The only exception is NEC Information Systems, which employs its proprietary "thimble" element, the second basic type available for formed-character printers. The thimble element (Fig. 2B) differs from the daisywheel element in more than just its appearance. It contains two characters per spoke, the second accessed by a shift function similar to that used in typewriters to access the upper-case characters. Another difference is that the thimble's standard character count is 128, enough to accommodate the full 96-character ASCII set as well as 32 additional special and/or graphics characters.

Formed-character printers lack the speed and flexibility of the typical dot-matrix printer, particularly in printing graphics characters. However, the formed-character printer has the advan-

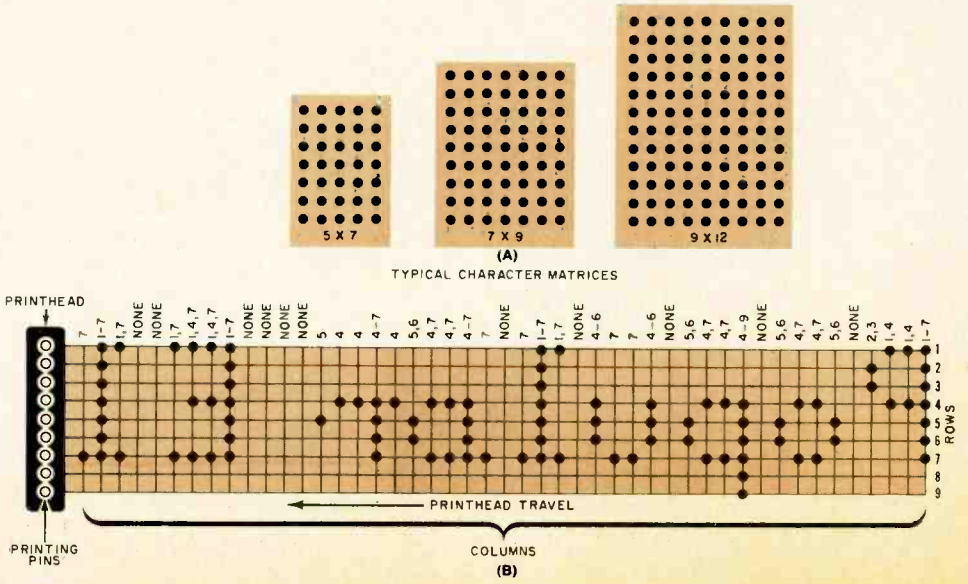


Fig. 1. At (A) are typical matrices for dot-matrix printers. Diagram at (B) shows a dot-matrix printhead printing a row of type.

tage that type style (font) and size (pica or elite) can be changed quickly. If you wish to change font and/or size, you simply snap out the daisywheel or thimble and replace it with the desired one. Daisywheel and thimble printing elements are available in a wide variety of styles, including special foreign-language symbols and characters, APL characters, and OCR (optical character recognition) characters. Plastic daisywheel print elements from Diablo and Qume range in price from $8.50 to $12.00 each, while metal daisywheel print elements for Diablo printers range in price from $40 to $46. Thimble printing elements from NEC, all nylon-reinforced fiberglass, cost about $14 each.

The most important advantage obtained from daisywheel and thimble printers is the professional quality (so-called "letter quality") of the printed characters. Just as important can be the printer's proportional-spacing ability (requires "proportional-spacing" element). Any printer can be made to justify the left and right margins. The dot-matrix printer can do this only by adding extra spaces to lines that don't print to full width. The formed-character printer, however, can be programmed to adjust spacing for the width of the characters being printed. Proportional spacing simply means that less horizontal spacing is given to narrow characters like *i*, *l*, and *I*, while more space is given to wide characters like *M*, *W*, *m*, and *w*.

Advantages of proportional spacing are two-fold. First, printed material looks much more professional—like the copy you're now reading. Secondly, you can get more characters on a page, for an overall saving in paper.

The major disadvantages of formed-character printers are their relatively high cost and low printing speed.

The choice between dot-matrix and formed-character printer must be based on your printing needs. If you require fast printing speed or low initial cost and can tolerate less-than-letter-quality print (such as in billing statements, accounts forms, etc.), you'll probably be best off with a dot-matrix printer. Too, if you have an urgent need to print graphics, the dot-matrix printer is more desirable. On the other hand, if professional-quality printing is of paramount importance in your operation, you have no alternative but to choose the formed-character printer.

Paper Feed. There are two basic types of paper used in most printers. One looks like conventional sheets, and one has holes on tear-off sides. The type and width of the paper used depends on the paper feed mechanism. Friction feed, as its name implies, is similar to the approach used in conventional typewriters where the paper is fed through the device by friction between a moving platen and its associated rollers. The other approach uses "pins" molded into metal or plastic wheels that engage the holes in the paper. These wheels are located on each side of the platen and, in most cases, the physical position of the pin wheels can be positioned along an axle to correspond to the width of the paper being used.

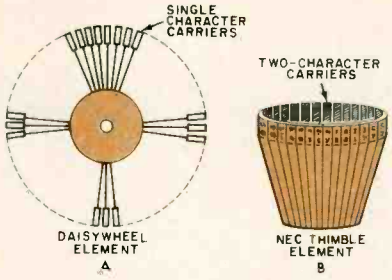


Fig. 2. A daisywheel element is shown at left; an NEC thimble at right.

Pin-feed paper usually comes as multiple sheets with some form of "carbon paper" between forms to produce multiple copies. This is excellent for generating mailing labels, and for other accurate print position requirements. Pin-feed paper usually comes as "fan fold," where each sheet is folded against its neighbor. Friction-feed paper can range from single sheets to rolls.

Friction-feed machines are less expensive than pin-and-tractor machines, as is the paper used for the respective types.

The ribbon can also take many forms ranging from conventional rolls, to unique "plug-ins" that not only can be self-inking, but can be changed with a minimum of fuss and effort (and making the fingers dirty).

Printer noise level should also be considered. This can range from the "clickety-clack" of the old-fashioned teletypewriter (as used for audio background on many radio and TV news programs), to the relatively quiet "hiss" of a modern printer with quiet mechanism. This choice should be made dependent on the area where the printer will eventually be used.

By The Numbers. As with any other electronic device—and more so with a computer peripheral—the numbers given in tables of specifications are extremely important. Much of your decision to buy a given printer make and model will rely heavily on specifications figures. For this reason, we've included the Sampler Table of Printers, which gives you an opportunity to compare models available by type, price, specifications, and features. All models listed are print-only devices, having no originating keyboards as in printing "terminals." All are also impact printers. Let's take a look at what some of the column headings mean.

Type simply tells you whether the printer uses a formed-character or dot-matrix printing mechanism and, if the latter, its matrix arrangement. Note that dot-matrix models offer from as small a matrix as 5 × 7 to as much as 18 × 18.

The smaller matrices usually do not produce full descenders on certain lower-case letters (y, p, g, j), and where needed, cannot produce an underline. Keep this in mind when examining printing examples of the selected printer. Larger matrices produce a much "smoother" printed character, and in many cases allow the user to specify (and print) unique graphics, foreign language letters, etc.

Print Speed is the number of characters per second (cps) the model can print out. The typical formed-character printer can provide about 55 cps. Print speed can also be as low as 17 cps or as high as 80 cps, depending on printer cost. Dot-matrix models, on the other hand, typically offer speeds in the range of 100 to 200 cps. High speed in our tabulation for dot-matrix printers is 200 cps and low speed is 30 cps, again reflecting price.

Character Set tells you how many characters (alphanumerics, punctuation, special, and graphics) are available. Most printers offer the full 96-character ASCII set and many provide even more, allowing you a high degree of flexibility in printing.

Characters Per Line tells you the maximum number of characters you can print on a line with a given printer. Double entries mean that you can select either of two character counts, usually by flipping a switch or through console command.

Lines Per Inch tells you the maximum number of lines of type you can have per vertical inch. Again, double entries offer you a choice of either of two quantities, usually selected by the software or by console command.

Interface is the means by which the printer connects to the computer. No computer peripheral, including the printer, can directly connect to the computer. Connection is accomplished by way of either a parallel or serial interface module that provides the physical port required. Each port assigned by the computer's operating system/hardware

SAMPLER TABLE OF PRINTERS

Manufacturer Name/Address	Model	Price	Type	Print Speed (cps)	Character Set	Characters per line	Lines per inch	Drive	Paper	Interface
Anadex, Inc. 9825 DeSoto Ave. Chatsworth, CA 91311	DP-8000 DP-9000	$1125 $1550	9×7 Dot Matrix 9×9 Dot Matrix	112 150/200	96 96	80 80/132	6 6/8	Sprocket Tractor	Fan fold, Forms Fan fold	Serial Parallel Serial Parallel
Axiom Corp. 5932 San Fernando Rd. Glendale, CA 91202	GP-80M	$399	5×7 Dot Matrix	30	NA	80	6/9	Tractor	Fan fold, Forms	Serial Parallel
Centronics Data Computer One Wall St. Hudson, NH 03051	739	$995	7×8 Dot Matrix	100	96	80/132	6	NA	Roll, Fan fold, Form	Serial Parallel
Diablo Systems, Inc. Hayward, CA	1640 630	$3195 $2295	Daisywheel Daisywheel	NA 35-40	NA 96	NA NA	NA NA	Tractor Friction	Sheet, Roll Roll	NA NA
Epson America 23844 Hawthorne Blvd. Torrance, CA 90505	MX-80 MX-100	$645 $995	9×9 Dot Matrix 18×18 Dot Matrix	80 80	96 96	80 233	6-10 6	Tractor Tractor, Friction	Fan fold Sheet, Roll Fan fold	Serial Parallel Serial Parallel
Heath Co. Benton Harbor, MI 49022	Z-25 H-14	$1595 $395	Dot Martrix 5×7 Dot Matrix	150 75	96 96	222 80/96/132	6/8 6/8	Tractor Tractor	Fan fold, Sheet, Fan fold	Serial Serial
C. Itoh Electronics 5301 Beethoven St. Los Angeles, CA 90066	Starwriter	$1750	Daisywheel	25	96	136	48	NA	NA	Serial Parallel
Micro Peripherals Inc. 2099 W. 2200 S. Salt Lake City, UT 84119	88G	$748	11×7 Dot Matrix	100	96	80-132	6/8	NA	Roll, Fan fold, Cut sheet	NA
Microtek 9514 Chesapeake Dr. San Diego, CA 92111	Microline 82A	$299	7×7 Dot Matrix	NA	NA	80	NA	NA	Sheet, Roll	Apple Atari TRS-80
NEC Personal Computer Div. 1401 Estes Ave. Elk Grove Village, IL 60007	5510RD	$3055	Thimble	55	128	163	6/8	Friction, Tractor	Sheet, Fan fold	Serial
Okidata Corp. 111 Gartner Dr. Mt. Laurel, NJ 08054	Microline 82A	$840	9×9 Dot Matrix	120	96	80/132	6/8	Friction, Tractor	Fan fold, Sheet	Serial Parallel
Printerm Printer Terminals Corp. 124 Tenth St. Ramona, CA 92065	879	$1290	7×9 Dot Matrix	180	95	80/132	8	Sprocket, Friction	Roll, Fan fold	Serial Parallel
Qume Corp. 2350 Qume Dr. San Jose, CA 95131	Sprint 9/56	$2830	Daisywheel	55	125	132-198	3-8	Friction, Tractor	Sheet, Fan fold	Serial
Radio Shack 1800 One Tandy Center Fort Worth, TX 76102	Line Printer V Line Printer VI Line Printer VII Line Printer VIII	$1860 $1160 $300 $799	Dot Matrix Dot Matrix 5×7 Dot Matrix Dot Matrix	160 100 30 40-160	152 132 96 158	NA NA 40/80 NA	10 NA 8 NA	Tractor Tractor Sprocket NA	Fan fold Fan fold, Sheet Fan fold Fan fold, Roll, Sheet	NA NA Serial, Parallel Serial, Parallel
Star Micronics 200 Park Ave. Suite 2308 New York, NY 10166	DP-8480	$495	7×9 Dot Matrix	80	96	132	NA	Friction, Tractor	NA	Serial Parallel
TEL, Inc. 5075 South Loop E. Houston, TX 77033	3431	$1895	9×9 Dot Matrix	150	94	136	6/8	Tractor	Fan fold	Serial Parallel

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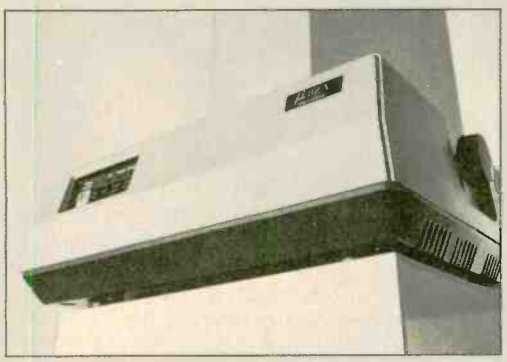
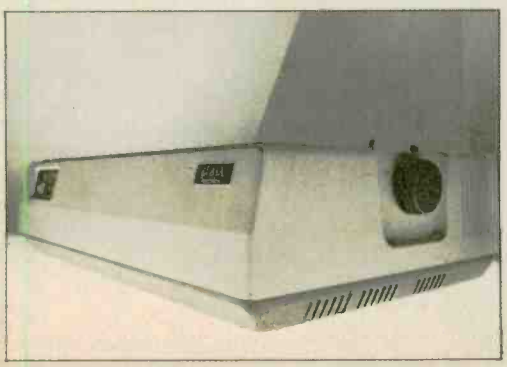


ML-82A: Prints 80 columns bidirectionally at 120 cps, has 9-pin head for true descenders. Short line seeking logic increases throughput by 80 percent.



ML-83A: All the features of the 82A, including double-width and bold characters. The 136-column-wide carriage can handle paper up to 16 inches wide.

ML-84: Correspondence quality and data processing throughput. Prints bidirectionally at up to 200 cps, including charts, illustrations, forms, or dot-addressable graphics.

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is designed to accommodate a specific type of peripheral. Ports are configured for either data communication equipment (DCE) or data terminal equipment (DTE). DCE ports have only one-way data flow and are ordinarily used for printer peripherals. DTE ports, on the other hand, are designed to allow data to flow in both directions and are generally used for printing terminals, video terminals, modems, and any other peripheral that both sends and receives data. Although the printer usually connects to a DCE port, it can also connect to a DTE port, following instructions supplied in the operating manual. Thus, it's possible to connect two (or more) printers into a computer system, each with its own port assignment.

For all practical purposes, it makes no difference to the printing operation whether you select a parallel- or a serial-feed printer, using the printers we have listed in the Sampler Table. The only consideration to take into account here is that you must use a parallel interface with a parallel-feed printer and a serial interface with a serial-feed printer.

Parallel ports are much faster than serial ports. However, given the slow-speed limitations of the character-by-character printers listed, there is little advantage in opting for a parallel printer, since even the serial port is sufficiently fast, even at 9600 baud, for the printing mechanism.

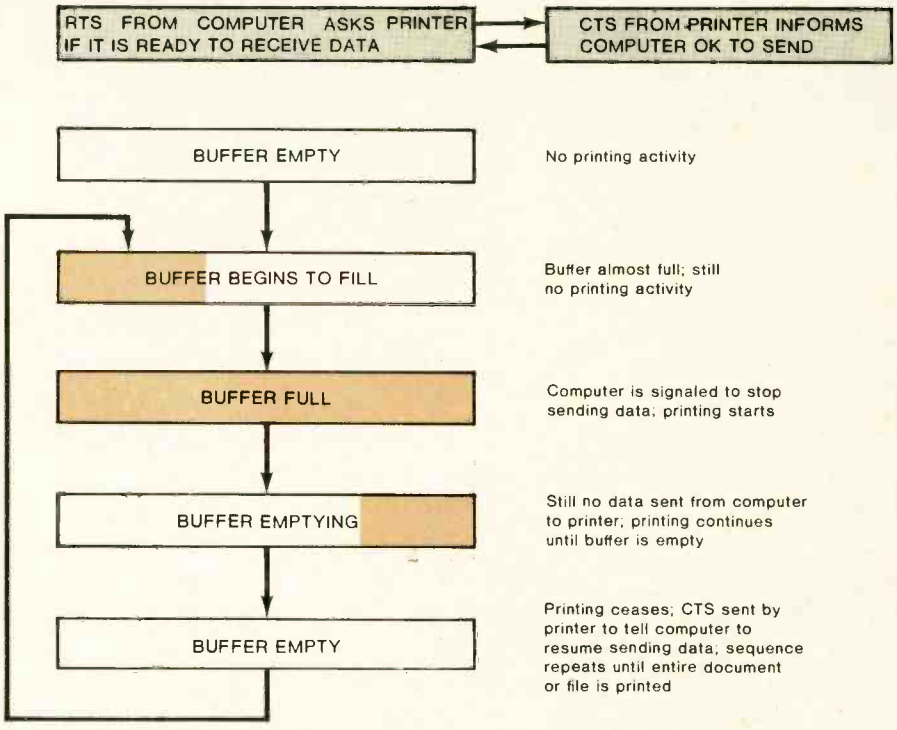

Fig. 3. Diagram shows how data coming into the printer is steered to the buffer, which accepts only as much as it can store. The printer then sends a message back to the computer to stop sending data. The printer starts to print, continuing until buffer is empty.

An important factor in considering the type of interface is the communicating speed (also called port speed or baud note) at which the printer can be programmed to accept data. Baud rate is generally selectable at both the computer and printer ends. The only important thing to remember here is that the computer and printer must be set to the same rate; otherwise, the computer won't be able to communicate with the printer. The faster the baud rate, the faster the printer's input can accept data. It is *not* a reflection on the print speed, which is a function of how fast the printing mechanism can operate.

Almost all of the printers in the table are capable of bidirectional printing. What this means is that as the printing element comes to the end of the line in a left-to-right direction, it feeds the paper up, via a line-feed (LF) command, for the next line of print without initiating a carriage return (CR). Printing then resumes from right to left. This process is repeated at the end of each line. By eliminating the CR command and the need for the printing element to return to the left margin for every line to be typed, the printer operates at its optimum speed.

Most printers also have built into them a "paper-out" alarm that informs

you that the paper is running out and simultaneously suspends printing. After you reload with paper, you can tell the system to resume printing where it left off. If the printer doesn't have a paper-out alarm and doesn't suspend printing until you reload, you risk losing copy during unattended printing operations.

Another almost-standard feature you'll find in today's printers is a "self-test" function. Activating self test causes the printer to continuously print out its entire character set until the function is disabled. In almost all cases, print-out starts with the upper-case alphabet, proceeds through the lower-case alphabet, and is followed by the numerals 0 to 9, ending with punctuation and special characters.

"Intelligence." Like video terminals, there are "dumb" and "smart" printers. A "dumb" printer is one that simply prints a line of text, performs a CRLF (carriage return/line feed) and continues along its merry way churning out copy. There are various levels of "intelligence" with "smart" printers, ranging from those that have backspace, overprint (for highlighting), character pitch change, etc., to those having a very broad array of printing modifications. Before purchasing a printer, make up a list of what you intend to print, keeping in mind that some printers can even change colors in midstream. If you also intend to print sketches, there are printer/plotters that can perform both alphanumeric and graphic operations, with color changes if desired.

Logic-seeking carriages are especially desirable when a printer is used for word processing since carriage return is initiated at the end of a short typed line instead of moving to the margin. Thus, throughput is improved.

System Operation. Once a printer is connected to a computer through the appropriate interface, the printing capability of the system can be called up at any time from the console terminal. Typical call instructions are the LPRINT statement in BASIC and pressing the PRINTER ON key when operating from a word-processing package.

With the printer activated, data from the computer flows through the interface port, which translates the data to be printed into a form usable by the printer. The computer sends a request to send (RTS) query to the printer to determine if the printer is ready to accept data. In turn, if the printer is ready

"Believe me, Mr. Walker, you're not the only person in the world who can't understand BASIC!"

to receive data, it sends a clear to send (CTS) acknowledgement back to the computer. Upon receipt of the CTS, the computer sends its first line of data to be printed. The whole process takes only microseconds to complete.

Data entering the printer isn't acted upon directly by the printing mechanism for the simple reason that the computer spews out data at a rate hundreds of times faster than the mechanism can accommodate. Therefore, incoming data is stored in a "buffer," which feeds the data to the printing mechanism at a rate the mechanism can handle.

Buffers built into modern-day printers can generally accommodate at least one line of data to be printed. Some printers have buffers that can handle several lines of text data, while still others have buffer capacities of a full page or more of text data. Regardless of how much buffer storage is available, the buffer will accept and store data at the maximum speed (baud rate) to which the computer and printer are set and releases the data at a rate no faster than the printing mechanism can handle (cps). In effect, the buffer acts like an electronic "reduction-gear" system that assures smooth and error-free printing operation.

Referring to Fig. 3, data coming into the printer from the computer is steered to the buffer. The buffer accepts only as much data as it can store, at which time, the printer sends a signal back to the computer to have the latter suspend sending data. Now, data in the buffer is fed to the printing mechanism character-by-character until the buffer is once again empty. When data for the last character is sent to the printing mechanism, the printer informs the computer that it is ready to accept data again. This process is repeated until the entire document is printed.

During the printing operation, the computer spends most of its time in a "standby" mode, waiting for the printer to complete the printing operation for the data stored in its buffer. The only time the computer is fully active is when it is sending data to the printer. Considering the fact that the computer operates at microsecond speeds and the typical printer speed is in the range of a millisecond per character, the computer will be idle more than 95% of the time during any printing operation.

Making a Buying Decision. Computer printers are by no means inexpensive items to add to a small-computer system. Even at the lowest end of the scale, expect to spend about $600 to $700 for a relatively flexible dot-matrix printer, while high-quality formed-character printers go for as much as $3000. In fact, the *average* suggested retail price for printers as a whole is more than $1000. (Our Sampler Table gives manufacturer suggested retail prices. Most retailers, however, give discounted prices. Even so, expect to pay a premium for printing capability.) So, your wisest approach to selecting a printer to go with your small computer is to bone up on what the technical specifications mean and how they relate to your printing requirements.

Perhaps the most intelligent step you can take in the choosing process is to draw up a list of your current and near-future needs, based on the reasonable useful life of the printer. Items to include on this list are print quality (formed-character or dot-matrix), printing speed, versatility, reliability, simplicity of operation, availability of service, and manufacturer's reputation.

Don't be lulled into topping your list with a price. If you do, you're likely to make an error in judgement and select a printer with a very attractive price but one that's barely adequate to fill your current needs. After all, even if you spend only $400 for a printer that lacks essential capabilities, that's $400 down the drain when you consider that you'll eventually have to move up to a more expensive printer. To make a really objective choice of available printers you shouldn't even consider putting a price down on your list until you've compared all the features listed against your needs and have come up with several possible models from which to make your selection. Then and only then should you narrow down the possible models to the price range you can afford. A word of advice: If your budget is too limited to allow you to buy the printer you need now, delay buying your printer for a few months until you can afford the one that best suits your requirements.

Print quality is probably the most important factor in the final selection process and, fortunately, is the easiest to handle. By this time, you'll already know if the printing format must be letter-quality formed character or dot matrix. Therefore, if you decide on one format, you can immediately eliminate all models of the other format.

Printing speed is a matter that requires careful consideration. Here, you'll have to assess your printing volume carefully with a view toward meeting reasonable goals. Keep in mind that the faster the printer, the more expensive will be its purchase price. If your computer/printer system is to be used professionally for large printing volumes that require a very fast printer, don't view the selling price of the printer as too expensive. Remember that the faster printer saves time and that time saved is money saved. And the more money the increased speed saves, the faster will your investment pay for itself.

If you take the time and effort to learn all you can about computer printers, weigh all the advantages and disadvantages of each model possibility against your master list of needs, and don't jump into a buying decision until you're ready, you'll be rewarded with a reliable system that can grow with your growing needs. ◇

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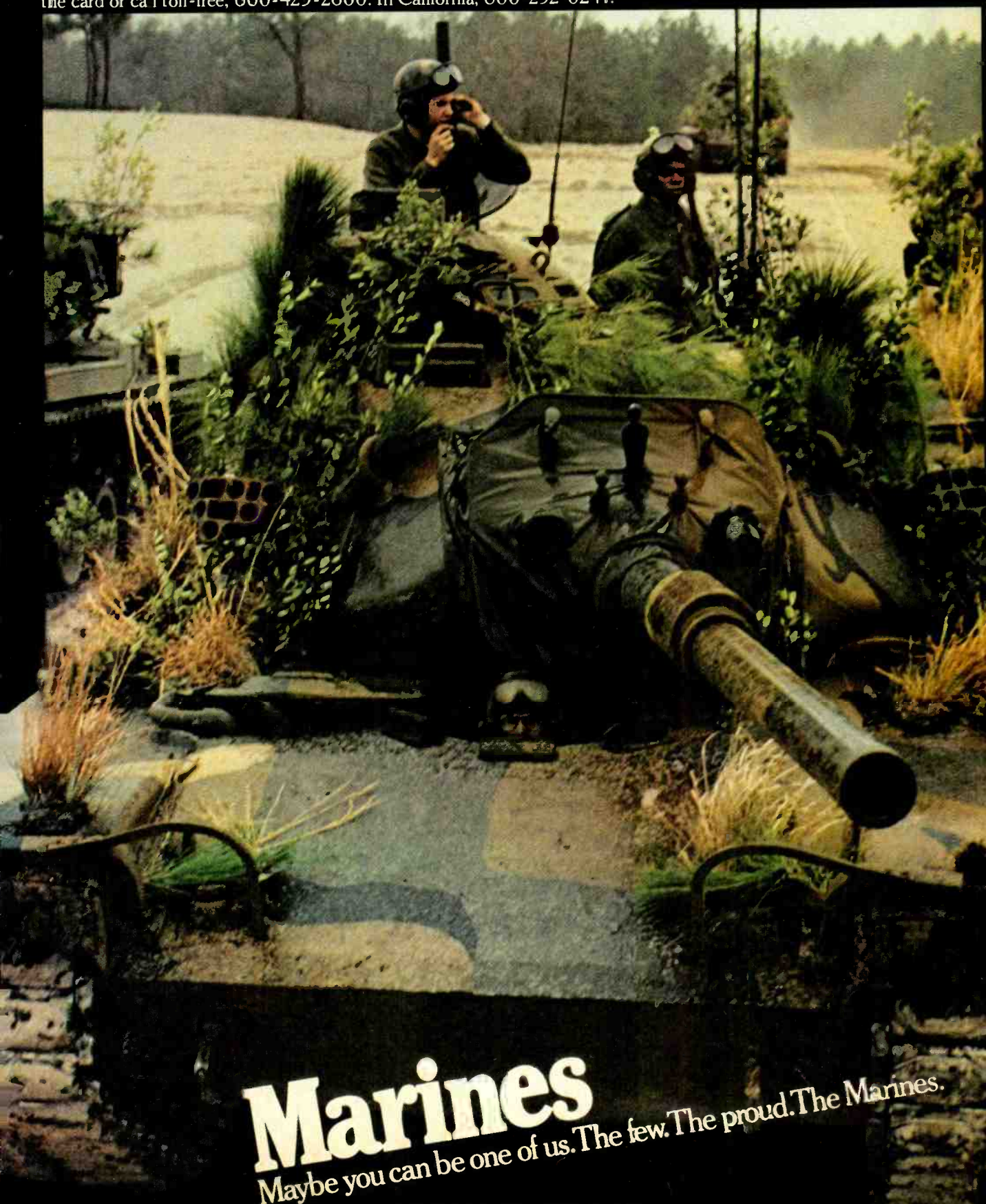

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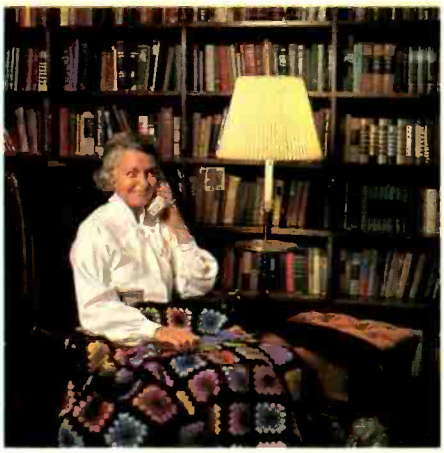
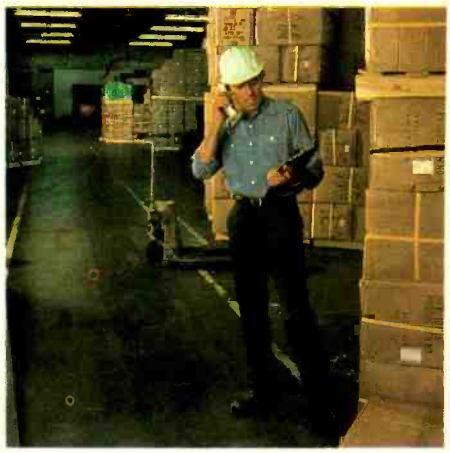

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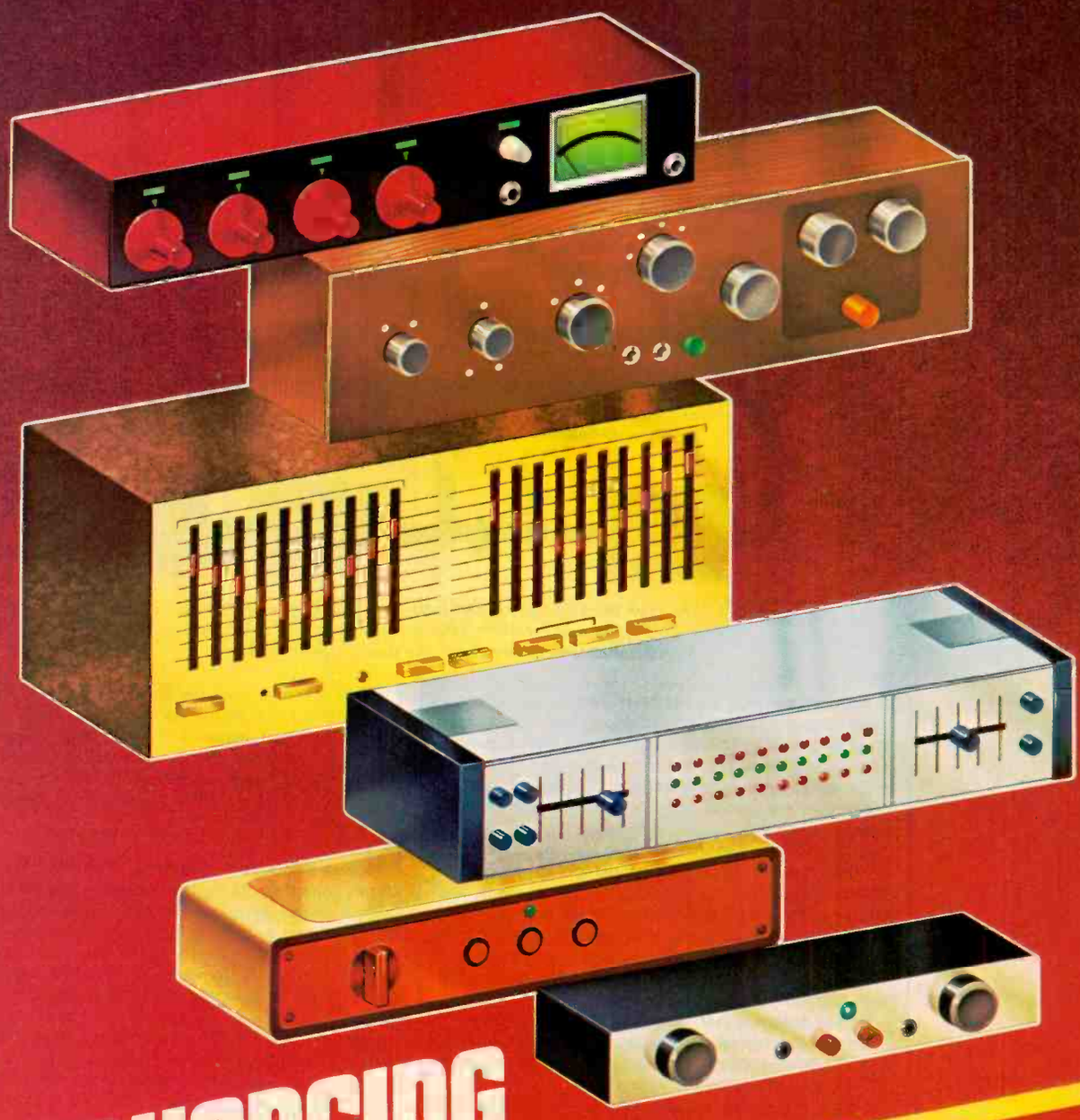


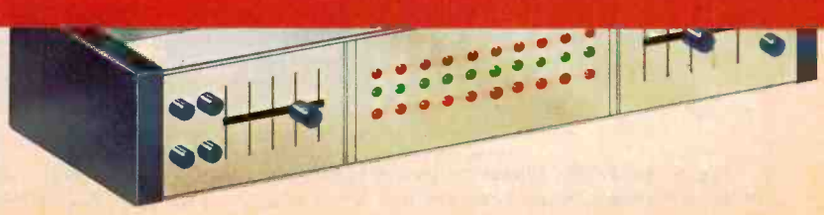
ENHANCING STEREO SOUND WITH SIGNAL PROCESSORS

BY LEONARD FELDMAN

Audio quality is more controllable than you might suspect. Here's how you can eliminate tape hiss and other noises, increase dynamic range, remove annoying frequency peaks, and add more presence in your listening environment.

(over)

ENHANCING STEREO SOUND WITH SIGNAL PROCESSORS



quency response at a prescribed rate (Fig. 10). By

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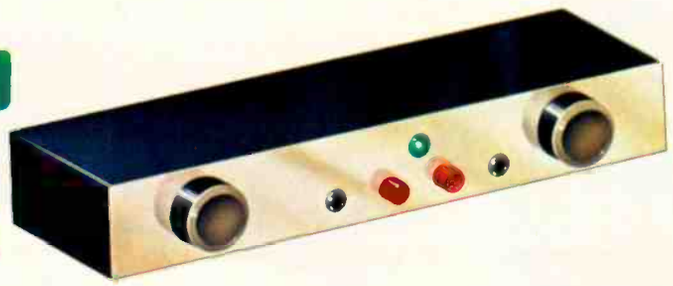

sharply attenuating high-frequency response, tape hiss and record surface noise are greatly reduced. Unfortunately, such attenuation also alters tonal balance, since most musical harmonics (and some fundamentals) fall in the same frequency range as the unwanted noise.

If a high-pass filter's cut-off frequency varied with the needs of the program material, from moment to moment, it would do a much better job at reducing audible noise. Such "dynamic filters" have been around for years now, but only recently have the active elements been available on an integrated circuit (National Semiconductor's LM1894).

The DNR™ system, also devised by National Semiconductor, provides up to 14 dB of noise reduction in stereo program material and is based upon two principles. First, noise output is proportional to system bandwidth (reduce bandwidth and you reduce noise). For example, if bandwidth is reduced from 30 kHz to 1 kHz, system signal-to-noise ratio will improve by 14.8 dB. Second, whenever one sound is heard (music), that sound decreases the ear's ability to hear another (noise). DNR system designers found that if program material is always at least 29 dB above the system noise, adequate masking can usually be obtained.

The DNR system consists of one low-pass filter per stereo channel placed in the signal path with its cut-off point controlled by the amplitude and frequencies of the incoming signals (Fig. 11). Each filter passband is flat, with a smooth roll-off above its cut-off frequency for any control setting (Fig. 12). The filters have a slope of 6 dB per octave, which has been found best for music.

Steeper slopes can be achieved by using two filters in cascade, an arrangement suited to material that lacks substantial high-frequency content. Attack and decay times for the active filter's control circuit have been carefully selected so that very short ticks or noise bursts cannot "open up" the bandwidth of the system. Attack time for the DNR system is 0.5 milliseconds, while decay time is 50 milliseconds (to 10% of maximum value).

The DNR system is finding its way into the audio channels of videodisc players, video cassette recorders, and add-on devices. Other significant single-ended dynamic noise filters have been developed, including the KLH DNF 1201A dynamic noise filter and the Phase Linear 1000 Series Two noise reducer. The Series Two operates on the principle of autocorrelation to provide about 10 dB of single-ended noise reduction.

Eliminating Transients. All of the noise-reduction systems described so far work best with continuous noise levels. However, some of the most annoying distractions are caused by record groove scratches (transients). These familiar ticks, clicks, and pops get through because their attack time is so fast. But a few manufacturers make devices that actually remove those annoying pops and clicks.

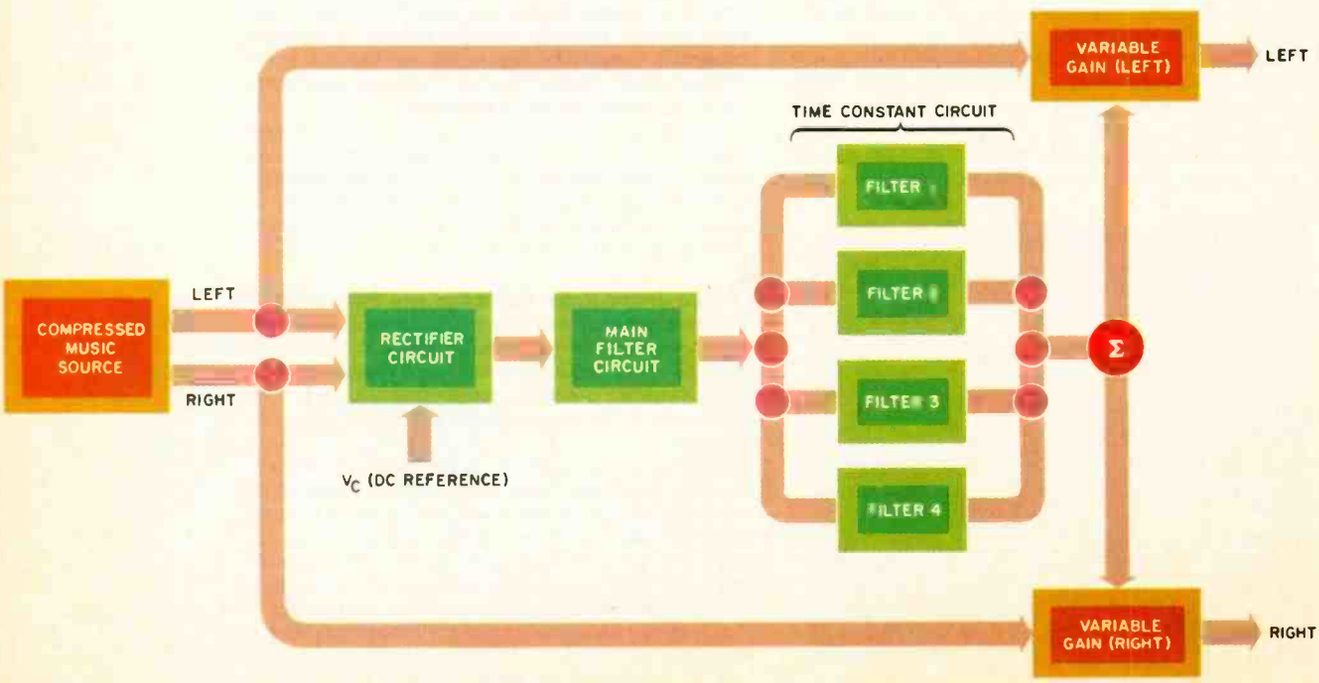

Fig. 9. In the CX decoder, the control of variable gain in the two channels is provided by a rectifier, a main filter, and time-constant circuits.

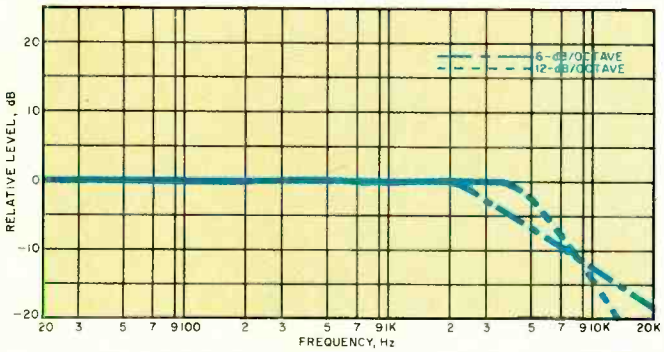

Fig. 10. Typical response of the high-cut filter found in most stereo amplifiers and receivers.

These devices generally operate by placing a short time-delay in the program signal. A sensing circuit detects any sharp clicks, and the delayed program signal path is automatically shut down when such transients are present.

In the more sophisticated units, program material that came just before the pop is substituted to "fill in" during the shut-down period. The whole process typically takes place in less than a millisecond. Examples of available transient noise eliminators include the KLH Corporation TNE-7000 and SAE's Model 5000A.

Single-Ended Expanders. Just as single-ended noise-reduction devices reduce noise in nonencoded program sources, it is also possible to expand nonencoded program material that has been arbitrarily compressed, thereby simulating the dynamic range of the original music. Single-ended expanders work on the same variable-gain principle as the expander portion of a two-sided compander.

However, with single-ended expanders, it is necessary to set "thresholds"—arbitrary signal levels above which the signals are made louder and below which the signals are made smaller. Perhaps the most elaborate unit of this type is the dbx model 3BX in which bass, mid-range, and treble frequencies are processed individually. With this approach, the possibility of audible "pumping" or "breathing" is significantly reduced.

As an example, consider a loud bass drum beat in a single-band system. The drum beat tells the system to increase gain so that the drum will be even louder. If, at the same time, other instruments are playing along (flutes and piccolos or brass), the intensity of these latter instruments also will increase. If the same music was processed through a three-band expander, only the channel involving bass frequencies would have increased gain. Also available from dbx is the model 2BX, which divides the frequency spectrum into two bands before applying expansion, and the much less costly single-band model 1BX.

All dynamic-range expanders provide some noise reduction, too, since they make soft passages (including noise) softer. Other companies who manufacture dynamic-range expanders include RG Dynamics, MXR, Pioneer, and the Heath Company. The Heath model AD-1706 is a dynamic expander noise reducer in kit form.

Variable Bias Enhances Cassettes. Although Dolby is best known for noise-reduction systems, it has also developed an interesting circuit that improves cassette tape dynamic range, particularly at high frequencies when high-level signals are being recorded. A general problem with tape recording is that the recording bias that's best for middle and low frequencies is too great for high frequencies, while optimum for high frequencies is too low for middle and low frequencies.

Dolby reasoned that the "sensing signal" already used to alter high-frequency response (as in the Dolby B

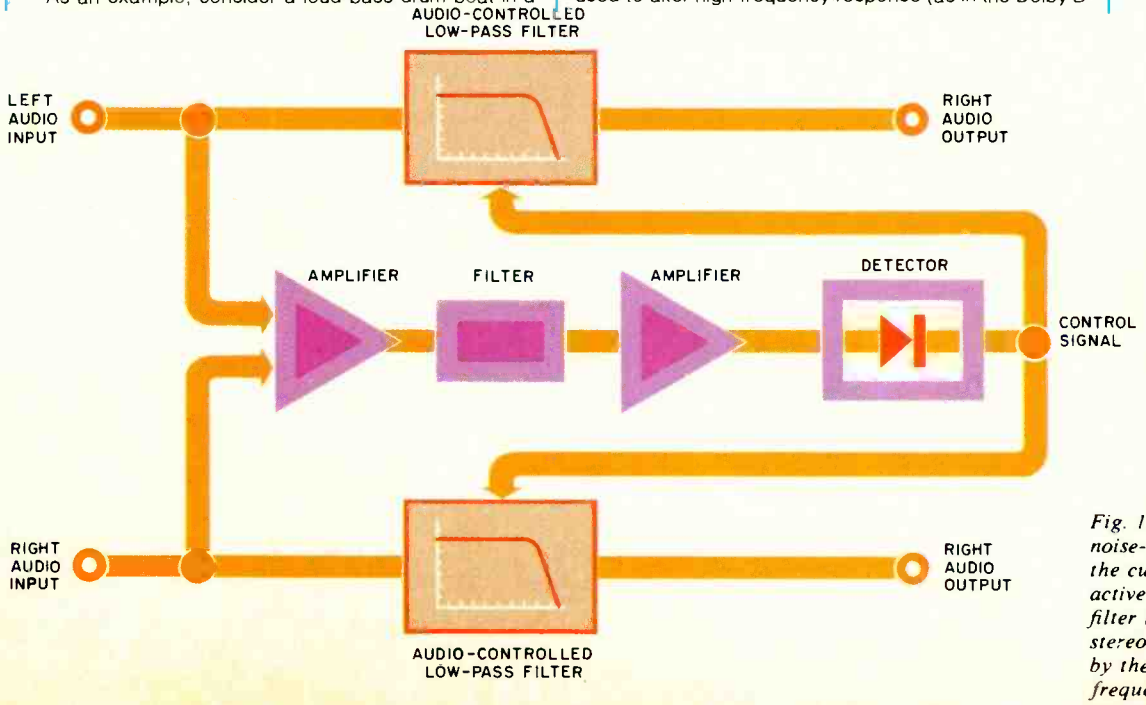

Fig. 11. In the DNR noise-reduction system, the cut-off point of an active low-pass filter in each stereo channel is controlled by the amplitude and frequencies of incoming signals.

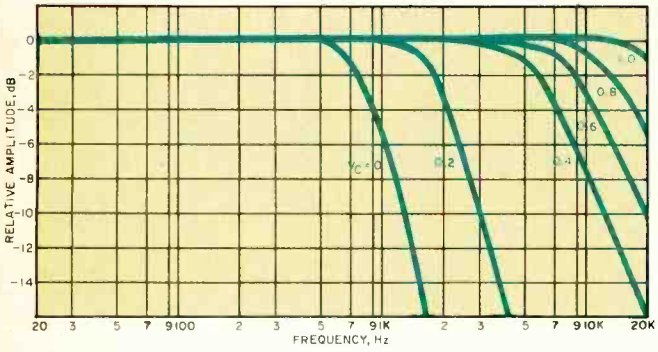

Fig. 12. Audio controlled filter responses for the DNR system relative to various control voltage levels.

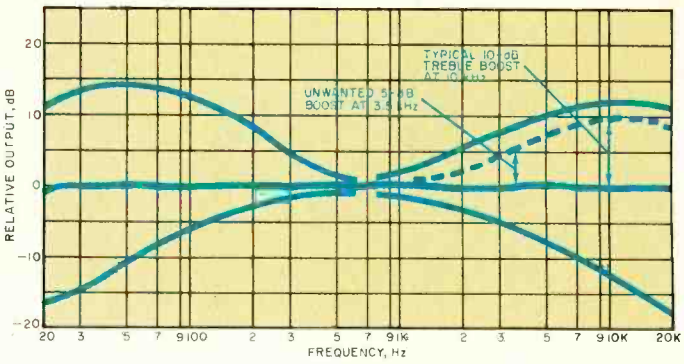

Fig. 13. Solid curves are typical responses of stereo bass and treble controls. Note that any adjustment to correct a particular deficiency affects a wide range of frequencies.

system) could also dynamically vary the recording bias levels, and the best bias level could be maintained for all recorded signals. This bias-varying system (which also alters recording equalization to some degree) is called Dolby HX (for "headroom extension"). It continuously monitors signal content during recording, increasing the bias only when low- and mid-frequency signals are present, and decreasing the bias only when high-level, high-frequency signals are present. It has not been adopted by many audio manufacturers, though.

Bang & Olufsen, the well-known Danish producer of stereo components, recently improved upon Dolby HX (with the blessing of Dr. Dolby) so that the system would not degrade low- and mid-frequency program content while improving high-frequency headroom. The new variation is called Dolby HX Professional and can be found in B & O's latest stereo cassette deck, Model 8002.

Beyond Tone Controls. The typical bass and treble controls found on stereo amplifiers, preamplifiers, and receivers have serious limitations. Ideally, there should be no need for tone controls of any sort. Unfortunately, speakers, listening rooms, and stereo components are not always perfect. That being the case, you must adjust your stereo system response to compensate for one or more noticeable defects.

For example, your loudspeaker system just isn't "putting out enough" from about 8 kHz up. You reach for the treble control, only to find that the upper mid-frequency content of the music has become overpowering (Fig. 13). In attempting to boost the treble by 10 dB at 10 kHz (where you thought the tweeters needed help) you have also boosted frequencies around 2 or 3 kHz by as much as 5 dB. Mid-range boosting wasn't called for, but "all or nothing" tone controls aren't very selective.

Such problems inspired development of the graphic equalizer as an add-on component for home stereo. A graphic equalizer is nothing more than an elaborate tone-control system. Instead of toying with half the audio spectrum, each control on a graphic equalizer may control just one or two octaves, or perhaps half an octave or even one-third of an octave, depending upon the number of controls offered.

Figure 14 illustrates the range available to each of the eight controls per channel of an eight-band stereo equalizer. Any complex curve within the upper and lower bounds of these response plots can be created (Fig. 15). No simple bass and treble controls could have produced this response. Yet such a curve is exactly what is needed to produce a "flat" response in the typical listening environment.

One of the problems inherent in using a graphic equalizer is trying to adjust all of its controls by ear to achieve the desired results. Trying this, some people end up with systems that sound a lot worse than before the equalizer was added.

Because the ear can be deceived without a reference, various methods for adjusting an equalizer have been devised, including special test records, meters, complex real-time spectrum analyzers, calibrated microphones, and oscilloscope displays. Until recently, these sophisticated adjustment methods were so expensive they were primarily the tools of professional sound contractors.

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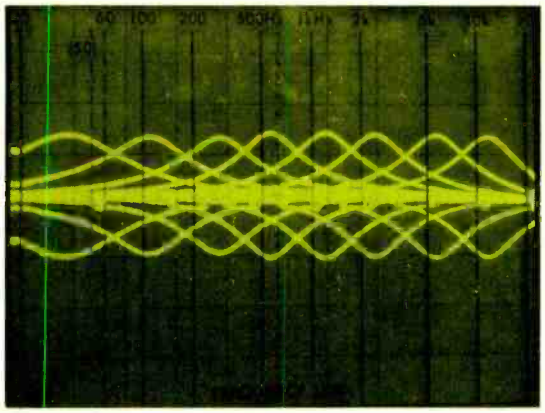

Fig. 14. Multiple response plots show range of control of 8 bands of a graphic equalizer. Horizontal sweep is 20 to 20,000 Hz; vertical sensitivity is 10 dB/div.

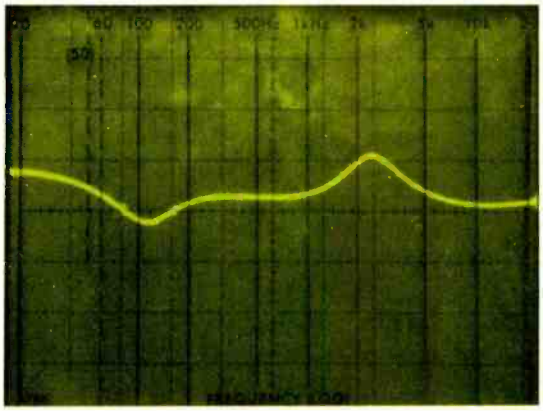

Fig. 15. Complex response curve achieved with the aid of a graphic equalizer could never be accomplished with simple bass and treble controls.

But now there are equalizers which incorporate noise generators, calibrated microphones, and displays that can equalize a system fairly rapidly and inexpensively. Examples are Audio Control's Model C-101 and Soundcraftsmen's AE2420-R, which offer everything needed (built-in) to adjust to their ten-band graphic equalizer.

There are even graphic equalizer/analyzers available that will do all the adjusting by themselves. For instance, Sansui recently introduced its model SE-9—an eight-band-per-channel unit, complete with a spectrum analyzer display, electret microphone and pink noise source (pink noise contains equal energy in each audio octave). Just position the microphone where you intend to listen, push a button, and sit back as tiny motors adjust each control's position for a flat response (as perceived by the microphone).

The whole operation takes less than half a minute. And the SE-9 can memorize the curve it has established for up to four locations about your listening room. It can recall any one at the touch of a button.

Another self-adjusting equalizer/analyzer is the Model 20/20 offered by dbx. This unit features an electronically adjusted 10-band equalizer (no moving slider controls), with the final setting appearing on a large LED grid—the same grid used for real-time spectrum analysis when the device is going through its microprocessor-controlled self-adjustment routine. The 20/20 will remember ten different equalization curves (one can even be the average setting based on the other nine responses), and it comes complete with a calibration microphone and a built-in pink noise source. A special feature is the unit's built-in sound pressure level meter. It reads directly in decibels for an exact measure of how loud the program is at a particular listening location.

Acoustic Research has shown a prototype model of a digital signal processor that uses a Texas Instruments TMS-9995 16-bit CPU. With a built-in dedicated computer, it is said to automatically adapt music signals to the needs of the loudspeaker and room it's correcting.

Fewer Bands, More Adjustment. There is another type of equalizer which is also used in conjunction with home stereo: the parametric equalizer. A parametric equalizer may have far fewer frequency bands than a graphic equalizer (usually only three or four), but each of these bands can have three degrees of adjustability.

Like a graphic equalizer, the amount of boost or cut at the center frequency of any given band is adjustable. However, you can also move the center frequency of each band over a substantial range. Furthermore, you can adjust the range of frequencies affected by each control (Fig. 16).

Audio experts who favor parametric over the graphic equalizer argue that, in most audio systems, there are only two or three frequency regions that require compensation. While the center frequencies of such response aberrations may not be exactly predictable, the number of such aberrations is never enough to justify ten or more separate control bands. By providing just a few bands, with the center frequency of each adjustable over a fairly wide range, parametric equalizers are said to accomplish what is needed without unnecessary complication.

The ability to change the frequency range within each band (variable filter "Q") makes parametric equalizers particularly flexible. It is not unusual for the peaks and valleys in a system's overall response curve to be extremely narrow. In the bass region, for example, there can be a resonance caused by room dimensions involving just a few hertz of bandwidth. The Q adjustment permits compensation for such a narrow deviation without affecting nearby frequencies.

Parametric equalizers for consumer use are available from Phase Linear, Rotel, SAE, and Superex. ADC Pro-

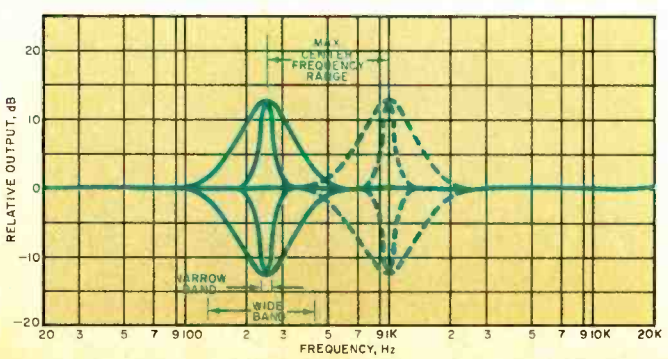

Fig. 16. The parametric equalizer has active filters whose center frequency, gain, and Q (bandwidth) can be independently adjusted over a wide range.

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fessional Products (Division of BSR) manufactures a "Paragraphic" equalizer (Model Three IC) which combines the features of both parametric and graphic equalizers. This company also makes a relatively inexpensive real-time spectrum analyzer with a built-in pink-noise generator and calibrated microphone that can be used to adjust any type of equalizer. Real-time analyzers with similar price and performance specs are also available from Crown International, Rotel, H.H. Scott, and Soundcraftsmen.

Ambience and Stereo Enhancers. The last major group of audio enhancement devices surveyed here embraces two basic product types: those that electronically alter the listening room acoustics and those that enrich the stereo effect of a two-channel program. In the first category are audio time-delay units. They introduce a 20-100-ms time delay (often variable) to the stereo signals and then feed the delayed signal to an auxiliary speaker pair (usually positioned behind or to the extreme left and right of the listener).

In any concert hall of reasonable size, sounds reach the listener's ears a few milliseconds after they leave the performers' instruments. Those sounds also reach various reflecting surfaces (walls, balcony, ceiling), then return to the listener delayed and attenuated; and the first set of reflections is not the last. Additional reflections reach the listener even later—and at a progressively diminishing amplitude (Fig. 17). All these reflections (beyond the first early reflection) determine the building's reverberation characteristics and are unique to each concert hall.

It is easy to appreciate that when a record, tape, or radio program is played at home in a small room, the sense of space cannot be conveyed with two speakers mounted against one wall. This is true even if the reverberance of the concert hall has been "mixed in" with the stage sounds in the stereo recording. In real life, reflected sound would reach the listener from directions other than "stage front" and arrive delayed relative to the sounds emanating from the two primary speakers in a typical stereo system.

Early attempts at recreating the ambience of an original performance were made with rather crude "reverb" units that used metal springs with transducers at one end and pickups at the other to artificially create the missing time delays. Expensive reverbs often performed quite well (some recording studios use such systems today), but most imparted a metallic, "twangy" sound to the program. Now, thanks to microcircuitry, audio time delays can be created electronically. Two basic devices are used: one involves digital electronics, the other charge-coupled devices (CCDs).

With the digital approach, program signal amplitudes are translated to numerical pulse codes with an analog-to-digital converter. In this coded form, the information can be stored in short-term memory and then released after a few milliseconds for conversion (by means of a digital-to-analog converter) back into audio.

The CCD approach to audio time delay involves solid-state devices that act much like a chain of small capacitors connected in cascade. Signals applied at one end of the chain make their way down the line bucket-brigade style from one "capacitor" to another, taking a discrete amount of transition time. The CCD technique is in the analog realm, but delivers the same result as a digital time-delay system.

Of course, to completely replicate the reflection pattern depicted in Fig. 17 requires that signals be fed back again and again, circulating the early reflections as well as the original signals around and around to create "concert hall" ambience. Some manufacturers have

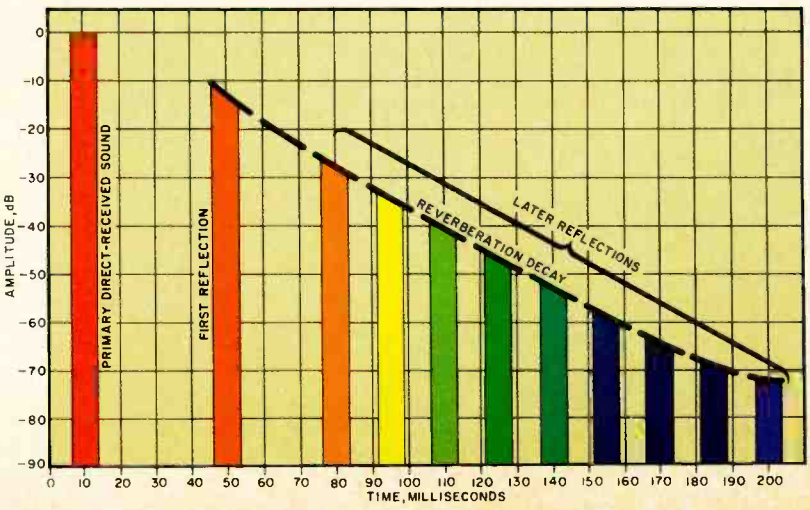

Fig. 17. This reflection and reverberation pattern must be generated electronically to simulate "live" music in a large concert hall.

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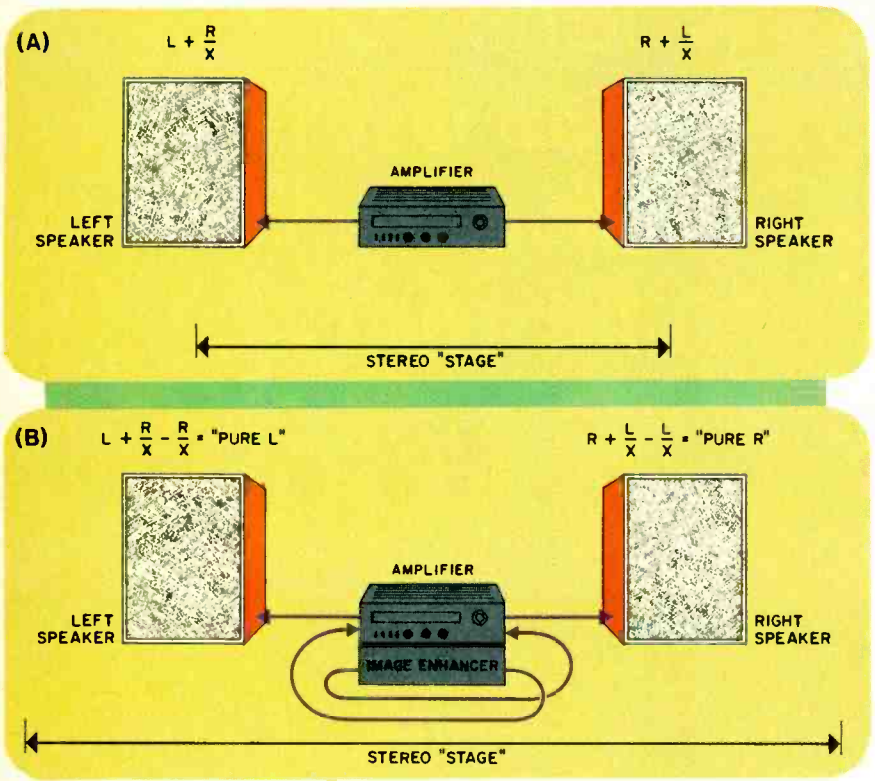

Fig. 18. The basic principle of stereo image enhancement involves adding out-of-phase cross-channel signals to each main stereo channel.

introduced devices that fulfill these requirements in varying degrees. All use a second pair of speakers, and some systems provide the extra stereo amplifier that's required.

Many companies produce audio time-delay units. Though some use descriptive names, such as the Sound-Space Control by Advent and the Ambience Restoration System by Sound Concepts, they all accomplish much the same result. There are differences in adjustments and range of control, of course. The ADS Company offers Model ADS 10, a digital delay system that includes a 100-W/channel stereo amplifier plus an extra pair of speakers. (The same product—minus the amplifier and speakers—is available as Model 1001). Other units include the Koss Corporation's digital (16K RAM) Model K-4DS, Phase Linear's analog Model 6000, SAE's Model 4100, the Bose CCD Spatial Expander, Pioneer's SR303, and Sansui's RA-700 reverberation amplifiers. Sound Concepts makes a version of its Ambience Restoration System for use in automobiles. Prices for audio time-delay units vary greatly, with basic units (not including the extra amplifier or extra pair of speakers) starting at about $400, and complete systems costing well over $1000.

Related to the audio time-delay units, but simpler (and very different) in terms of circuitry, are the stereo image-enhancement devices. These devices attempt to broaden the apparent "sound stage" from side to side (and, in some instances, even from front to back), giving a "third dimension" to stereo music reproduction. Space does not permit a detailed description of all these devices, but a brief analysis of one general approach gives an idea of what's involved.

In a typical stereo program, the left speaker reproduces the signal that was "picked up" by the left studio microphone (or microphones) plus some small amount of sound that was intended for the right microphone (or microphones). The converse is true at the right loudspeaker. "Right" information coming from the left speaker and "left" information from the right speaker reduce the apparent separation. If both speakers reproduced equal amounts of left and right information (the extreme case), sound would be "heard" only from a midpoint between the two speakers, and there would be no stereo separation at all.

In the early days of stereo, it was discovered that by adding some out-of-phase "left" information to the right-channel signal and some out-of-phase "right" informa-

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tion to the left-channel signal, apparent stereo separation increases dramatically. This is because the out-of-phase components (having opposite polarity compared with in-phase signals) cancel the unwanted opposite-channel sound components which were present in the original program material (Fig. 18).

When more out-of-phase opposite-channel material than necessary to cause this cancellation is crossfed, it becomes possible to greatly exaggerate the stereo effect. Now sounds seem to originate from points beyond the space between the two speakers.

This explanation is, admittedly, oversimplified. Some stereo-enhancement devices go far beyond simple phase inversion, employing angular phase shifts and time delay, in combination with other electronic manipulation. An example of such a stereo image-enhancement device is incorporated in the Carver C-4000 Sonic Hologram Generator Control Console, which includes "Auto Correlator" noise reduction, dynamic range expansion, time-delay features, and a power amplifier. The Sonic Hologram Generator feature alone is also available as the Carver C-9 at only moderate cost.

Omnisonix, Ltd. offers both its Model 801 Imager for in-home use and the 801-A for in-automobile image enhancement. Other stereo image devices currently available include the Audionics Space and Image Composer, the JVC BN-5 Biphonic Processor, and the Sound Concepts IR-2100 Image Restoration System. Also, Phase Linear has a device, the Model 180, designed for use with headphones to reduce the "in-head" localization effect so common with headphone listening.

Sony's recently introduced SEH-10 combines a graphic equalizer with an echo/reverb system, a stereo image enchancer, and a microphone mixing input. Pioneer Electronics of America, too, recently announced a new signal processor, its BP-520 (replacing its AD-30). Designed for car use, it's a seven-band graphic equalizer with built-in variable echo.

Mixers Make a Difference. Once you go beyond recording off-the-air or copying records, you will soon discover that a single microphone—or even two for stereo—will not deliver a professional-sounding live recording. That's when it's time to look into microphone mixers—devices that accept several microphone signals while controlling the relative levels of each independently. Sounds are mixed together to create one composite output signal for each stereo channel.

Though most home users would be intimidated by the 24-, 32-, or even 48-track consoles found in professional recording studios (they're really just mixers, too), mixers sold for home use have just 2 to 16 inputs. They may include line-level input capability so that you can mix several microphone inputs with outputs from preamplifiers (tapes, records, broadcasts). Among the better-known compa-

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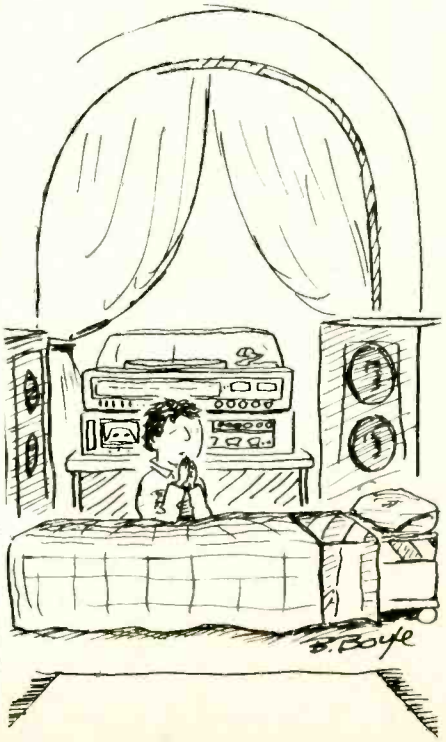
nies manufacturing small consumer-type audio mixers are JVC, Pioneer, Sansui, Shure Brothers, Sony and Teac (through its TASCAM division).

With the aid of a small mixer, you can make live recordings sound a lot more professional than they would if just the left and right "mic inputs" on your cassette or reel-to-reel machine were used.

Conclusion. Several other interesting outboard and built-in circuits for enhancing the home stereo music system are available. For example, no discussion of stereo enhancement would be complete without a brief mention of what is affectionately known as the "boom box"—officially designated the Model 110 Subharmonic Synthesizer by its maker, dbx, Inc.

This ingenious device actually "creates" subharmonics of any bass frequencies present in the program material. If the device is fed a 100-Hz signal, for example, it delivers not only 100 Hz, but significant amounts of 50 Hz (the subharmonic) which wasn't present in the original program. While some audio purists frown upon adding anything to recorded music that wasn't there to begin with, others find the effect pleasing. (Hard rock and disco usually benefit from a bit of bass boost).

From the foregoing, it's clear that you are not tied to what your basic stereo system can produce in a given listening area. Electronic signal processors offer many ways to let personal taste shape reproduced sound. ◇



"And thank you for the miracle of ambient sound."

Servicing Solderless Sockets

Contacts and holes should be cleaned periodically

BY JOHN T. BAILEY

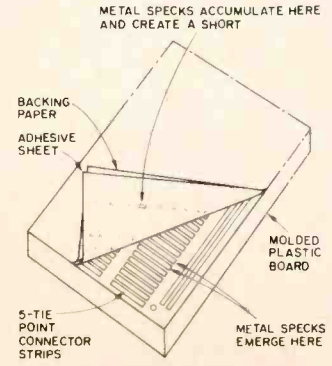
SOLDERLESS molded circuit boards, often called solderless sockets, made by a number of manufacturers, are excellent devices for breadboarding circuits. However, after long use, they may develop faults, the two most usual being poor electrical contacts and holes plugged with wire inserts that have broken off flush with the board. Another problem that arises from time to time is internal short circuits for no apparent reason.

Poor electrical contacts result from deformation of internal pin connectors after many cycles of use. Plugged holes occur when wire is nicked during insulation stripping so that, with flexure, it breaks off slightly below the upper surface of the board and is almost impossible to remove. Intermittent shorts, as we shall see, arise in a more complex way.

Cures. A typical solderless socket (see drawing) has a backing paper and an adhesive sheet covering its underside. Carefully remove both of these to expose the electrical connectors. Then use a pin to push out any short lengths of wire stuck in connectors. Long-nose pliers can be used to pinch each connector prong very gently to improve contact. Then use a fine brush to clean the underside of the socket.

Examine the side of the adhesive sheet that faced the contacts. There may be small islands of metallic specks adhering to the sheet in some places. These specks, apparently soft metal scraped from wire jumpers or IC pins during insertion and removal, drop into the internal troughs and pile up to short adjacent contacts. Solve this problem by turning the adhesive sheet over so that its clean side is against the connector strips. Then restore the backing paper to its place.

By performing these simple maintenance steps regularly, you can reduce the chances that a serious breadboarding session will be interrupted by a malfunctioning solderless socket. And each socket should have a longer useful lifetime as well. ◇



A typical solderless socket has a backing paper and an adhesive sheet covering its underside.

4-TO 3-WIRE TAILLIGHT CONVERSION

Connect brake and turn signal lights of trailers to foreign cars

BY MICHAEL S. CRANMER

VIRTUALLY all foreign cars and trucks have taillights that use separate bulbs for the turn signals and brakes. This type of system uses a 4-wire configuration, which makes it possible to have the turn-signal light blinking and the brake light on at the same time on the same side. A problem occurs, however, if you want to hook up a U.S.-made trailer to the foreign car or truck. Trailer lights are usually wired on a standard 3-wire system. That is, the turn signal and brake light share the same bulb. With this configuration, if the brake is on and the right signal is on, the right bulb blinks while the left bulb indicates brake operation.

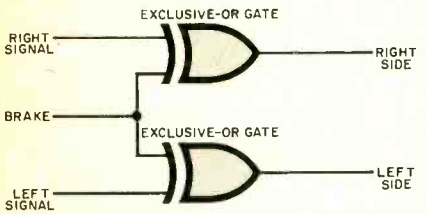


Fig. 1. Basic signal connections to the EXCLUSIVE-OR logic gates.

The problem of connecting a 4-wire signal system to a 3-wire system can be solved by using an EXCLUSIVE-OR gate between the two systems. The truth table for this logic gate is given in Table I while the basic connections to the gate are shown in Fig. 1. Figure 2 shows all possible input conditions of left or right signal and brake light with the resultant output of the EXCLUSIVE-OR gate. Note that the ground wire is not shown in Fig. 2. The complete schematic of the circuit is shown in Fig. 3.

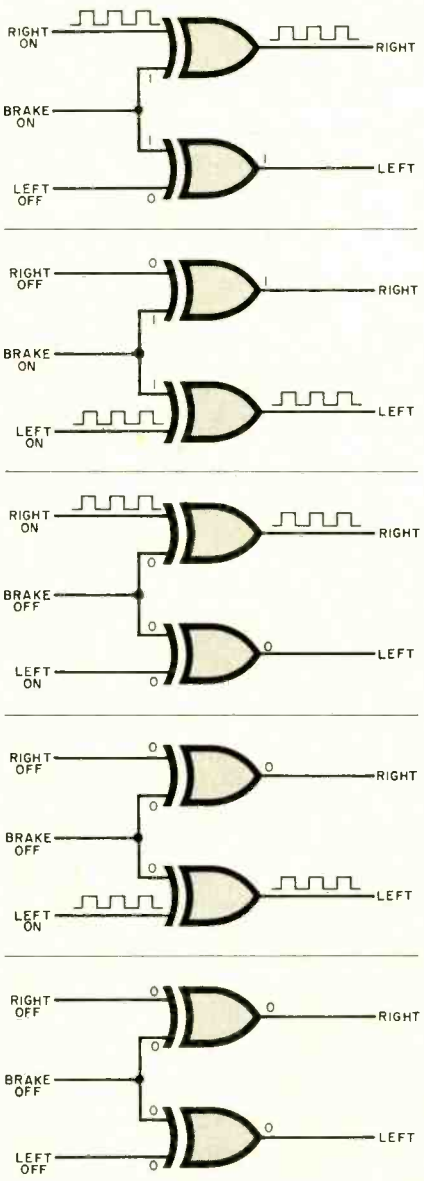


Fig. 2. All possible input conditions of directional and brake signals.

Circuit Operation. The circuit is powered by the signal display system on the foreign car or truck. The three diodes, in parallel with the inputs, conduct current to the power Darlingtons and the EX-OR power supply pin. The diodes also prevent current from conducting back to another gate input. (These diodes are not needed if a separate 12-volt line is run from the battery.) The three 1-kilohm resistors, tied to the inputs of the gates, are used to pull to ground the input gate voltage. (This is needed to keep the gate inputs from floating high.) The other 1-kilohm resistors are used as current limiters. Unused input pins on each gate must be tied to V_{cc} or ground. Also it would be advisable to place an in-line fuse on the 12-volt supply.

TABLE I—EXCLUSIVE-OR TRUTH TABLE

Inputs		Output
0	0	0
0	1	1
1	0	1
1	1	0

Construction. Building this circuit is simple and inexpensive. Most of the parts can be mounted on a piece of perfboard with the power Darlingtons mounted on heat sinks. Usual care should be taken with the CMOS IC to insure that it is not damaged by static electricity. ◇

PARTS LIST

D1-D3—1N4004 diode
IC1—quad 2-input exclusive-or gate
R1-R5—1-kΩ, ¼-watt resistor
Q1,Q2—2N6388 power Darlingtons, (Radio Shack 276-2068 or similar)
Misc.—Case, perfboard.

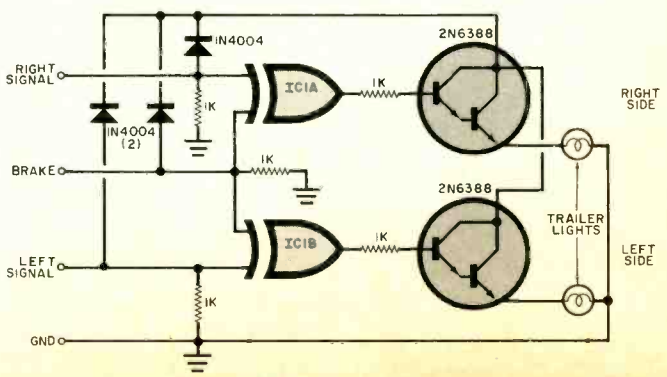
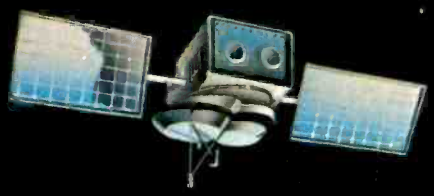


Fig. 3. Complete schematic of the circuit between car and trailer lights.



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GX-388

ADD DOUBLES TO YOUR COMPUTER

BY JAMES BARBARELLO

Peripheral allows two to play computer games without crowding the keyboard.

MICROCOMPUTERS can be programmed to play many interesting games, especially those involving two human players (as opposed to one person playing against the computer). Usually, this involves each player, in turn, operating a specific key on the keyboard. Some systems use two joysticks with associated pushbuttons so that two players can compete without getting in each other's way. However, many systems do not include joysticks, so two-person games played on a keyboard become a little difficult when the action gets hot and heavy.

The Doubles peripheral presented here (Fig. 1), consists of a battery-powered two-IC circuit with two independent pushbutton switches, each at the end of a length of slender two-conductor cable. When connected to a cassette port, for example, and used with a simple BASIC program, the two players can now participate without interference in any game that requires only a simple key closure as an input. Although designed for a TRS-80 Model I, the approach can be adapted to almost any system whose BASIC includes OUT and INP (or their equivalents), with the "called" port easily accessible.

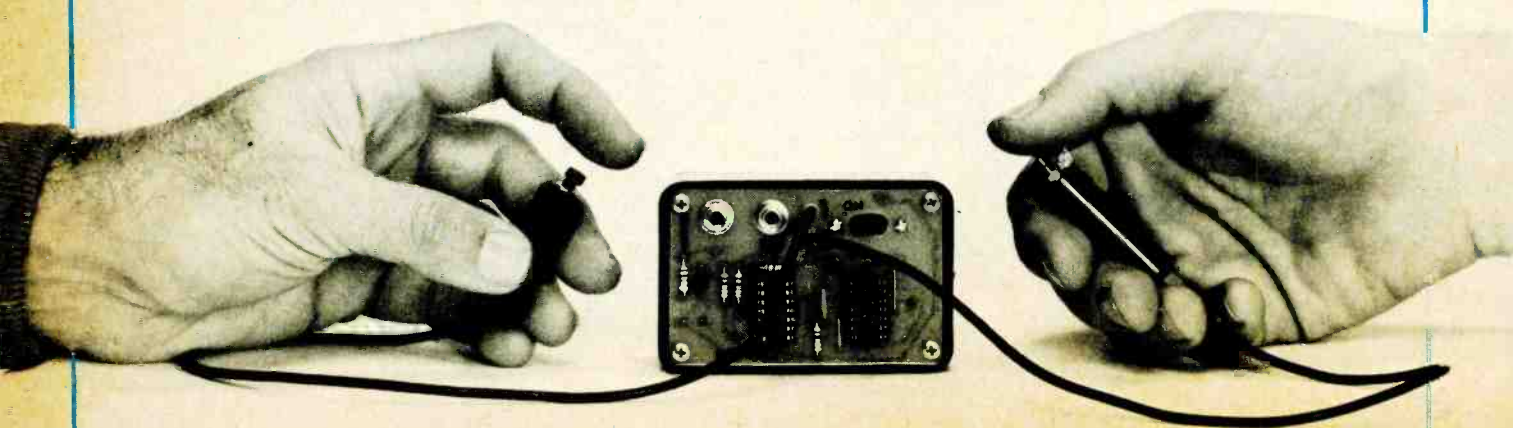
In the case of the TRS-80, when the BASIC command OUT 255,1 is issued, a logic-1 voltage level is present at output port 255 (cassette), while OUT 255,0 drops this voltage to the logic-0 level.

The command INP(255) senses the voltage level between the tip and ring of the cassette plug. If a logic 0 is present, the command will return the number 127. If a logic 1 is present at the cassette plug, the number 255 is returned.

Thus, by choice of OUT and INP commands, it is possible to communicate with an external circuit connected to the cassette port, and receive back its current status.

Circuit Operation. Two identical flip-flops, each having independent data, set, reset, and clock inputs, and Q and $\overline{Q}$ outputs, are contained in *IC1*. The logic level present at the D input is transferred to the Q output during the positive-going transition of the clock pulse.

When power is first applied (via *S3*), *C1* and *R3* produce a momentary pulse that loads input D of *IC1A* with



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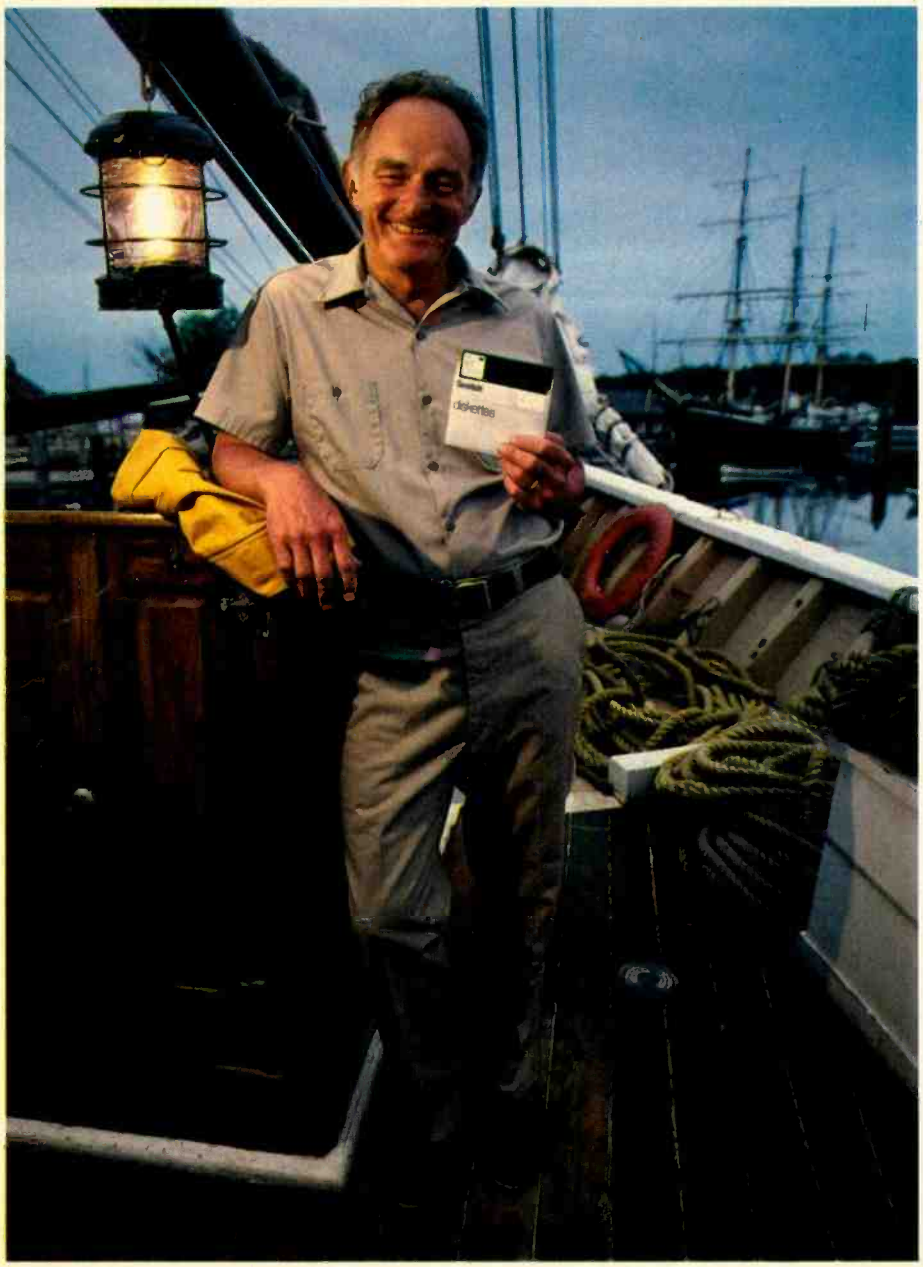

Eben Whitcomb, Owner-Operator, Dirigo Cruise Company, Clinton, CT

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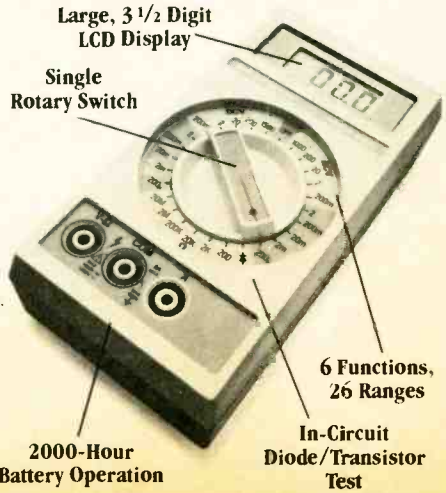
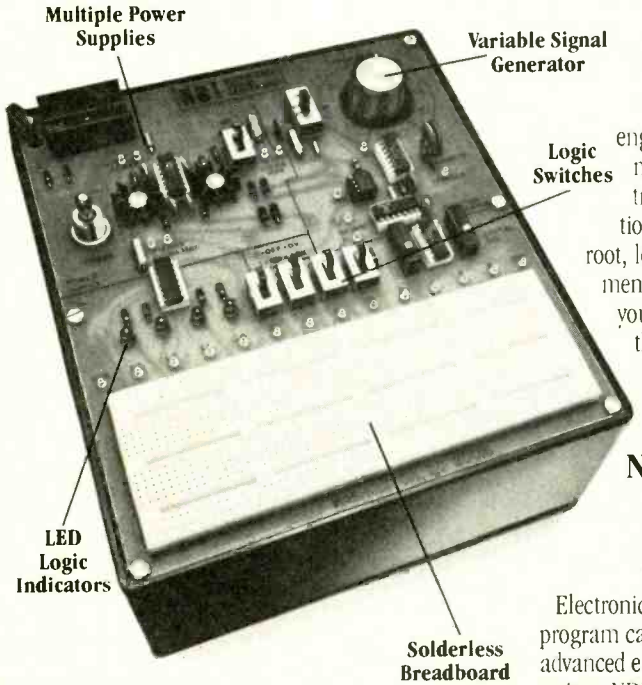


ELECTRONIC LOGY TRAINING



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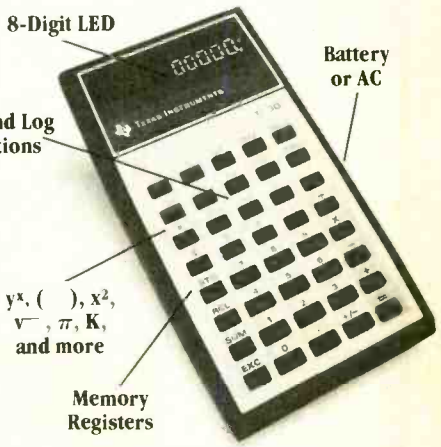

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a logic 1 and input D of *IC1B* with a logic 0. This occurs because of the set/reset action. Each time a clock pulse is applied to the clock inputs, the data on pin 5 is shifted through the Q output to the data input of *IC2B*, and the Q output of *IC1B* is loaded into the D input of *IC1A*. The net result is that, with clock pulses, a logic 1 alternates between the $\overline{Q}$ outputs of *IC1*.

Clock pulses from the computer output port are fed via *J1* and *R1* to the base of *Q1*. The output of *Q1* is connected to *IC2D* which acts as an inverter. The output drives the clock inputs of *IC1* and pin 9 of NAND gate *IC2C*.

The two inputs of gate *IC2B* are tied high via *R4* and *R5*. If both *S1* and *S2* (the player switches) are open, the output of *IC2B* is low and *IC2C* is high. With both inputs of *IC2A* high, a low is present at *J2*.

Without connections to the computer, if either player closes his switch, the logic states change and a high appears at *J2*.

When the circuit is connected to the computer and power applied, the circuit defaults with a logic 1 in *IC1A*. The simple software has made the computer aware that this condition has occurred, and from then on, each time the computer issues a clock pulse, it "knows" which flip-flop is being used. Since the computer can issue clock pulses very fast, both operators appear to be on-line at once.

Construction: The Doubles circuit can be built up on a perfboard, or a printed-circuit board constructed using the pattern of Fig. 2. Before handling the CMOS ICs, touch a ground point (such as the screw holding an outlet cover) to remove any static charge you might have. Mount jacks *J1*, *J2*, and switch S3 on the pc board as shown in Fig. 3. Connect battery clip *B1* at this time.

The final step is to construct and attach two switch assemblies. Each of these consists of a normally open pushbutton switch, about 18" of thin (1/8" diameter) coaxial cable and a 1/4" plastic phono plug cover. Strip one end of the coax cable and solder the center conductor to either switch lug. Solder the outer braid to the remaining switch lug. Make a knot in the cable about 1" from the switch lugs and pass the free end of the coax cable through the phono plug cover so that it exits the smaller end. Tighten the nut on the switch and then coat the sides of the switch with epoxy or a similar adhesive and push it into the large end of the cover as far as it will go. Wipe off any excess adhesive and let set. Repeat for the other switch.

When both switch assemblies are complete, pass the cables through the two 1/8" holes in the pc board (so that the cable ends are on the *foil* side). Strip the cable ends and attach to the board as shown in Fig. 3.

Attach a 9-volt battery to the battery clip. The unit can be used "as is" or can be mounted in a cabinet. (The pc board has been designed to replace the top cover of Radio Shack's Experimenter Box #270-231. The battery is taped to the inside of the box.)

Testing. Using the TRS-80 Model I or III as an example, connect the grey (large) cassette plug to *J1*, and the black plug to *J2*.

Enter the following short program into the TRS-80:

```
10 CLS
20 OUT 255,1: OUT 255,0
30 OUT 255,1: OUT 255,0:
  IF INP(255)=255 THEN PRINT "1",
40 OUT 255,1: OUT 255,0:
  IF INP(255)=255 THEN PRINT "2",
50 GOTO 30
```

Line 10 clears the screen, and line 20 initializes the Doubles circuit. Lines 30 and 40 alternately check for a closure of *S1* and *S2* respectively. Line 50 loops back to line 30, thus creating an endless loop that continuously checks the status of the switches. Turn switch *S3* ON and RUN the program.

Press switch *S1* and note that a series of 1s appears on screen as long as this switch is depressed. Release *S1* and close *S2*. Note that a series of 2s now appear. Holding both switches down simultaneously will cause alternating 1s and 2s. You can now identify and mark *S1* and *S2* for future use in playing.

Using the Circuit. To use the Doubler effectively, the computer must know which switch was operated, which was depressed first, and wheth-

PARTS LIST

B1—9-volt battery
C1—0.1-μF disk capacitor
IC1—4013 dual D flip-flop
IC2—4011 quad 2-input NAND gate
J1,J2—1/8" phono jack
Q1—2N2222A or similar
R1 through R5—10,000-ohm, 1/4-watt resistor
S1,S2—Normally open pushbutton switch (Radio Shack 275-1547 or similar)
S3—Spst switch
Misc.—Suitable lengths of 1/8" diameter coaxial cable, plastic enclosures for switches, epoxy, battery holder, suitable enclosure, etc.
Note: A complete kit of parts (less case and adhesive), including a game called DogRace that uses a program similar to that illustrated in this article, is available for $20 from J.J. Barbarello, RD 1, Box 241 H, Tennent Rd., Englishtown, NJ 07726.

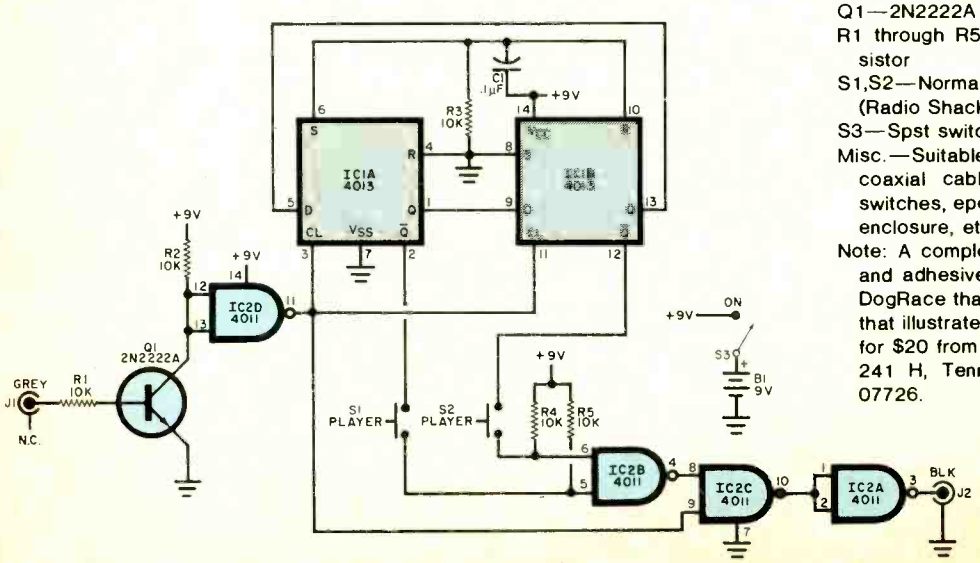


Fig. 1. The circuit consists of two IC flip-flops with the pushbuttons attached.

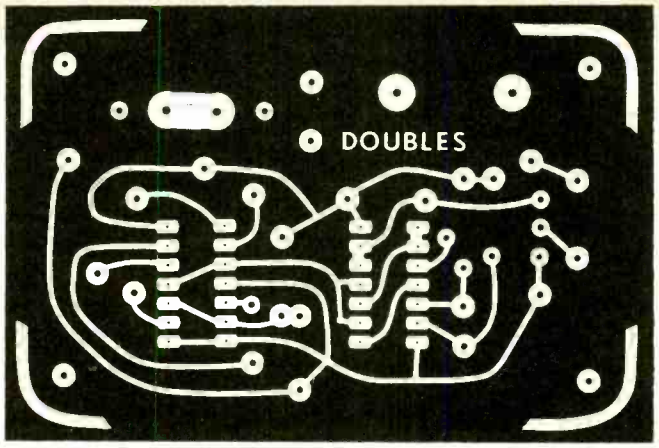


Fig. 2. Use this same-size foil pattern for the pc board.

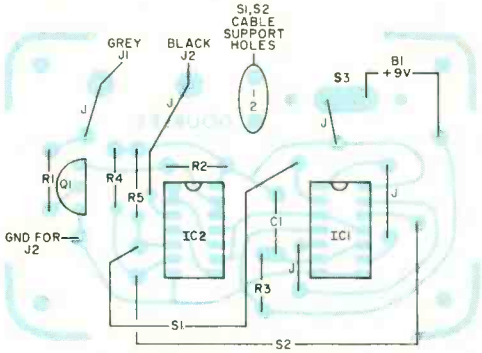


Fig. 3. Component layout for the pc board.

er a switch was depressed when it should not have been.

Enter the following sample program:

```
10 CLS: OUT 255,1: OUT 255,0
20 PRINT @ 408, "** GO **"
30 FOR J = 1 TO 20
40 FOR I = 1 TO 2: OUT 255,1: OUT
   255,0
50 IF P(I)<>255 THEN P(I) = INP(255)
60 IF P(I)=255 AND P(0)=0 THEN
   P(0)=I
70 NEXT I,J: PRINT @ 408,
   STRING$(8,32)
80 IF P(1) = 255 THEN PRINT "#1",
90 IF P(2) = 255 THEN PRINT "#2",
100 PRINT "#";P(0);"FIRST"
110 FOR I=0 TO 2: P(I)=0: NEXT I
120 FOR J = 1 TO 10 + RND(30)
130 FOR I = 1 TO 2: OUT 255,1: OUT
   255,0
140 IF P(I)<>255 THEN P(I) = INP(255)
150 NEXT I
160 IF P(1)=255 THEN PRINT@408,
   "FOUL #1":P(1)=0
170 IF P(2)=255 THEN PRINT@408,
   "FOUL #2":P(2)=0
180 NEXT J
190 FOR I = 0 TO 2: P(I)=0: NEXT I
200 GOTO 20
```

Lines 20 through 110 are the scoring lines, after line 20 prints ** GO **, line 30 causes the computer to loop through lines 40 through 70 twenty times. Each time line 40 "clocks" the Doubles circuit, line 50 "looks" for a switch closure. If a switch closure has been made, line 60 checks to see if it is the first. If it is, that switch number is stored as variable P(0). Lines 80 through 100 print out the number of the depressed switches, as well as which was closed first. Line 110 clears the variable P(0), which was first; P(1), switch 1 indicator; and P(2), switch 2 indicator.

Lines 120 through 180 are similar to lines 30 through 70, but these check for foul. The number of circuit scans is randomly chosen in line 120. Since there is no need to know which switch closed first in a foul situation, P(0) is not used. On each scan of the circuit, lines 160 and 170 check for a foul. If so, this information is printed. Line 190 clears variables P(0), P(1), and P(2), while line 200 loops the program back to the beginning.

To use the program, enter and run it. When ** GO ** appears on the video display, either or both switches may be operated. The switch number as well as which switch was operated first will appear on screen. If a switch was depressed before the ** GO ** appeared, then the "foul" indicator will appear. This short program can be used as the basis for many game programs, with scoring and graphics added if desired. ◇

CONTROLLING AC POWER

BY RALPH TENNY

Different methods of power control from simple on/off switching through digital and computer operation

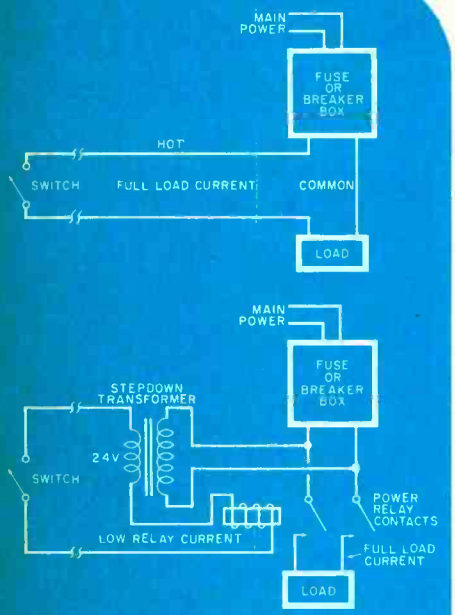


Fig. 1. Line-voltage control (A). Low-voltage system using a relay (B).

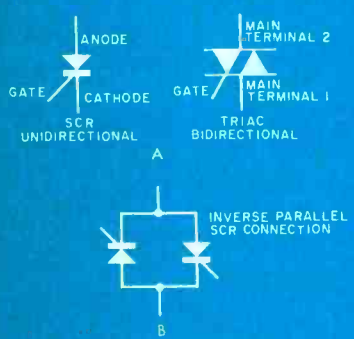


Fig. 2. Symbols for the SCR and triac (A). Two SCRs operating in an inverse parallel connection (B).

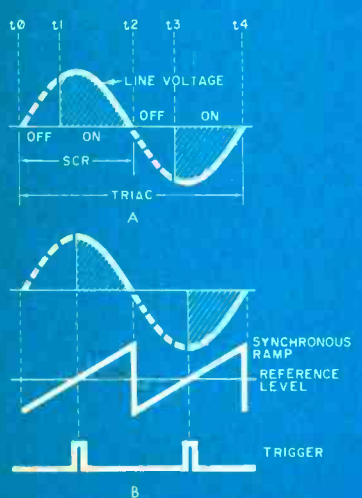


Fig. 3. Shaded areas in (A) show amount of time the SCR and triac are on. Waveforms in (B) show how to generate trigger.

ELECTRIC power supplied to a load can be controlled either by switching it on and off in discrete amounts or by using some means of continuously varying the amount. An example of the first type of control is the simple wall switch used to turn a room light on and off. The second type of control can be represented by the dimmer switch now commonly used to vary the same room light slowly and evenly.

In this article, we will discuss both on/off switching and also give the details of some techniques used in variable control systems.

On/Off Control. The simplest method of controlling electric power is a single-pole, single-throw switch connected in series with the load. A more elegant form of on/off switch is one that can be controlled by some event; i.e. a light that can be turned on and off by a timer, or a photoelectric scheme that controls a light by the rising and setting of the sun. In both cases, control is automatic and requires no human intervention except for the setting of the timer or the sensitivity of the photoelectric sensor.

On/off switching schemes are either line- or low-voltage systems. In line-voltage control, such as that shown in Fig. 1A, both the contacts of the switch and the wiring must carry the full line voltage and current required by the load. A low-voltage system (Fig. 1B) reduces the voltage by transformer action (usually to 16 to 24 volts) and operates at the low current required by the associated relay coil. The relay contacts, in turn, carry the heavy current required by the load. Also note that there is very little shock hazard in the low-voltage approach to power control.

One example of the low-voltage approach is that of thermostats (essentially a temperature-controlled on/off switch) in heating or cooling installations. Any type of on/off switch that responds to a stimulus (light, heat, humidity, smoke, fire, etc.) can be used to control the relay in the low-voltage application.

Variable Control. One of the earliest means of applying a variable voltage to a load was the rheostat, or variable resistor, connected in series with the load. Although this approach works, when a substantial load current is demanded, the I^2R losses in the rheostat produce a considerable amount of waste heat. This means the use of high-wattage, expensive rheostats; and lots of wasted energy in the form of heat. So the approach is inconvenient, wasteful, and dangerous.

The introduction of the autotransformer offered an improvement since the voltage across the load could be set between zero and some higher-than-line

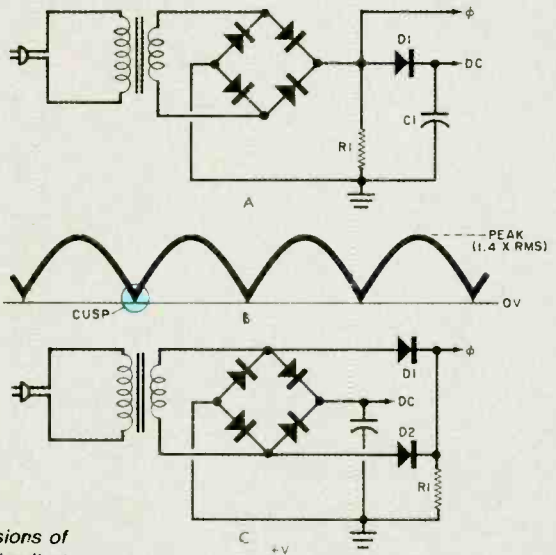
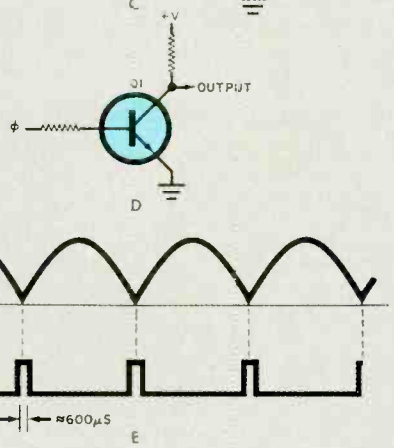


Fig. 4. Two versions of basic control. Circuit at (A) provides the rectified signal at (B). Circuit at (C) does a similar job but the load is split between diodes. Circuit at (D) provides a train of pulses (E).



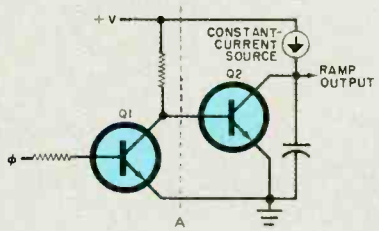
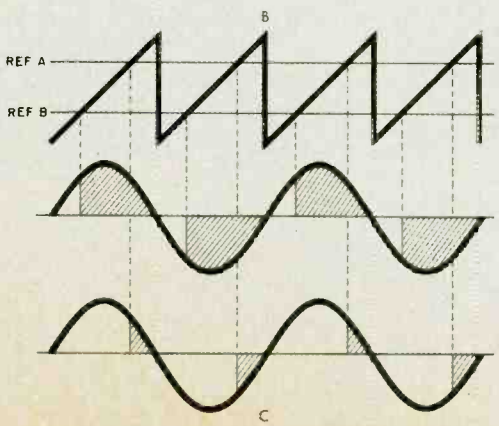


Fig. 5. A single ramp generator is shown at (A). Waveform at (B) is its output. Waveforms in (C) show variation in power using different reference levels on the ramp.



value as determined by the type of autotransformer used. However, in most cases, there is no isolation between the load and the power line, thus presenting a serious shock hazard to the user. Even an open fuse is no protection in some cases.

Semiconductor Control. It was the introduction of the semiconductor that allowed a more efficient control of power to a load. The SCR and triac are the workhorses here. Figure 2A shows the symbols for these two devices. Note that they are similar in that each has two power leads and one gate lead. Since both are formed from diodes, they conduct when the diodes are forward-biased. In the case of the single-diode SCR, a signal to the gate lead will cause conduction only when the anode is positive with respect to the cathode. Since the triac has two "back-to-back" diodes, it can conduct when either diode is forward-biased. In ac operation, the SCR conducts only on each positive-going half cycle, where the triac conducts on both half cycles.

When not gated on, both devices present a high impedance to the circuit. Once enough current is injected into the gate, conduction starts, the device internal resistance drops very low, and the semiconductor will remain in this state until the current it is passing drops below some low (holding) level.

The best way to cause an SCR or triac to stop conducting is to reduce its anode voltage to zero—something that happens automatically twice during each power-line cycle. If the gate trigger signal is delayed and turned on at some point during the cycle, the device will conduct for the remainder of that cycle. Thus, controlling gate turn-on time determines the power applied to the load. Figure 2B illustrates how two SCRs can be connected to simulate a triac. Operation is illustrated in Fig. 3A.

At time t0, the power line is zero, so the device is not conducting. As it goes into the positive-going direction, the semiconductor is turned on at time t1. Both the SCR and triac will then conduct for the remainder of the positive-going cycle. At time t2, the applied voltage drops to zero and the device shuts off. The SCR will not conduct for the following negative half cycle, but the triac will if triggered at time t3. It remains conducting for the rest of the cycle. At the next zero crossing (t4), the device shuts off.

The *power* delivered to the load is proportional to the shaded area under the curve of Fig. 3A. Moving t1 within the cycle controls this area and, hence, the power to the load. Note that the SCR is

capable only of half power, while the triac delivers twice as much. (Note also, that the device turn-on is very sharp and such a harmonic-rich waveform can produce transients that may interfere with radio and TV reception or, in some cases, produce line-voltage surges and spikes that can damage other sensitive devices coupled to the same power line.)

This approach is called phase control since the power controller is switched in phase, or synchronism, with the applied line voltage. Figure 3B shows one method of generating the t1 trigger signal. In this approach, a trigger signal having a certain amplitude is compared with a reference level formed from a ramp voltage synchronized with the power line. When the trigger amplitude exceeds the reference level, the trigger gates the associated power semiconductor on. In the case of an SCR, the power remains on until the next zero crossing. In the case of the triac, the power is turned on during both halves of the power-line cycle.

Some means must be found to sense the power-line zero crossing and turn on the trigger at the desired time. Two versions of basic concept for doing this are shown in Fig. 4. In 4A, the diode bridge and resistor *R1* derive the full-wave rectified signal labelled ϕ with *R1* ensuring that the cusps (Fig. 4B) drop below 0.6 volt. Diode *D1* and capacitor *C1* develop the rectified dc operating voltage. Diodes *D1* and *D2* in Fig. 4C work with *R1* to produce ϕ in that circuit. The advantage of Fig. 4C over Fig. 4A is that *D1* in Fig. 4A must carry the entire load current.

The zero-crossing signal is shaped by a circuit such as that shown in Fig. 4D. Using this simple circuit, the cusps (zero crossing) appear as a train of pulses about 0.6 ms wide (Fig. 4E).

The zero-crossing pulses can be used to control a simple ramp generator such as that shown in Fig. 5A. The output of this generator (Fig. 5B) is a series of voltage ramps synchronized with the power-line frequency. Since the ramp is linear, its level can be compared to some dc level and a trigger can be generated when the ramp voltage equals the selected dc voltage. Fig. 5C illustrates the phase delay resulting from two different reference levels with the shaded areas showing when power is applied to the load.

A typical circuit to mechanize this approach is shown in Fig. 6A. This circuit uses an IC comparator (a cousin to the op amp) to compare the ramp to some desired dc level. The waveforms are shown in Fig. 6B. Note that the transformer (*T1*) pulse can be moved up or down the ramp contingent on the set-

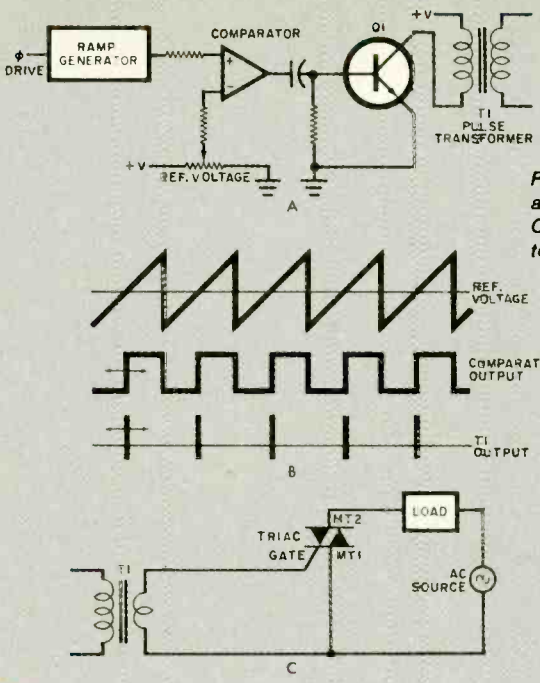


Fig. 6. Circuit at (A) generates a pulse as shown at (B). Circuit at (C) uses this output to drive the load.

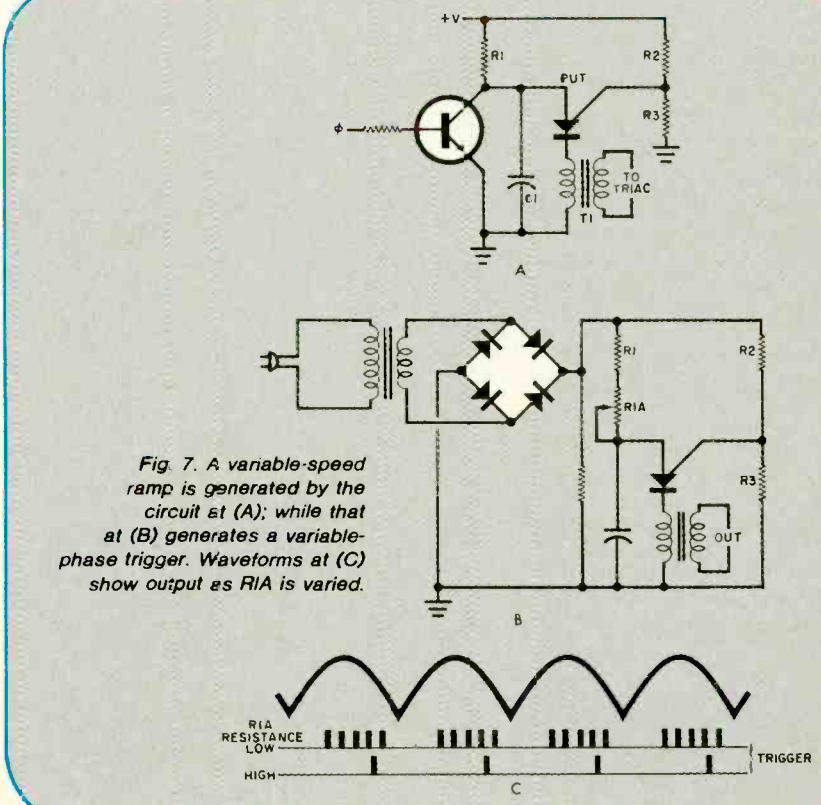


Fig. 7. A variable-speed ramp is generated by the circuit at (A); while that at (B) generates a variable-phase trigger. Waveforms at (C) show output as R1A is varied.

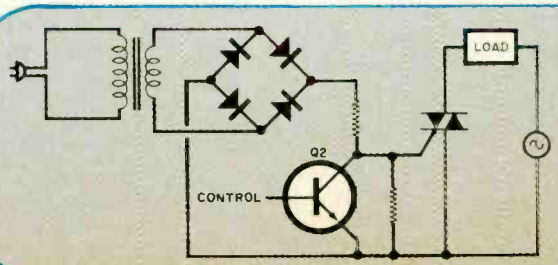


Fig. 8. A dc triggering circuit using a transistor to control the triac.

ting of the reference voltage control. Transformer *T1* is a pulse transformer, a specialized device that produces fast high-energy pulses capable of triggering SCRs or triacs.

A typical operating circuit, using a triac, is shown in Fig. 6C. It uses the output of Fig. 6A to drive the load. However, a form of variable-speed ramp can be generated by the circuit shown in Fig. 7. In Fig. 7A, a PUT (programmable unijunction transistor) is used as the trigger element. Resistor *R1* and capacitor *C1* generate a nonlinear ramp voltage while resistors *R2* and *R3* provide the dc reference point. When the ramp voltage exceeds the dc reference, the PUT discharges *C1* through the primary of pulse transformer *T1*. If this circuit is powered by a full-wave but unfiltered voltage, and *R1* is supplemented by *R1A*, the circuit of Fig. 7B is created. This is a variable-phase trigger that allows manual control (via *R1A*) of load power. Fig. 7C illustrates the waveforms as *R1A* is varied. Note that when *R1A* is a high resistance, only one trigger pulse is produced. The lower resistance values produce multiple triggers. In effect, the variable reference voltage of Fig. 6A has been replaced by a variable-speed ramp.

There is one more technique for operating a triac—called dc triggering. If a dc current of about 100 mA is applied to the triac gate, the triac will remain on and conduct full power until the end of the half cycle during which the dc drive is removed. The circuit shown in Fig. 8 uses a medium-power transistor to turn the triac on at the selected time during each power line cycle.

A triac can also be turned on by a relay (Fig. 9A), but this is not fast enough for phase control. An optical coupler (Fig. 9B) can replace the relay, but is still not fast enough for proper phase control.

Multiple Remote Control. Relatively simple digital techniques can be used for multiple remote control as shown, in Fig. 10.

Two of the leads (A and B) are used for the digital signals, while lead C is the ground return for both leads. The waveforms in the lower portion of the illustration show how three independent outputs are generated from two input signals simply by wiring the transistors as various types of simple gates. Of course, other logic forms such as ICs can be used. Since each output is momentary, a suitable flip-flop at each output will keep the remote appliance turned on until the receipt of another digital signal that will reverse the state of the flip-flop. The output of the circuit (D,E,F) or the outputs of any associated flip-flop can be used to drive the "appliance on" circuit—for example, a relay driver consisting of a transistor and relay.

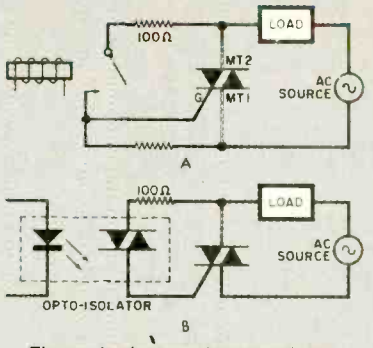


Fig. 9. A triac can be turned on by a relay (A) or an opto-isolator as at (B).

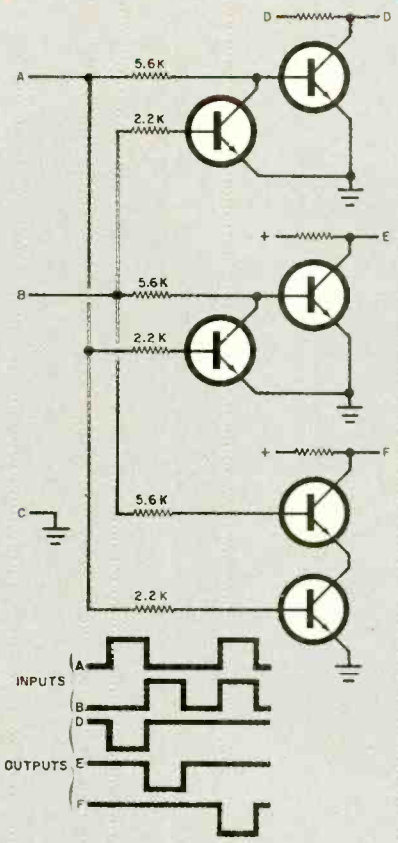


Fig. 10. A simple multiple remote control circuit using digital techniques.

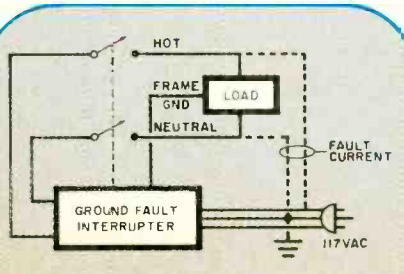


Fig. 11. How to connect a ground-fault interrupter for best protection.

Lest you think that a pair of leads can transmit only two signals, consider the current loop (or RS-232 loop) as used in computer technology. In this approach, a considerable number of data bits are transmitted on a pair of leads. If a code has *n* bits, then 2^n characters can be defined. For example, ASCII uses seven bits to define a character and control signal, while reserving the eighth bit for parity. Therefore, ASCII-like signals can have 2^7 or 128 (decimal) different codes. This means that if an ASCII-like transmission is used (which would require several ICs including a UART), up to 128 different functions can be controlled over a single pair of leads. If the eighth bit is used, 256 functions can be manipulated. Using this computer-like scheme, it is also possible for a remote device to "answer" a command to notify the controlling device of the status (on or off) of the remote device.

Other Control Methods. Since all buildings using electricity are internally interconnected via the electric lines, another method of remote control has been created. This involves the use of high-frequency audio tones transmitted along the line (similar to a "bus" system as used in a computer).

In this mode, the digital signal is converted into an audio tone with a high represented by one tone and a low as a different, non-harmonically related tone. These tones modulate a "carrier" signal that is placed on the power lines. Suitable decoders are used to demodulate the carrier and separate the two tones at each remote location. The tones are then decoded into appropriate digital levels to perform the actual control.

This method is called "carrier current" and is limited to locations that are on the same power-line transformer. In most cases, commercially available wireless intercoms can be used as the communications medium. This type of installation is inexpensive in an existing structure, since no additional wiring is required.

Remote control by radio can be used if you keep in mind that malfunctions can occur if radio interference is encountered. Also, a limited number of control applications permit the use of ultrasonic sound or infrared light to carry control commands. However, these techniques require line-of-sight conditions and little or no physical motion can occur within the area or malfunction will result. Like radio control, these two approaches do allow freedom of motion to the controlled device (a robot, or a

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boat, for example) within a prescribed area, and they offer a challenge to a serious experimenter.

Safety Precautions. Modification of existing electrical wiring is regulated by one or more governmental bodies; therefore, any such work must be performed by trained and licensed personnel.

When constructing electrical interfaces, complete power-line isolation must be observed in the interest of safety. Devices that handle high power must be adequately rated, all possible failure modes must be anticipated, and the design refined to "fail safe." Do not overlook failures external to the control system. For example, if the power line fails and then returns, will the system run amok without being manually reset? Any remote control system must have provisions for checking its integrity.

Keep in mind that conventional 117-volt household electrical power can injure or kill if precautions are not taken. Fuses or circuit breakers *and* a ground-fault interrupter (GFI) should be used. Such a device is connected between the device being controlled, the power lines and ground as shown in Fig. 11.

The two leads connecting power to the appliance are the "hot" and neutral, with the third wire connected to ground. The "hot" lead is energized with a voltage measured with respect to the neutral, while the neutral wire is maintained at essentially zero voltage with respect to ground. All load current is intended to flow from the hot wire, through the load, and back to the source via the neutral wire. No current, however small, should flow from either power line or the appliance to ground. If this does occur, since the ground lead is usually connected to the frame of the appliance, a possibly fatal voltage can be present between the frame and the ground. If a person completes the circuit between the now "hot" frame and earth ground, a serious reaction can take place. A GFI can detect this condition, and if it occurs, will immediately turn off the power to the appliance. Such a condition can occur (for example) in a household laundry room that uses an electric washer and/or dryer. These appliances usually have metal enclosures; and in many cases, the floor is cement and possibly damp (conductive to ground). If the metal enclosure is not grounded and a fault occurs, a possibly dangerous shock hazard exists for the person contacting the metal enclosure.

With the above considerations kept in mind, it is possible for the serious experimenter to design and construct a number of remote appliance controls that can save steps and time and bring his household into the electronic age. ◇

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CIRCLE NO. 54 ON FREE INFORMATION CARD

Popular Electronics Tests

The Heathkit Model IO-4550 Dual-Trace Oscilloscope

ALL THE instruments we have tested so far have been commercial types that were factory wired and tested before sale. This month, however, we are trying a new tack.

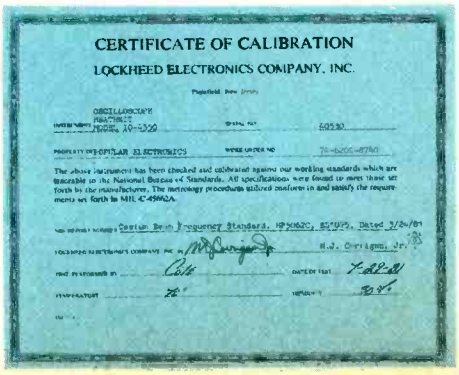
Since many readers build kits, we wanted to see if a kit instrument could be built and aligned satisfactorily according to its construction manuals. The instrument selected and reviewed here was the Heathkit Model IO-4550 10-MHz Dual-Trace Oscilloscope. It's designed for TV service and for modest circuit-design work.

The kit was assembled in accordance with the assembly manual and took approximately 27 hours to finish. We used a bench multimeter and function generator for calibration purposes, though a Heath oscilloscope calibrator kit is available separately for $17.95. The scope measures approximately 7"H x 13"W x 19¼"D. Kit price is $439.95.

General Description. The IO-4550 is a dual-trace, dc-to-10-MHz instrument. It has a nice, "modern" appearance. The two input channels and their controls are mounted on the left side of the cabinet adjacent to the CRT bezel, while all sweep controls are grouped on the right side of the enclosure. INTENSITY and FOCUS controls, along with the CAL feedthrough, are located along the bottom of the front panel. The rear apron holds the power cord supports and the submerged ASTIGMATISM control. Four skidproof rubber feet are on the bottom. A carrying handle/tilt stand is provided.

All controls are clearly marked with color coding, where required, and are spaced sufficiently far apart to allow easy access to each without disturbing the adjacent control.

Each vertical channel has three controls: the AC/GND/DC input selector, an 11-step (arranged in a 1-2-5 sequence) VOLTS/CM selector rotary switch with a coaxial VARIABLE vernier that permits adjustment of sensitivity from 10 mV/cm to 20 V/cm, and a vertical POSITION control that has a provision to turn the channel off. Each channel also has a recessed DC BAL adjustment. BNC input connectors are used for the signals applied to both channels.


CERTIFICATE OF CALIBRATION

LOCKHEED ELECTRONICS COMPANY, INC.

The horizontal sweep TIME/CM selector switch has 19 steps from 0.2 s/cm to 200 ns/cm, also arranged in a 1-2-5 sequence. The coaxial-sweep VARIABLE control can be pulled out for ×5 magnification to expand sweep speeds to 40 ns/cm. An EXT input is provided with a BNC connector. The TRIG LEVEL can be selected from EXT, Y1, Y2 or LINE—all either + or −. The TRIG MODE can be selected from DC, AC, or TV. The HORIZ POS control is coaxial with the TRIG MODE switch.

The INTENSITY control includes a PWR OFF position, which is indicated by a red LED adjacent to this control.

The 5" round CRT is enclosed by a square bezel having an 8 x 10-cm graticule. Complete specifications for the IO-4550 Oscilloscope are shown in the accompanying Table.

Comment. After assembly, the instrument was aligned in accordance with the operation manual supplied with the kit. Using our bench instruments, we

MANUFACTURER'S SPECIFICATIONS

VERTICAL
Deflection Factor:
Sensitivity: 10 mV/cm to 20 V/cm
Variable: Continuous between steps to approximately 60 V/cm
Accuracy: Within 3% (10° to 40° C)
Response:
DC Coupling: DC to 10 MHz (−3 dB) at 6 cm
AC Coupling: 2 Hz to 10 MHz (−3 dB) at 6 cm
Rise Time: 35 ns
Overshoot: Less than 5%
Input:
Impedance: 1 megohm shunted by 38 pF
Maximum: 400 V peak combined ac and dc
Modes:
Single: Y1 or Y2 selected by POSITION control
Dual: Chopped (200 kHz) or alternate automatically selected by TIME/CM switch
HORIZONTAL
Time Base:
Ramp: 0.2 s/cm to 200 ns/cm
Variable: Continuous between ranges to approximately 0.6 s/cm
Accuracy: Within 3% (20° to 30° C). 5% (10° to 40° C), referenced to 1 ms/cm at 25°C
External:
Sensitivity: 0.1 V/cm (approx.)
Impedance: 100 kilohms (approx.)
Polarity: Positive input causes right-hand deflection.
Frequency response: DC to 1 MHz (−3 dB)

TRIGGER
Internal:
Automatic: Adjustable over 10 div.
Normal: Adjustable over 10 div.
Slope Selection: + or −
Sensitivity/Bandwidth:
DC mode (auto/norm.):
1 or 1.5 cm, dc to 20 MHz
AC mode (auto/norm.):
1 or 1.5 cm, 20 Hz to 20 MHz
TV mode: (auto/norm.):
1 cm, 20 Hz to 1 kHz
1.5 cm, 15 Hz to 2 kHz
External:
Automatic: Adjustable over 0.8 V
Normal: Adjustable over 0.8 V
Slope Selection: + or −
Sensitivity/Bandwidth:
DC mode (auto/norm.):
1.5 or 1.0 cm, dc to 20 MHz
AC mode (auto/norm.):
0.5 or 1.0 cm, 20 Hz to 20 MHz
TV mode (auto/norm.):
0.5 cm, 20 Hz to 1 kHz
1.0 cm, 20 Hz to 2 kHz
Impedance: 1 megohm shunted by 40 pF
X-Y
Y Channel: Same as vertical
X Channel: Same as vertical except response limited to 1 MHz
Phase Shift: Less than 8 degrees at 100 kHz
GENERAL
CRT:
Type: 5-inch round, mono-accelerator
Acceleration Potential: 1.8 kV reg.
Power:
Voltage: 105/130 AC or 210/260 AC switch selectable; 70 W at 120 V.

"tweaked" each circuit to the best of our ability, and some excellent "book" waveforms were seen.

The IO-4450 10-MHz, Dual-Trace Oscilloscope was tested by the Lockheed Electronics Instrumentation Laboratory (Plainfield, N.J.) against standards traceable to the National Bureau of Standards, and it was verified that the instrument met or exceeded its claimed specifications.

Since we knew that the Heath scope had passed its electrical tests with flying colors, we decided to test it against our bench scope, which had better specifications (and cost a few hundred dollars more than the Heath model). We expected our bench scope to outperform the Heath, and indeed it did. But it was not sufficiently better to be worth the extra hundreds of dollars.

The IO-4550 triggers very solidly on low-level, high-frequency waveforms with excellent sync lock. Sync was good to about 20 MHz. The TV triggering is also excellent, and the trace brightness is good even at very high writing speeds. Both focus and astigmatism are excellent, and there was no difficulty in observing the trace in detail with the ×5 magnifier provided. We found the X-Y mode (used mostly in chroma alignment) on the Heath slightly better than the more expensive "house" scope, primarily due to the small differential phase shift between the two channels.

The IO-4550 runs cool, even after many hours of use, and there were little or no observable changes with the normal variation of line voltage we encounter during our working day. Both magnetic and r-f shielding are good, and no trace distortion was seen when operating a ham and CB rig in close proximity to the scope.

Physically, the IO-4550 is easy to handle as each control "fits" the fingers, and each is clearly identified. Since the controls are properly grouped as to function, the hand automatically goes to the right control. Even our left-handed technician had no problem.

We have been using the Heath IO-4550 for almost a month, and the consensus of the users is that it is an excellent scope, and well worth the money and time put into the kit. When assembled and calibrated by Heath, the cost is $670. So there's a $230 savings right there. Moreover, kit assembly is simplified through the use of only four printed-circuit boards. So the project has proved that, if the kit is built, it is possible to have a superior instrument at a reasonable cost. —*Les Solomon*

CIRCLE NO. 104 ON FREE INFORMATION CARD

COMPUTER BITS

By Carl Warren

Extend Your Apple

EXPANDABILITY is the Apple microcomputer's forte. You can easily add a Z-80 microprocessor with Microsoft's Softcard. And a wide variety of 80-column cards, bus expansion hardware, and other enhancement products are readily available.

One company that offers much for the Apple is Mountain Computer, Inc. (Scotts Valley, CA). Should you want to add a clock, Mountain offers two options. The first, called simply, The Clock, costs $350, fits into any available peripheral slot on the motherboard, and has its own on-board 4-day battery to keep time when the computer is turned off. The Clock can be used for more than just keeping time. By adjusting the interrupt frequency, the interval clock can be set from 0.1 ms to 33,554,432 seconds depending on the application.

If you are short on space and need more than a clock, you might consider the CPS Multifunction card. Priced at $239, this card contains a clock, plus serial and parallel ports. It can be configured to handle the Epson MX-80 or Diablo 630 printer, a modem, and clock functions—all at the same time.

Besides hardware, Mountain provides a series of software packages that allow using the CPS card in the Apple environment with Pascal or CP/M. And like the clock card, all you have to do is plug it in. However, the CPS card doesn't work with Computer Stop's DoubleVision 80-column card under CP/M. That's because of a software conflict that isn't easily resolvable. However, all is not lost. You can use the card easily with Sup-R-Term, or the Videx video card, and (reportedly) with Wesper Peripheral's new Whizzard-80 card.

The Expansion Chassis. With only 8 card slots, you may quickly run out of space on a basic Apple. Mountain has done something for that with the Expansion Chassis. This $750 package allows eight more slots and is easily connected via an adapter card and cable.

The adapter card can be plugged into any slot, but three is a logical choice since it gives easy availability to a rear opening in the Apple cabinet. The expansion chassis comes with appropriate software hints to aid in using it under software control. The chassis doesn't just augment the Apple but allows another bank of eight slots for adding peripherals. However, plug-ins like the Softcard and video cards must reside in the main Apple. In addition, when the chassis is selected (either by a front-panel switch or software), the video card won't work; but in most cases this doesn't really cause a problem.

The expansion chassis is a good location for such products as: ROMPlus, priced at $155; A/D + D/A card for $350; and possibly even RAMPlus for $189. The latter item boosts the Apple memory to 80K bytes and can reside either in the Apple itself or the expansion chassis.

Because of its unique architecture, the expansion chassis can be used with other systems that allow access to the bus signals. All that is necessary is to design a bus adapter.

Should you use the ROMPlus card, either in the expansion chasis or the basic Apple, there will be 12K bytes of ROM available for any home-designed applications. The chassis design supports either six 2316 or 2716 EPROMs, and can be set up so the programs are accessed when the Apple is turned on.

Interestingly, you can couple the ROMPlus with the CPS multifunction capabilities and have an automatic communication system. And, if you have an application requiring the gathering of analog data, an A/D + D/A board can be used. This board gives 16 channels on either side and can be used for spectrum analysis, remote data gathering, curve tracing, temperature sensing, and a host of other applications.

The only problem we encountered with software was with the previously mentioned conflict between the Doublevision card and CP/M. Not really a problem, but something you need to be aware of, is that the expansion chassis may cause RFI, specifically on TV channels 2 and 3. However, no other problems were noticed, and no interference to the disk or display operation was observed. The RFI source appears to be the flat cable connecting the expansion chassis to the Apple. This RFI can be

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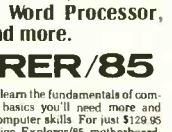

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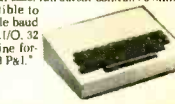

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damped by wrapping the cable with aluminum foil and grounding one end. We recommend using grounded three-wire power line to ensure proper system operation. We found that interference increased to where it did affect the CRT display when operating with a floating ground.

Other Software Systems. Some other software worth your attention comes from Datamost, 19273 Kenya St., Northridge, CA 91326 (213-366-7160). This software company supplies, for $29.95 each, Thief and Snack Attack. The first is very much like the old game of Robots, but with some interesting twists—it lets you fight back. For those of you hooked on the famous arcade game Pacman, there is Snack Attack. The idea is to eat as many gumdrops as you can and avoid the guards. The action is very fast and it's a hard game to win.

Along the same line is a really classy program called Olympic Decathlon, from Microsoft Consumer Products. Based on the Olympic track-and-field events, the under-$30 game uses both keyboard and game controls to let you try to win the Decathlon. What makes this package exciting is its full use of Apple's graphics and sound effects. Decathlon begins by presenting the Olympic rings and theme music. Then you're off after that elusive gold medal.

Should your Apple applications be more business oriented, consider Software Publishing Corporation's Personal Filing System (PFS) and Report. Both of these products are under $100, and allow data handling as it suits you best. The PFS package lets you design a blank form and enter data in any way you desire. In addition, you can retrieve any data in the file without needing a special key file.

The Report program is similar in that you use a form that you design to specify how reported data is arranged. Unlike other report generators, Report adjusts the columns, and all you need to know is what data you want. Even if you purchase an Apple III with a hard disk, Software Publishing has PFS and Report packages available, and they promise similar support for the new 68000-based Apple expected this June.

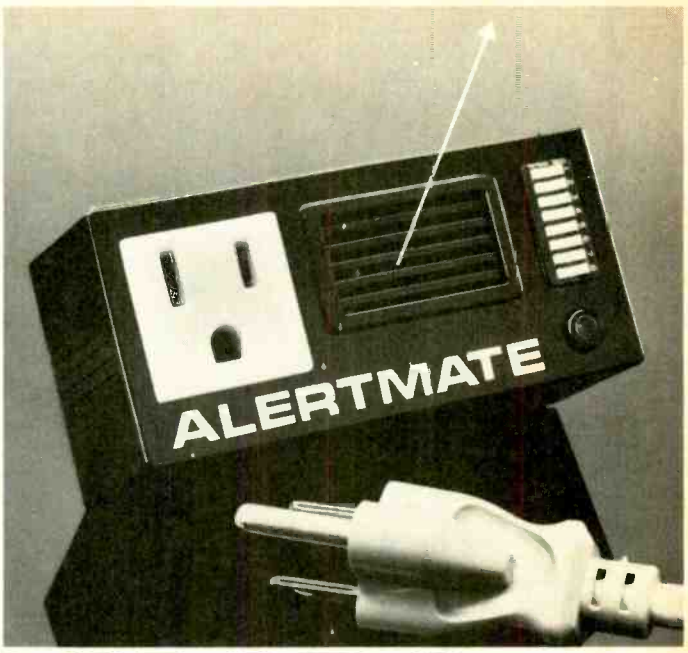
If you're using the Z-80 Softcard, and want to expand your Apple, I recommend (for starters) the CPS Multifunction card. This card, with the associated software, gives the functions necessary to access services such as Micronet.

Once you've got the system configured, sign into Micronet and request the CP/MIG users' group. You'll find CP/M programs for everything from games to complex calculations. A program you'll particularly want to look for is called Bye. It has several aliases, including H89/Bye, but all versions are basically the same.

What Bye does is allow your Apple (or any other CP/M-based machine) to be accessed from and then controlled by another system. We're currently using Bye on the Apple and other systems for this purpose, and have added XModem, which is also available on the Net. XModem is a program for uploading or downloading from a remote location.

To quickly see what's on a Micronet, run Access by typing R ACCESS. This program will tell you what's available and how to gain access. Remember that this software is public domain (i.e., free), except for the cost of using Micronet. You can reduce that time by getting SQ—the squeeze program. SQ reduces program size, thus conserving disk space and reducing download time.

Applefest/Boston. This is the second year for the Apple-Specific Computer Show (the largest of its kind in the country, with over two hundred displays and booths plus seminars and panel discussions). It will be held May 14 to 16 at Boston's Hynes Auditorium from 11 a.m. to 6 p.m. daily. Tickets are $6 for one day or $15 for all three days. For information, call or write National Computer Show, 824 Boylston St., Chestnut Hill, MA 02167. 617-739-2000. ◇



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COMPUTER SOURCES

Hardware

NiCad Adapters. Using a conventional AA-size rechargeable nickel-cadmium cell, this novel system has an adapter sleeve to emulate a C-cell in applications requiring such a cell size. The C-cell sleeve can be inserted within a D-cell plastic sleeve to create that size cell. Thus, a single AA cell can be used in many applications. Four sets of sleeves are $12.95 including cells. Optional recharger for 2 or 4 AA, or one 9-volt battery is $6.95. AA cells are $1.99 each, and adapter sleeves are $1.50 per C and D set. Add $2 postage/handling. **Address:** Burton Products Corp., Drawer E, Coram, NY 11727 (Tel: 516-698-1272).

Disk Emulator. The Disk Emulator simulates a disk drive for the Apple II. Its 64K RAM card can be accessed via the DOS 3.3 LOAD, SAVE, OPEN, READ, WRITE, etc., commands in BASIC, or the RWTS of machine language. A pseudo SLOT/DRIVE number accesses the emulated drive, and the emulator will not interfere with the operation of a peripheral card installed in that slot. Since there are no motor, step, nybble, or search delays, the emulator is faster than the disk. A single 64K card can simulate 256 disk sectors (tracks 3 through 18), in half-disk mode, or two 64K cards simulate 32 disk sectors (tracks 3 through 34). The Disk Emulator will support up to six 64K RAM cards to provide 384K bytes of online storage organized as three 128K-byte disk drives. It can copy the contents of a floppy diskette, or load the emulated diskette into the floppy, within 18 seconds. The package contains two 64K RAM cards, Disk Emulator 2.1, and demo. $700. **Address:** Great Lakes Digital Resources, POB 32-133, Detroit, MI 48232.

STD I/O, Timer, Counter. The STD-VI08 board features eight programmable I/O ports, with each of its 64 I/O lines individually programmable as input or output. 16 handshake lines permit high-speed data transfer. Four 16-bit timers range from 2 μs to hours, automatic pulse output on I/O line, and interrupt-on-time out capabilities are provided. Four 16-bit event counters monitor incoming I/O without CPU intervention. Four programmable shift registers permit serial data to be sent/

received, and programmable interrupts avoid overhead of software polling. Switch-selectable addressing and standard 50-pin headers are provided. $199. **Address:** Forethought Products, 87070 Dukhobar Rd., Eugene, OR 97402 (Tel: 503-485-8575).

Color Computer Buffer. The Colour Buffer for the TRS-80 Color Computer gains access to the system bus via the game card slot. It terminates in a standard 22/44 card edge connector and provides fully buffered address, data, and control lines. It allows the user to plug in a variety of peripherals including this firm's upcoming RAM cartridge, serial and parallel I/O port, and an EPROM Programmer. $59.95. **Address:** TBH Canada, 67-3691 Albion Rd., Ottawa, Ontario, Canada K1T 1P2.

Apple Printing. Apple AP PAK contains an AUTO PLOT printer control card, interface cable, and software programs to allow the Apple to use all graphics capability of the 88 or 89 graphics printer. An unlimited number of character fonts, large headlines, intermixed fonts, and graphics dumps of hi-res files can be performed. It can also generate individualized computer letters. FONT WRITER allows text, bold, or italics in three heights and six widths besides the conventional ASCII fonts resident in the printer. LETTER POST facilitates generation of letters to specified names in Apple Post or Mailing List Database programs. Graphics can be inserted in text. $145. **Address:** MPI, 4426, South Century Drive, Salt Lake City, UT 84107 (Tel: 801-263-3081).

Software

ELF Pilot. The easy-to-use Pilot language for the ELF II requires 4K memory plus ASCII and video boards. Besides the usual Pilot instructions, it includes UP (move text pointer up xxx lines), DOWN (move text pointer down xxx lines), BEGIN (move text pointer to start of text and display new line), END (end of text), INSERT (one line of text), KILL (delete xxx line of text and display new line), TYPE (type xxx lines), CLEAR (delete text), SAVE (dump to cassette), APPEND (inputs from cassette appends to current text), MONITOR (returns control to system), RUN (execute), and LENGTH (text buffer length). Cassette is $19.95. **Address:** Netronics R&D Ltd., 333 Litchfield Rd., New Milford, CT 06776 (Tel: 800-243-7428).

Color Computer Instructor. The TRS-80 Color Computer Learning Lab (26-3153) includes eight ready-to-run cassettes and a 30-lesson text to allow the user to gradually develop programming skills. The first section introduces the computer, programming, and self-grading lessons. The second section in-

volves games, formulas, music, sorting, art, and teaching. Each of the 10 lessons contains examples and experiments. The third section contains eight lessons covering programming guidelines that can be copied or modified, and take full advantage of color graphics and sound. It can be used with all versions of the TRS-80 Color Computer. $49.95. **Address:** Radio Shack and participating dealers.

BASIC Tool. BPSXREF produces a formatted program listing and an alphabetized list of program variables and functions cross referenced to the line numbers where they are used. It is designed for Microsoft BASIC-80 5.x. The formatted listing allows for page titles, numbers, and skipped lines. A variety of options allow a simple listing or detailed cross-reference or a combination. It operates on ASCII formatted CP/M files as produced by MBASIC SAVE, with A option, or text editors such as ED, WORDMASTER, or MINCE. It requires a 48K CP/M system. $124. **Address:** BPS, 82 Woods End Rd., Fairfield, CT 06430 (Tel: 203-254-1659).

6800/6809 Catalog. The White Catalog contains programs and hardware for 6800/6809 users including DOS Utilities 0 covering six transient commands, DOS Utilities 1 for the Smoke Signal DOS, FTRAN, a file transfer routine for CP/M, SCREDITOR II, a screen-oriented editor with 60 commands, MASTER, a multiple disk catalog indexing system, CONFORM, a form-controlled automatic I/O package, SCARF, a data transfer system, ADVENTURE, a game, and TREK-68, a real-time arcade-type game for DOS or FLEX systems. **Address:** UNITEK, POB 671, Emporia, VA 23847.

Pascal/Z. Version 4.0 of this firm's Pascal/Z compiler with overlays and SWAT (software analysis tool), an interactive symbolic debugger is now available. The Pascal/Z is pure Pascal optimized for speed, and yields object code that is both ROMable and reentrant. Since no interpreter is needed, Pascal/Z runs 5–10 times faster than code run under interpretive pseudo-code implementations. The overlay capability allows programs larger than memory and uses a linking-loader. SWAT allows use of both absolute and conditional breakpoints, set a watch on variable or routine, display breakpoints and variables and statement/module numbers, display runtime requirements at any point, display the last 10 statements executed, and trace and display the procedure/function stack. The user can modify global and local variables including subscripts of arrays, fields of records and enumeration types. **Address:** Ithaca Intersystems Inc., 1650 Hanshaw Rd., Ithaca, NY 14850. ◇

SOLID-STATE DEVELOPMENTS

By Forrest M. Mims

Focus on CMOS

THANKS to new and better chip fabrication methods and design techniques, the concensus of many semiconductor manufacturers and users is that CMOS will soon become the most popular integrated circuit family. Conventional CMOS has a wide operating voltage range and is relatively immune to noise. Because of its very low current consumption, CMOS is almost universally used in digital watches and pocket calculators.

On the other hand, CMOS is slower than NMOS, its most important rival, and typically only a fourth as fast as TTL. Also, CMOS gates require more chip area and processing steps than those made using other MOS technologies. These drawbacks of CMOS technology have posed cost, speed and fabrication difficulties in the design of complex microprocessor and telecommunication chips.

These problems are beginning to disappear, however, with the new generation of CMOS chips. These chips have smaller gate dimensions and use clever design techniques. The smaller dimensions increase internal switching speeds to, in some cases, those of TTL. Simpler circuitry also speeds up the new chips and makes possible a higher density of gates per chip.

Now that CMOS performance has been substantially upgraded, it's being considered for a wide range of large and very large scale integrated circuits. For example, a conventional 16K RAM made with NMOS technology is a power-hungry chip which consumes nearly a full watt while operating. The heat dissipated by such a chip almost reaches the thermal limit for inexpensive plastic DIPs. CMOS technology could provide a 16K RAM chip a standby power consumption of well under half a milliwatt!

An 8-Bit CMOS Microprocessor. RCA has pioneered in CMOS technology. Its CDP1802 is an 8-bit microprocessor with a total instruction fetch-execute time as low as 2.5 microseconds. This chip forms the processing unit for RCA's CDP18S601 Microboard, a moderately priced computer development system. More than forty CMOS expansion boards and hardware accessories have been designed to interface with the Microboard.

The CDP18S601 can, if desired, be powered by batteries. It can be programmed in BASIC and can be expanded to include a keyboard and CRT monitor. For more information about the Microboard and its accessories, write RCA (Solid State Division, Box 3200, Somerville, NJ 08876) or call RCA Microsystems Marketing toll-free (800-526-3862).

Netronics R&D Ltd. (333 Litchfield Road, New Milford, CT 06776) makes the Elf II, a microcomputer designed around the CDP1802 which is available for much less than the RCA Microboard. For details about this computer, write the company or read its ads in recent issues of this magazine.

A 32-Bit Microprocessor. Probably the most ambitious CMOS chip to date is the Bellmac-32, a full 32-bit single-chip microprocessor. This remarkable chip is the latest in a series of CMOS microprocessors developed at Bell Laboratories. Its instruction set is similar to that of a minicomputer which executes a million instructions per second.

The Bellmac-32 includes some 100,000 transistors on a chip having an area of only 1.45 square centimeters. Bell Labs plans to squeeze a new version of the Bellmac-32 onto a 1-square-centimeter chip by reducing the minimum fabrication dimension from 3.5 to 2.5 microns and by replacing space-consuming random and control logic with programmable logic arrays (PLAs).

One key to the Bellmac-32's 8-MHz operating speed is the so-called "twin-tub" structure shown in Fig. 1. In conventional CMOS either the n or p channel devices can be formed in appropriately doped regions which assume a tub-shaped profile. Twin-tub fabrication combines the advantages of the tub structure by allowing *both* n and p channel devices to be formed on the same substrate.

Another important feature of the Bellmac-32 is a form of circuitry called *domino-CMOS*. This new circuit ar-

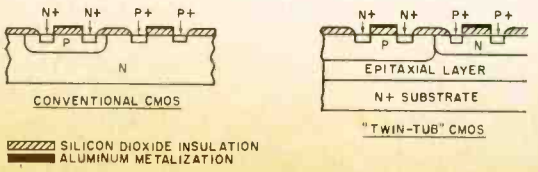


Fig. 1. Comparing traditional CMOS with the new "twin-tube" approach.

rangement is responsible for *doubling* the speed of the Bellmac-32 over that which would have resulted from using standard circuitry.

Figure 2 shows a hypothetical domino-CMOS gate array. In operation, all the gate inputs and outputs go low when the clock signal is low. When the clock goes high, the logic signals present at the various inputs pass through the array a stage at a time in a manner reminiscent of a row of falling dominoes.

The Bellmac-32 is not commercially available, but it may one day become an important part of the Bell System's massive network. For more information about this important new microprocessor, see the article written by several of its developers in the October 6, 1981 issue of *Electronics* (pp. 106-111). Or write Bell Telephone Laboratories (Murray Hill, NJ 07974). Bellmac-32 is a trademark of AT&T.

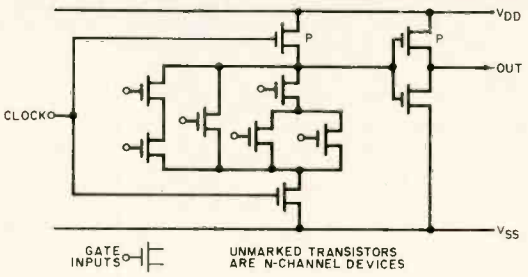


Fig. 2. Hypothetical domino-mode CMOS gate array.

A CMOS Engine Controller. Though microprocessors are being used in various kinds of electronic ignition systems for automobiles, RCA thinks a relatively simple controller is a better approach. RCA selected CMOS for its new controller since it is far more tolerant of heat and electrical noise than conventional NMOS devices. This means the new controller can operate in the relatively harsh environment under the hood instead of behind the dash. The result is a considerable reduction in electrical wiring between the controller and its sensors and the various engine systems being controlled.

The new engine controller is called Rombic (*R*ead-*o*nly-*m*emory-*b*ased *i*gnition *c*ontroller). Rombic incorporates relatively standard CMOS construction in a two-chip set. The controller chip, which is designated TA11130, includes an on-board 5-bit analog-to-digital converter and a microprocessor-like arithmetic and logic unit.

A complete Rombic is formed by pairing the TA11130 with any standard CMOS 1K × 8-bit ROM as shown in Fig. 3. In operation, the TA11130 continually receives from engine sensors real-time engine speed and manifold pressure. Optimum spark timing information for all ranges of engine speed and pressure are stored in the ROM. The sensor data, when converted into digital form, specifies a ROM address containing the relevant timing data. This data is then processed by the arithmetic and logic unit in the TA11130 and sent through an appropriate driver circuit to the engine's ignition coil.

A major problem with electronic ignition systems is reliability. Some owners of 1981 Cadillacs with the 4-6-8 cylinder electronic control system have learned about the pitfalls of total electronic engine control the hard way. This highly sophisticated system uses twelve sensors to monitor temperature, throttle position, fuel flow, catalytic converter status and other parameters. The electronic control unit (ECU) then adjusts the fuel volume delivered to the fuel-injection system and decides how many

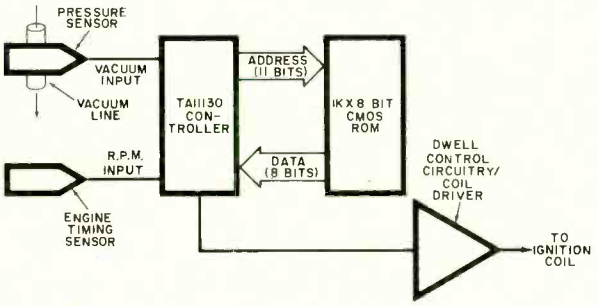


Fig. 3. RCA's Rombic automobile CMOS engine ignition control system.

cylinders (4, 6 or 8) are required for optimum fuel economy.

Cadillac's ECU is so sophisticated that the driver's foot controls a throttle transducer, not the fuel entering the carburetor. The system even records if the car travels in excess of 85 mph and whether it has been taken to a repair center within thirty engine starts following activation of a "Check Engine" warning lamp!

Rombic is considerably simpler than Cadillac's ECU. It has only two transducer requirements and it controls only the engine's timing. Furthermore, in the event of a problem, Rombic defaults and permits the engine to operate without its assistance.

RCA claims the two-chip Rombic can be purchased for as little as $7 in volume. This compares to $20 or more for more sophisticated microprocessor systems. For more information about Rombic, write RCA at the address above.

A CMOS Watch Chip. Most watch chips use CMOS fabrication because other MOS families consume too much power. Though many CMOS clock and watch chips are available, space requirements limit this column to coverage of but one, Intersil's ICM7273. This six-function chip includes an on-chip oscillator, frequency divider, alarm register, segment decoders, voltage multiplier (for the liquid crystal display) and alarm driver. A watch can be assembled by adding a standard 32,768-Hz crystal, trimmer capacitor, two voltage-multiplier capacitors and a 3-volt liquid-crystal display. Several miniature switches, a 1.5-volt watch cell and an appropriate alarm transducer complete the watch.

Figure 4 is a simplified block diagram of the ICM7273. This highly complex circuit consumes a miniscule 3 microamperes when the power cell delivers 1.4 volts. Though you can buy the ICM7273 and similar CMOS watch chips separately, I suggest you first look into completely assembled watches or watch modules such as Radio Shack's PCIM-161 (catalog number 277-1005). The latter device includes easy access to the

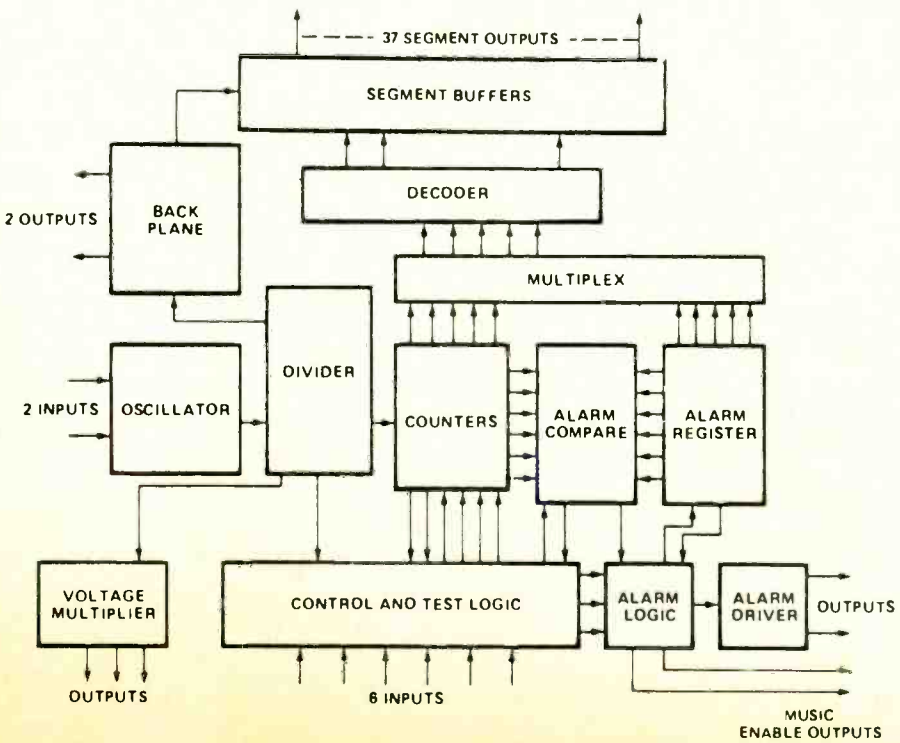


Fig. 4. Intersil's ICM7273 CMOS watch chip includes alarm and music enable.

chip's control and output terminals and is easily interfaced to various alarms, solid-state switches and relays. If you wish to find out more details about Intersil's ICM7273, request a data sheet from an Intersil representative or write the company (10710 N. Tantau Avenue, Cupertino, CA 95014).

CMOS Calculators. Several years ago nearly all pocket calculators used NMOS technology and LED displays. Now many pocket calculators combine low-current CMOS processors with micropower liquid-crystal displays.

Continuous memory is an important advantage of some CMOS calculators. Since power consumption of a CMOS memory chip is so low, it's possible to leave the memory turned on in a standby or idle mode while the processor chip and display are off. Continuous memory in a simple 4-function calculator is usually limited to the preservation of data in a single memory register. In more advanced CMOS calculators, continuous memory can store hundreds of program steps and the data in dozens of memory registers. Even the status of the calculator's operating condition when last turned on can be remembered.

Two recently introduced CMOS calculators, Hewlett-Packard's HP-11C and HP-12C, store all programs and data when the power switch is off. The HP-11C is designed primarily for scientific problem solving while the HP-12C is intended for financial calculations. Both will operate for about one year from a set of disposable button cells.

Other CMOS Chips. Many new telecommunications, electronic music, voice synthesizer and memory chips are being designed using CMOS technology. One interesting example is Commodore Semiconductor's new melody chip. This programmed tone generator is available in three versions which play either one or two tunes. In one of the dual tone versions, the user selects the tune to be played. In the other, the chip automatically alternates between tunes.

Tunes played by the melody chip last up to a full minute. "Happy Birthday" and other standard tunes are available but volume customers can have their own selections programmed into the chip's ROM. Price of the chip in 1000 quantities is 70¢ each. For more information, contact Commodore Semiconductor/Frontier Division (2955 Airway Avenue, Costa Mesa, CA 92626).

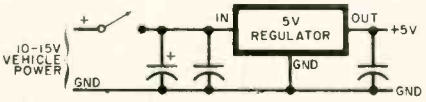
Finally, both National Semiconductor and Motorola are introducing a new family of CMOS logic chips which are functionally similar to standard TTL LS parts. The new family is designated 74HCXX. Speeds and pinouts will match those of equivalent LS devices. I predict these new chips will find widespread acceptance among hobbyists and experimenters as well as the engineering community. As for myself, I can hardly wait to try some in actual circuits. ◇

HOBBY SCENE

Vehicular TTL

Q. I have a number of TTL circuits that I would like to use in my recreational vehicle. Can I use a 5-volt regulator with the 12-volt battery in the vehicle?—George Adamson, Wheeling, WV

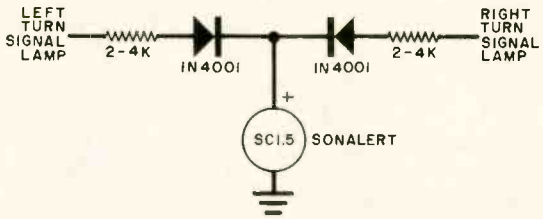
A. You surely can since the 12 volts available in cars, trucks, recreational vehicles and most boats will easily drive a conventional 5-volt regulator circuit such as the one shown here. Only two things to keep in mind. Don't run the vehicle battery down, and make sure that the load does not exceed the output level of the selected 5-volt regulator.



Audible Turn Signal

Q. I am one of those people who does not realize that the turn signal on my car is still operating long after I have made the turn. To avoid this, can you suggest an audible alarm system that will warn me that the turn signal is still blinking?—S. Shore, Brooklyn, NY

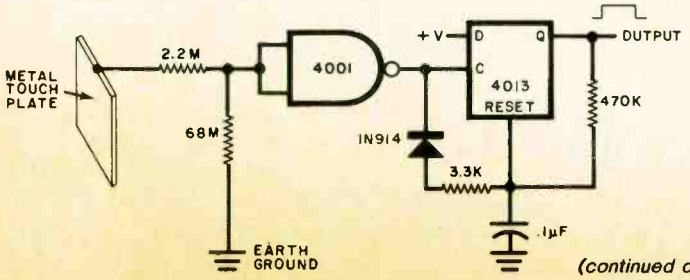
A. The audible alarm circuit shown here uses a Mallory SC1.5 Sonalert that operates at about 3500 Hz, and loud enough to be heard in a moving vehicle. Connect one power lead to the right and left turn signal lamp circuits and the Sonalert minus terminal to chassis ground. Since the turn signal circuit is supplied with +12 volts when the turn switch is operated, the alarm sounds off. The diodes isolate each side from the other, while the resistors limit the alarm current. If you have a 6-volt system, reduce the value of the resistors. If you have a positive-ground vehicle, reverse the diodes and alarm.



Elbow Switch

Q. I want to build a room light control system that does not use finger-operated wall switches. When one is carrying an armful of packages, it would be great to be able to turn on the lights with the elbow. Can I do this?—Arch Vallen, Montreal, Canada.

A. Most certainly. A simple touch-plate circuit will work very well for this purpose. The sensor plate is a few inches square and connected to the input of a CMOS gate (almost any will work). The gate drives a 4013 retriggerable monostable whose output can be used to drive relays, SCRs, or other devices to control the lights. Sensitivity is determined by the size of the touch plate. Keep this circuit isolated from the ac lines!



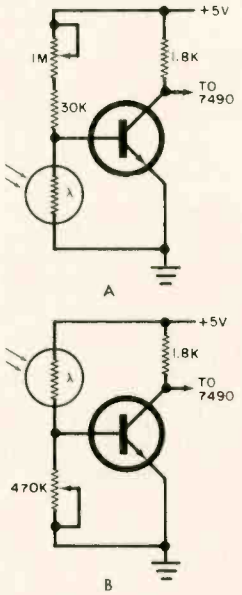
(continued on page 102)

hobby scene

In/Out Counting

Q. I am experimenting with ordinary 7490 TTL decade counters. Until now, I have been using a conventional clock circuit. Is there a simple way that I can build a circuit to detect and count the number of people entering a given area?—Jose Atranga, Isleta, NM

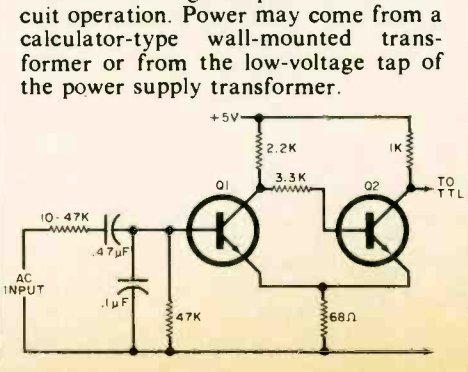
A. In the two circuits shown, the output can be coupled directly to the count input of the 7490. In (A), the counter will increment by one each time the photoresistor is darkened (this resistor should have a lit resistance of about 1000 to 3000 ohms and at least 100 kilohms when dark). In circuit (B), the opposite is true and one count is generated when the LDR is illuminated. The potentiometer can be used as a "sensitivity" control.



TTL Trigger

Q. How can I use the commercial power line to trigger TTL logic? I wish to sync the circuit to the 60-Hz power line.—Al Defson, Columbus, OH

A. The circuit shown here will condition a low-voltage ac signal (any power-line frequency from 25 Hz up) into a TTL-compatible signal. The 0.1-μF capacitor reduces the effect of any line noise present, and this value can be changed as required. Keep the value of the input resistance as high as possible with circuit operation. Power may come from a calculator-type wall-mounted transformer or from the low-voltage tap of the power supply transformer.



EXPERIMENTER'S CORNER

By Forrest M. Mims

How to Protect Profitable Ideas— Part 1. Adventures of an Idea Peddler

HAVE YOU devised a circuit or created a computer program that is both original and has money-earning potential? If so, you have probably wondered how you can profit from your idea while protecting it from the unscrupulous.

I've been down this road several times over the past ten years. Along the way I've dealt with $200-per-hour patent attorneys, negotiated with powerful corporate officers, and watched my home office be searched from top to bottom by a team of well-dressed lawyers from one of the biggest corporations in America.

While I don't have all the answers, my adventures in the corridors of the U.S. Patent Office, plush executive offices, and the land of NIH (*N*ot *I*nvented *H*ere) may provide some helpful hints for those of you who want to cash in on a valuable idea.

In this installment I shall relate just two of my half-dozen or so unfortunate experiences in this area. In a subsequent column I'll cover ways to protect your ideas and suggest some tips for making money from them.

The Marvelous Martian Music Machine. In 1973 Exar Integrated Systems, Inc. introduced the XR-2240 programmable timer and XR-2207 voltage-controlled oscillator. An application note by Exar engineer Alan B. Grebene described a very interesting pseudo-random tone synthesizer made from these two chips. The circuit, which is shown in Fig. 1, produces a repeatable sequence of 256 tones.

I asked Exar for permission to approach a nearby consumer electronics firm with a prototype version of the synthesizer I had assembled with chips Exar supplied. I added cadmium sulfide light-sensitive photocells to my version to cause the tones to appear even more random as the cells responded to light variations.

The president of the electronics firm offered me a 5-percent royalty on sales of the synthesizer in return for my assistance in preparing it for market. The company eventually produced a few hundred synthesizers. Dubbed the "Marvelous Martian Music Machine," the units sold for about $60 each. In spite of repeated requests, I never received a written confirmation of the royalty agreement. Nor did I receive any royalties.

Prior to the firm's subsequent bankruptcy, the president told me how a consumer electronics firm much larger than his had copied and begun to produce a color organ he once sold them. Though outraged by what had happened to him, he displayed no sympathy toward me.

The moral seems clear. Always secure a written agreement from a firm *before* helping them place your idea into production. But even that important step would not have guaranteed royalty payments in my case in view of the company's eventual fate. A second lesson, then, is: attempt to deal only with reliable, well-established companies.

Mims vs. Bell Laboratories. Dealing with a reliable firm was very much on my mind on May 29, 1973 when I mailed the patent department of Bell Telephone Laboratories a letter describing several applications for light emitting diodes which both emit *and* detect light. The genesis of these ideas occurred in 1962 when I discovered that a cadmium sulfide photocell, normally a detector of light, will *emit* greenish yellow light when connected to several kilovolts.

In 1966 I received, with a silicon solar cell, audio tones carried by the weak infrared emission from an identical current-pulsed solar cell. Figure 2 shows the circuit used in these experiments. This work led to experiments in the transmission of tones and voice back and forth between various kinds of LEDs.

There are several useful applications for components which double as sources and detectors of light. The most important is a fiber-optic voice or data link with a single dual-function emitter/detector at either end of the link. This permits two-

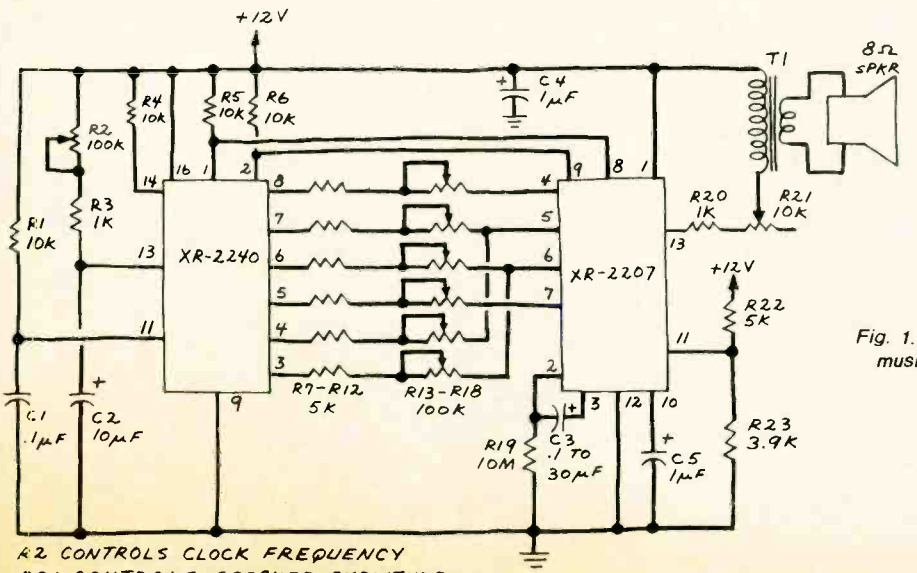


Fig. 1. Schematic diagram of the Exar musical tone sequence generator.

way transmission over a single fiber as shown in Fig. 3.

Unable to afford a patent search, I conducted an extensive literature search at several libraries. The search revealed no similar developments. I then submitted the ideas to Bell Labs. What could be safer? Bell Labs is the most prestigious laboratory in the United States and maybe the world. Seven of its scientists have won Nobel Prizes. From there sprang the junction transistor, silicon solar cell, and the helium-neon laser. And Bell Labs is part of the Bell System, a massive utility whose assets of $125.5 billion exceed the *combined* assets of Exxon, Mobil and General Motors!

William L. Keefauver, then Bell Labs' General Patent Attorney and now Vice President and General Counsel, agreed to have my suggestion reviewed if I would consent to

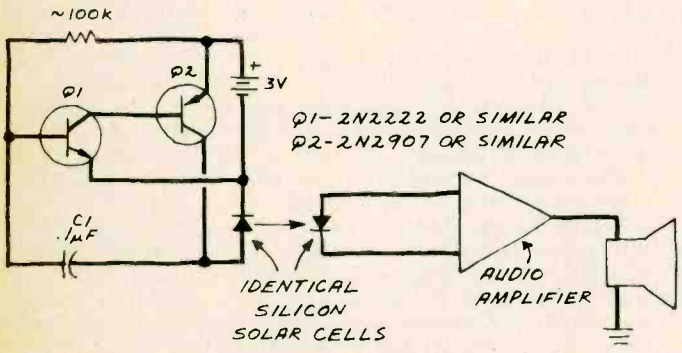


Fig. 2. Simple infrared tone transmission system.

an agreement of non-confidentiality that included the following provision:

"Should we want to make use of the suggestion, and if it is not already known to us and is not in the possession of the public and is original with the party submitting the suggestion . . . we would expect to discuss the matter with such party in an effort to arrive at an agreement that is mutually satisfactory."

I agreed and my suggestion letter was then reviewed by a member of the laboratory's technical staff and his supervisor. The scientist who reviewed my suggestions related in detail the different operating requirements of semiconductor detectors and emitters and concluded: "A single LED/detector device usually cannot be designed to meet these conflicting requirements." His supervisor then observed: " . . . I think it extremely unlikely that systems considerations would permit a single device to operate as both source and detector. Certainly all of our present thinking has been along the lines of separate fibers for transmitting and receiving."

The Bell Labs patent attorney assigned to my review then concluded in a letter to Mr. Keefauver: " . . . it appears that this outside proposal has negligible value to the Bell System, both at the present time and in the foreseeable future. Accordingly, we feel that acquisition of any rights in this proposal is *not* warranted."

At the time I was unaware of the in-house review process given outside ideas by Bell Labs. I was simply informed by Mr. Keefauver that the letter disclosing my ideas did " . . . not contain any novel features of sufficient interest to us at the present time to warrant our acquiring rights thereunder."

I clearly recall the sinking feeling which accompanied the receipt of this rejection. I remained convinced that the idea had merit. Since I had disclosed the idea in a book published in March 1973 ("Light Emitting Diodes," Howard W. Sams & Co., Inc.), the law provided a one year grace period in which to file a patent application. But my limited income as a relatively new freelance writer was insufficient to finance a patent search, much less a complete patent application.

After the rejection from Bell Labs, I described in an article for POPULAR ELECTRONICS ("Communicate Over Light Beams with the First Single-LED Transceiver," March 1974) construction details for a two-way infrared communicator that used a single GaAs:Si LED as a dual-function emitter-detector. The system could be used through the air or with an optical fiber. The article concluded: "The fiber-optic mode of operation is a precursor of what telephone systems of the future are likely to resemble."

I continued to write about dual-function emitter-detectors in this and other publications after 1973, all the while fully convinced the idea had practical merit. You can imagine my surprise upon learning in November 1978 that Bell Labs had developed a dual-function emitter-detector! According to the press release, the "new device" doubled as a detector and light source, thus " . . . greatly simplifying the problem of coupling separate detector and transmitter devices to the same end of a hair-thin fiber."

Bell Labs used this diode in a telephone powered by light sent along a glass fiber. The diode converted the light into electrical power for operating the phone and both received and transmitted voice signals. The phone and its diode received widespread press coverage in 1979.

Electronics magazine reported " . . . the new phone could establish AT&T as the No. 1 provider of wideband services to home and industry such as color television, data and computer services, and electronic mail" (October 25, 1979). *Business Week* described the new phone as " . . . so radically different it may eventually transform American Telephone and Telegraph Co. and the entire telephone industry, with profound effects on data communications, cable television, and every phone user . . . and dramatically alter the basic nature of the phone network" (December 4, 1978).

Naturally, upon learning about Bell Lab's new enthusiasm for diodes which both emit and detect light, I immediately called Mr. Keefauver to remind him about my suggestion and our agreement nearly five years earlier. There followed dozens of letters and phone calls and two trips from my home in Texas to the corporate offices of Bell Labs in Murray Hill, New Jersey to negotiate my claims with Mr. Keefauver and Dr. N. Bruce Hannay, Vice President of Research at Bell Labs. I even managed to discuss the matter in a telephone conversation with Dr. Ian Ross, President of Bell Labs.

I had in mind two goals. First, I sought compensation for the use of my idea. Second, I asked that Bell Labs scientists, when writing papers about the new telephone, footnote either the book or the POPULAR ELECTRONICS article which disclosed the idea.

Bell Labs eventually offered $15,000, $20,000 and, finally, $25,000 if I would undertake various writing and consulting projects for them and agree in writing not to publicize my claims. They also agreed to ask their scientists to consider referencing my work in describing their new telephone.

I wished to avoid litigation if at all possible, but the statute of limitations would soon run out. Following a final effort to obtain a settlement which didn't involve working for Bell Labs, I asked a patent law firm that I had previously contacted to file suit against Bell Labs in Federal District Court.

What happened next would teach me more than I ever

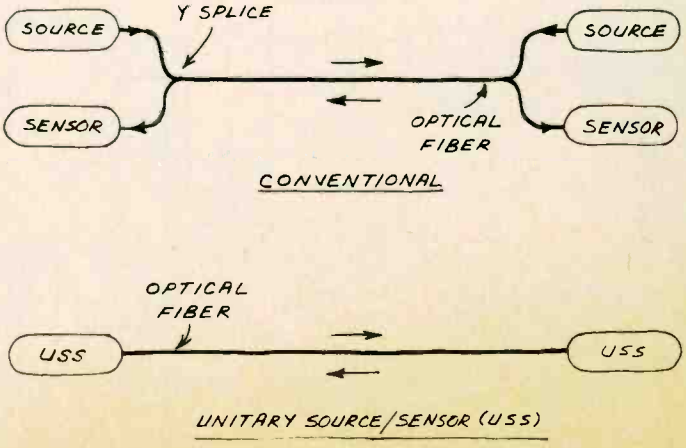


Fig. 3. Conventional and simplified optical-fiber systems.

cared to know about lawyers, courts, judges and Bell Labs. To relate all the details would require all the pages in this magazine! So I'll simply touch upon a few of the more memorable incidents.

First, I made three trips to New York City to be present during the giving of depositions by various Bell Labs scientists and officials. Settlement was alluded to at the first meeting,

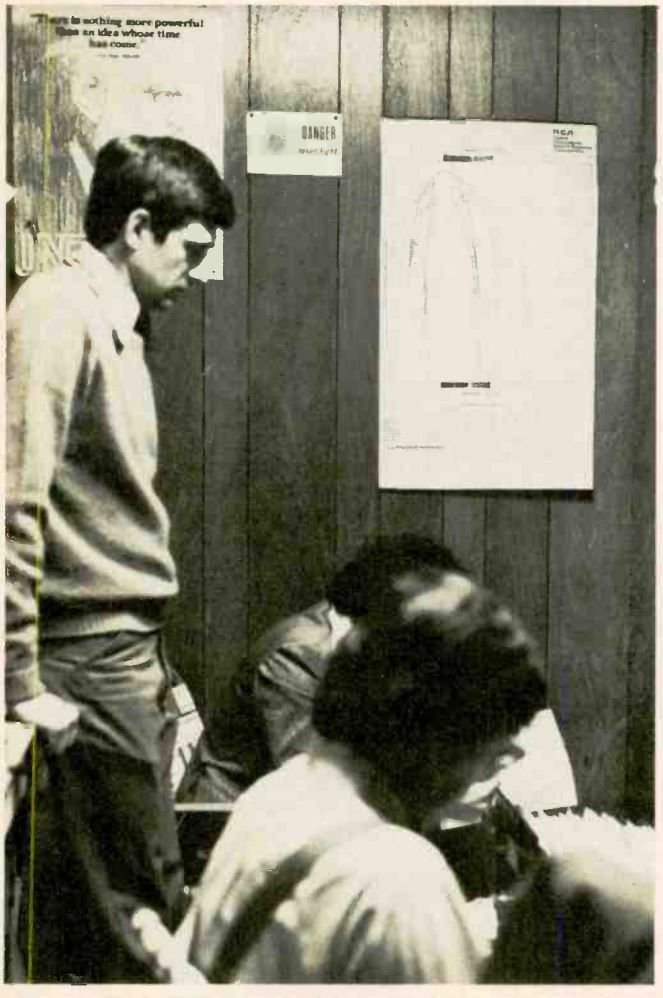


Fig. 4. With the author looking on, attorneys from Bell Laboratories and Western Electric performed a thorough search of his office and electronics shop.

so the depositions were postponed. Bell Labs cancelled the second deposition without notifying my attorneys. I found out about this shortly after arriving in New York!

Fireworks flew when the opposing attorneys finally got down to the business of deposition taking on the third trip. Bell Labs was represented by a team of attorneys from Western Electric and Bell Labs. Though most of these lawyers seemed friendly enough, their chief attorney for the case was remarkably uncooperative and did not get along well with my attorney.

As part of the pre-trial discovery procedure, Bell Labs had provided us with some, but not all, of the many documents we had requested. I was required to produce documents for Bell Labs as well. My attorneys decided to demonstrate our openness by allowing Bell Labs' attorneys to search my office and home for the documents they had requested. For some eight hours, three lawyers searched through *every* paper and folder in my file cabinets, desk and attic. They even read every page in my lab notebooks. Eventually they pulled more than 2000 pages for copying!

Later, I was required to give my deposition. Bell Labs had retained a prominent Texas trial attorney, and for four straight days he quizzed me on everything from the physics of light-emitting semiconductors to the possibility of my telephone being tapped.

Finally, at the end of the fourth day and after the Bell Labs attorneys had left for the airport, their high-powered lawyer propped his feet on the table and said our dispute should be settled out of court. Bell Labs would admit no guilt. Within minutes, he and Ted Lee, my principal attorney, had worked up an agreement. A week later my lawyers and I posed for pictures along with a check from Bell Labs.

A court-issued protective order prevents me from disclosing in this column much of what I learned about Bell Labs in the course of my suit. I can say, however, that Bell Labs abandoned a patent application for an "optical telecommunication system" that incorporated a diode which doubled as both an emitter and detector!

Was the experience worthwhile? In some ways, yes. I learned much about lawyers and litigation. And the results of a massive literature search by Bell Labs will enable me to write a definitive article, and perhaps a book, about diodes which both emit and detect light.

On the other hand, several of my editors and friends were subpoenaed by Bell Labs to give their depositions. I spent hundreds of hours researching the case and writing briefs and memos to my attorneys. And to this day, Bell Labs has steadfastly refused to reference any of my writings about emitter-detector diodes in any of its papers about its new optical fiber telephone.

I hope my experiences—one with a very small company and one with the largest corporation in America—have shown you some of the pitfalls that await the neophyte idea merchant. In the next installment, I'll cover some ways to protect your ideas. ◇

DX LISTENING

By Glenn Hauser

Researching the Shortwave Audience

THANKS to continuing scientific research by Dr. Kim Andrew Elliott, at the University of Massachusetts, we are learning more and more about the shortwave listening audience in America. Though there are certain to be millions of us, the exact number and other demographic data have never been determined accurately; nor are they likely to be, since SWLs are so widely dispersed geographically, and of minor commercial interest compared to domestic radio listeners and televiewers. Furthermore, SWLs are unlicensed in this country, and cannot be reached by mail, as hams can be.

Under these circumstances, the best approach is to conduct a survey using a scientifically selected random sample of known SWLs. Here are some of the findings of a 1981 survey by Dr. Elliott. About 10% of the subscribers to *Review of International Broadcasting* were sent a questionnaire; 72% replied. Of course, it must be kept in mind that the participants are likely to be more "active" than the truly typical SWL, for the very reason that they have gone to the trouble to subscribe to *RIB*.

Question 1: Please estimate the average number of hours per week you listen to shortwave broadcasts from anywhere. *Response*: Range, 0 to 35 hours per week. Mean (average), 12.67 hours; median, 10 hours. (The zero above reflects the fact that some people subscribe to the magazine to read about SWL without currently being active.)

Question 2: How much of your shortwave broadcast listening time is spent on DXing and how much on program listening? *Response:* Sixty-six percent of the respondents spent more than 80% of their shortwave time on program listening, as opposed to DXing.

Question 3: Please estimate the number of reception reports, for the purpose of obtaining a QSL card or verification from a SWBC station, that you sent during the previous year. *Response:* Range, 0 to 400. Mean 14.9. Fifty-six percent sent no reception reports.

Question 4: Which receiver(s) do you use for SWBC listening? Response: 78 different models were mentioned. The top ten, in order, were: Panasonic RF-2800 or 2900; Sony ICF-2001; Realistic DX-160; Kenwood R-1000; Panasonic RF-2900; Sony ICF-5900W; Yaesu FRG-7; Panasonic RF-2800; Panasonic RF-4800 or 4900; Panasonic RF-4900.

Question 5: Please list up to four of your favorite international broadcasting persons heard on international broadcast stations. The top ten were: Ian McFarland, *Radio Canada International*; Alistair Cooke, *BBC*; Barbara Frum, *CBC*; David Monson, *Belgian Radio*; Jonathan Marks, *Radio Netherlands*; Glenn Hauser, various; Margaret Howard, *BBC*; Joe Adamov, *Radio Moscow*; Vladimir Pozner, *Radio Moscow*; Keith Glover, *Radio Australia*.

Question 6: Your age. *Response:* Range, 15 to 71. Mean, 34.32. Median, 32.

Question 7: Sex. *Response:* 98.2% male, 1.8% female. Of course, the entire mailing list could be inspected for a more accurate proportion, but this is probably close. SWLing has long suffered from the mistaken belief that it requires great technical skills, more associated in traditional sex roles with males than females. Also, some female SWLs maintain that their numbers are proportionally greater, but they are less likely to join groups.

Question 8: Please indicate the highest level of education you have completed. *Response:* 6.4% less than high school; 9.2% high school; 22.9% some college or postsecondary; 33.9% college 4-year baccalaureate degree; 25.7% advanced degrees.

Question 9: Your full-time occupation. *Response*: There was a wide spread, with the largest single group (20.2%) being students.

Question 10: In which region do you live? The USA was split into six regions, Canada into two; and a ninth category covered all other outlying US areas beyond the continental 48 states. (Subscribers in other countries were not eligible for this survey.) The response to this becomes significant only when the percentage of SWLs in an area is compared to the percentage of the total population residing in that area. In most regions the numbers were approximately the same, but the exceptions are interesting. In the northeast USA with 44.4% of the population, there were 32.7% of the SWLs. In the southeast USA with 16.7% of the population, there were 3.7% of the SWLs. Again, a study of the entire mailing list would refine these data.

Question 11: List the magazines, journals, and other periodicals to which you subscribe or obtain at least four times per year (excluding newspapers and

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dx listening

RIB). *Response:* Mentioned most often were *FRENDX* (journal of SWBC DX club NASWA), *National Geographic, Time, SPEEDX* (a DX club), *Popular Electronics, Newsweek, Stereo Review,* and *BBC London Calling.*

Question 12: Please indicate the types of international broadcast programming and/or programming styles that you like to listen to and would like to hear more of. *Response:* There was a clear preference here for nonpolitical information, and music and news about the station's country or region. International news is covered so well by major stations, such as the BBC, that listeners would prefer smaller stations to concentrate on covering their own country rather than competing with the *BBC.* Surprisingly, the category "domestic service programming" drew the smallest number of votes, perhaps because of the language barrier and the generally inferior reception compared to external service.

Question 13: What programming don't you like and would like to hear less of? *Response:* The trend here went against popular music and political commentary, equally. There is a strong sentiment that many SWBC stations play too much of the same kind of music, which can also be heard on domestic radio; nor do listeners enjoy being regaled with outright propaganda barrages, which unfortunately is standard fare on some hostile stations.

Inventory of Program Listening. The major part of the *RIB* survey asked respondents to indicate the specific international broadcast programs to which they listen at least once a month, and to estimate how many days a month they listen to it. Here are the top ten, ranked by the percentage of respondents who listen to at least one installment of the program.

1) "DX Digest" (now "SWL Digest") on *Radio Canada International,* 41.7%. 2) "World News" on *BBC,* 25.2%. 3) "DX Juke Box" (now "Media Network") on *Radio Nederland,* 24.3%. 4) "Letter from America," *BBC,* 16.5%. 5) "Radio Newsreel," *BBC,* 15.3%. 6) "Letterbox," *BBC,* 13.1%. 7) "Moscow Mailbag," *Radio Moscow,* 12.6%. 8) "DX Party Line," *HCJB , Ecuador,* 11.8%. 9) "Shortwave Merry-go-round," *Swiss Radio International,* 11.0%. 10) "As It Happens," *CBC,* 10.9%.

The ratings were compiled again, using only the respondents with program listening rather than DXing orientations. There was no change in the order of the top six, but the next four became: 7) "As It Happens," *CBC.* 8) "Sunday Morning," *CBC.* 9) "Twenty-Four Hours," *BBC.* 10) "Moscow Mailbag," *Radio Moscow.*

The inventory of program listening shows the domination of DX/SWL/communications programs, even among the non-DXing subsample, and of news feature programming from English-speaking nations. ◇

Popular Electronics

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Early Wireless

by Anthony Constable

Here's something unusual: a book that traces the development of the radio (wireless) from the first crude detection devices at the turn of the last century, to the development of broadcasting. Drawings are used to help describe the early equipment, e.g., the Hertz resonator, coherers, Marconi detectors, the Fleming valve, etc. The highlight of the book is the section on receivers and speakers of the 1920s and '30s; there are many photographs of these artistic items. If you've never seen a book like this before, it's worth checking out.

Published by Sterling Publishing Co., Inc., New York, NY 10016. Hard cover. 160 pages. $19.95.

Designing with Field-Effect Transistors

Arthur D. Evans, Editor in Chief

This book, written by engineers at Siliconix, Inc., describes the technical development of the FET, gives information about the early patents for the device, and illustrates the numerous characteristic curves for FETs. Practical in approach, the book deals with various FET specs, operating parameters, low- and high-frequency circuits, and the FET as an analog device. It also examines voltage-controlled resistors and FET current sources, FETs and ICs, and typical circuits using FETs. The many circuit diagrams should prove useful to anyone working with TV, radar, hi-fi equipment, or industrial controls.

Published by McGraw-Hill, New York, NY 10020. Hard cover. 293 pages. $24.50.

Oscilloscopes

by Stan Prentiss

Stan Prentiss has done a thorough job in providing an overview of most types of oscilloscope measurement. Coverage includes professional scopes, logic analyzers, storage/sampling oscilloscopes, time-domain reflectometry, video cassettes, waveform analysis, etc. The book contains over 200 illustrations, as well as suggestions for the application of various oscilloscope techniques.

Published by Reston Publishing Company, Reston, VA 22090. Hard cover. 160 pages. $16.95.

Packet Radio

by Robert Roulean and Ian Hodgson

The technique of packet radio breaks down information into blocks of digitally encoded signals and transmits it at

(continued on page 125)

PROJECT OF THE MONTH

By Forrest M. Mims

Power Pulse Generator

THE LM150/LM250/LM350 is an adjustable voltage regulator capable of delivering from 1.2 to 33 volts at a maximum current of 3 amperes. Normally this chip is used in both fixed and adjustable power supplies, voltage regulators and voltage references.

Since I'm always looking for a new way to obtain high-current pulses for flashing lamps and driving motors, I have recently been experimenting with ways to switch the output of the LM350T on and off. Since the output voltage of this chip is fully adjustable, a circuit which switches its output on and off provides a variable-amplitude power pulse generator.

Before looking at an LM350T power pulse generator, let's first examine the operating characteristics of this versatile chip. Figure 1 shows the pin diagrams for both the TO-220 packaged LM350T and the TO-3 versions of the LM150/LM250/LM350.

The chip requires a minimum of external components. For straightforward voltage regulation, only two external resistors are required. As shown in Fig. 2, these form a voltage divider connected to the chip's voltage adjust terminal. Altering *R2*'s setting varies the circuit's output voltage.

If the LM150/LM250/LM350 is located some distance from the power supply filter capacitor, the addition of a 0.1-μF bypass capacitor across the input is required. Transient response, as during momentary high current loads, is enhanced by connecting a 1-μF capacitor across the output.

The LM150/LM250/LM350 includes on-chip thermal shutdown circuitry to protect the chip from being damaged by overloads. This circuitry remains functional even if the voltage adjust terminal is disconnected.

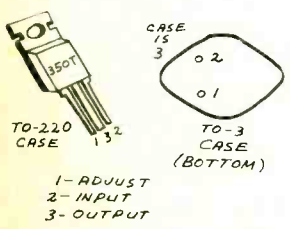

Fig. 1. Pin arrangement and configuration of the LM350 and LM350T voltage regulator.

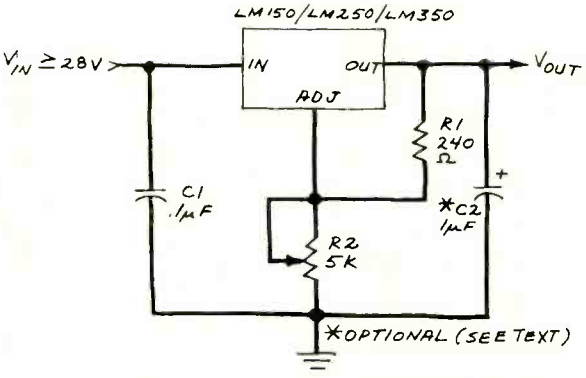

Fig. 2. LM150/LM250/LM350 1.2-to-25-volt adjustable regulator circuits.

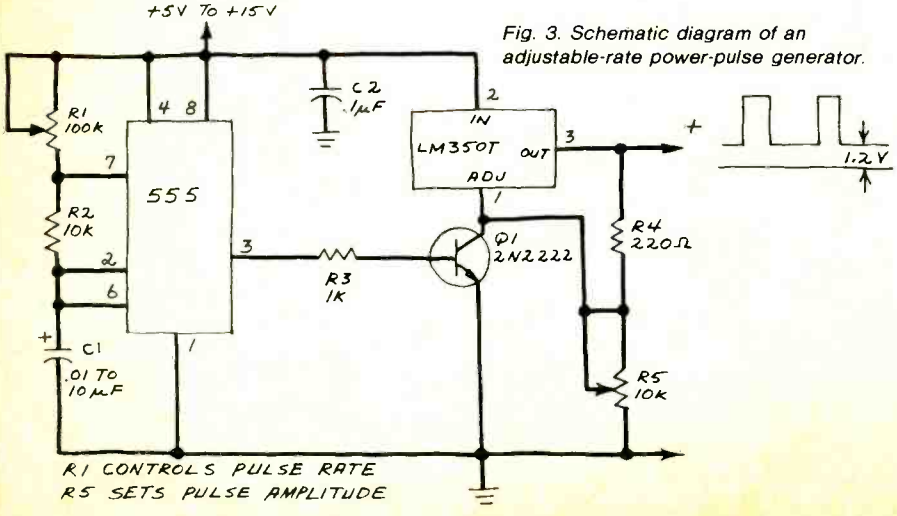

Fig. 3. Schematic diagram of an adjustable-rate power-pulse generator.

Power Pulse Generator. Figure 3 shows one way to switch the LM350T between its minimum output of about 1.2 V and the voltage set by *R5*. In operation, the 555 timer forms an oscillator which turns *Q1* off and on. When *Q1* is on, the output of the LM350T falls to its minimum 1.2-V level as the voltage adjust terminal is shorted to ground through *Q1*'s collector-emitter path. When *Q1* is off, the LM350T functions normally.

Resistor *R1* permits the pulse repetition rate to be altered, and *R5* controls the amplitude of the output pulses. Capacitor *C1*'s value can be increased or decreased to, respectively, slow down or speed up the pulse rate. When *C1* is 2.2 μF, the output pulses have a duration of 1.5 ms. The pulse duration increases to 2.5 ms when *C1* is increased to 3.3 μF.

Though this circuit has many applications, I've found it to be particularly effective as a flasher for incandescent lamps. Between flashes, the voltage across the lamp's filament falls to about 1.2 V instead of ground as in conventional lamp flashers. This minimal voltage can be considered a "keep-alive" voltage which keeps the filament glowing dimly between the flashes. When the lamp receives a current pulse, its filament reaches full brightness much faster than when a keep-alive current is not flowing.

You can operate an incandescent lamp at much more than its rated current level so long as the current is applied in brief pulses and the duty cycle is kept low. The resulting flashes are surprisingly sharp and brilliantly white. Applications include emergency strobes, close-range flash photography and novelty lighting.

Keep in mind other applications for the circuit. For example, it can deliver adjustable-rate pulses to a dc motor, thus serving as a speed control. It can also be connected to a large speaker and used as an attention-getting warning tone generator. ◇

OPERATION ASSIST

If you need information on outdated or rare equipment—a schematic, parts list, etc—another reader might be able to assist. Simply send a postcard to Operation Assist, POPULAR ELECTRONICS, 1 Park Ave., New York, NY 10016. For those who can help readers, please respond directly to them. They'll appreciate it. (Only those items regarding equipment not available from normal sources are published.)

Raytheon Model 401-2AM70 video terminal. Need schematics and any other technical data. Anthony Ploski, 40 Brookside Terrace, Clark, NJ 07066.

Eldorado Electrodata Model 1800 digital multimeter. Need operating manual and schematic. Jim Hamby, 5614 Briercliff Rd., Knoxville, TN 37918.

Telefunken Model 5083W stereo system. Need schematic and service manual. M. Gentleman, 929 Linden, Burlingame, CA 94010.

General Electric Model # CAM602WVY 19" B/W TV. Need schematic. Neal Mason, Rt. 1, Box 445, Gaylesville, AL 35973.

Martin Model 505 SSB transmitter. Need any information available. Tom Sturm, 1792 Hartford Ave., St. Paul, MN 55116.

Sperry 1942 searchlight. Need technical manual or operating manual. William Russell, 418 Scott Ave., Greensboro, NC 27403.

Zenith Model 7G605 trans-ocean radio. Need owners manual. Edgar T. Woodson, Box 69, Marysville, OH 43040.

Knight kit R-55 receiver. Need schematic and manual. Richard Granholm, 42C So. Fairway, Pullman, WA 99163.

Univac printer Model TST1030, type number 0769-02. Need installation instructions. William Sinoff, Box 1251, Alhambra, CA 91802.

Stanley Vemco Model 3100 garage door opener. Need schematic and wiring diagram. William D. Kraengel, Jr., 65 Sunset Rd., Valley Stream, NY 11580.

Magnavox Model 1S7331 Color TV. Need manual and schematic. George Bartzokis, 124 Aletha Rd., Needham, MA 02192.

Sparton Models 1466 and 1476 radio. Need schematic diagram or any information available. Myron Williams, 18000 McCaleb Rd., Little Rock, AR 72206.

Deforest Radio Limited Model #D586 shortwave AM receiver. Need schematic and alignment data. R. Marklund, 4710-56 Ave., Lloydminster, Alberta, Canada T9V0Z6.

Hickock Model 533A-600A-605A tube tester and CA-5 adapter. Need tester instruction manual and circuit diagrams. Harry Lookabill, 504 W. 86th Terr., Kansas City, MO 64114.

Crown Radio Corp., Model TRF-2200A radio. Need schematic. Rick Butler, 392 Putnam Hill Rd., Sutton, MA 01527.

Raytheon BH type tube. Need tube used in battery eliminators to replace B battery in late 1920's. James Hoffman, 105 Sherman Ave., Glen Ridge, NJ 07028.

Precision Model E-2-0-C signal generator and Model EV-10-S VTVM. Need schematics and manuals. J.S. Meyers Jr., 822 Bonzo St., New Castle, PA 16101.

Hallicrafters Model S107 multi-band receiver. Need dial cord stringing schematic. Joseph Abromaitis, Box 323, Watertown, CN 06795.

JVC Model CDS200 cassette deck. Need schematic. Jennifer Morgan, 577 Houston Dr., Thousand Oaks, CA 91360.

National Model VP-876A FM signal generator made by Matsushita. Need schematic. Hans Verhoeven, Box 4636, Mt. View, CA 94040.

National model RAO-6/NC-120 signal generator. Need schematic and service manual. Herman G. Hamilton, 33 Graite St., Apt. 105, New London, CT 06320.

Superior Instruments Co., Model 670-A multimeter. Need technical manual and schematic. Hugh McAllorum, 250 S. Wasson, Coos Bay, OR 97420.

Conway Model COS326. Need schematic, service manual and operation manual. Kirk Beach, Surgery RF-25, Univ. of Washington, Seattle, WA 98195.

Schulmerich Carillon Model CHU-25 electronic chimes. Need schematic and instruction manual. Vince Norvell, Immanuel Baptist Church, 306 Ogle Ave., Knoxville, TN 37920.

Eico Model 460 oscilloscope and **Superior Instrument Co.**, Model TV-50A signal generator. Need schematics, parts lists and any other information available. Jose A. Rodriguez, Calle C con 14. N C 50., Quibor, Edo. Lara 3014, Venezuela.

Fosgate Model PR2100 amplifier. Need schematic diagram. Ronald J. Burke, 2901 B. NE Rene, Gresham, OR 97023.

Solar Type CB-1-60 capacitor analyzer. Need manual and schematic. M.M. Schauer, 3489 Saratoga Dr., Hamilton, OH 45011.

Accurate Instruments Co., Model 257 tube tester. Need manual. Haleem Goode, 20230 Klinger, Detroit, MI 48234.

Sudfunk Model Simonetta radio. Need schematic. John Okolowicz, 836 Sunnyside Ave., Audubon, PA 19407.

Roberts Model 770 tape recorder. Need service manual, schematic and technical information. E.W. Hoffhine, Box 252, Kihei, HI 96753.

Panasonic WV-033V television camera. Need schematic. Bill Shaffer, Box 629, Marion, IN 46952.

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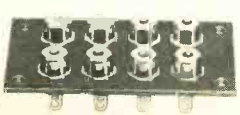

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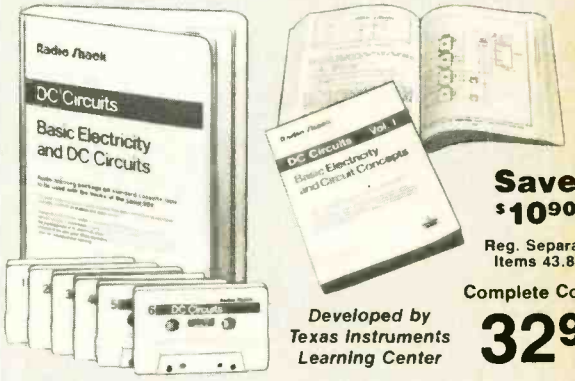

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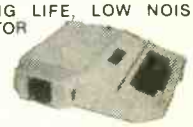

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LM386V	1.50
LM555V	.39
LM556	.69
LM565	.99
LM566V	1.49
LM567V	1.29
LM723	.49
LM733	.98
LM741V	.29
LM747	.79
LM748V	.59
LM1310	2.90
MC1330V	1.89
MC1350V	1.29
MC1358	1.79
LM1414	1.59
LM1458V	.69
LM1488	.99
LM1489	.99
LM1800	2.99
LM1889	2.49
LM3900	.59
LM3909V	.98
LM3914	3.95
LM3915	3.95
LM3916	3.95
75451V	.39
75452V	.39
75453V	.39

74S00 SERIES

74S00	.44	74S74	.69	74S163	3.75	74S257	1.39
74S02	.48	74S85	2.39	74S168	4.65	74S258	1.49
74S03	.48	74S86	1.44	74S169	5.44	74S260	1.89
74S04	.79	74S112	1.59	74S174	1.09	74S274	19.95
74S05	.79	74S113	1.98	74S175	1.09	74S275	19.95
74S08	.48	74S114	1.50	74S181	4.47	74S280	2.90
74S09	.98	74S124	2.77	74S182	2.95	74S287	4.75
74S10	.69	74S132	1.24	74S188	3.95	74S288	4.45
74S11	.88	74S133	.98	74S189	14.95	74S289	6.98
74S15	.70	74S134	.69	74S194	2.95	74S301	6.95
74S20	.68	74S135	1.48	74S195	1.89	74S373	3.45
74S22	.98	74S138	1.08	74S196	4.90	74S374	3.45
74S30	.48	74S139	1.25	74S197	4.25	74S381	7.95
74S32	.98	74S140	1.45	74S201	14.95	74S387	5.75
74S37	1.87	74S151	1.19	74S225	8.95	74S412	2.98
74S38	1.68	74S153	1.19	74S240	3.98	74S471	9.95
74S40	.44	74S157	1.19	74S241	3.75	74S472	16.85
74S51	.78	74S158	1.45	74S244	3.98	74S474	17.85
74S64	.79	74S161	2.85	74S251	1.90	74S482	15.60
74S65	1.25	74S162	3.70	74S253	7.45	74S570	7.80
						74S571	7.80

7400 SERIES

7400	.19	7451	.23	74136	.50	74186	18.50
7401	.19	7453	.23	74141	.65	74190	1.15
7402	.19	7454	.23	74142	2.95	74191	1.15
7403	.19	7460	.23	74143	2.95	74192	.79
7404	.19	7470	.35	74144	2.95	74193	.79
7405	.22	7472	.29	74145	.60	74194	.85
7406	.22	7473	.34	74147	1.75	74195	.85
7407	.22	7474	.35	74148	1.20	74196	.79
7408	.24	7475	.49	74150	1.35	74197	.75
7409	.19	7476	.35	74151	.65	74198	1.35
7410	.19	7480	.59	74152	.65	74199	1.35
7411	.25	7481	1.10	74153	.55	74221	1.35
7412	.30	7482	.95	74154	1.40	74246	1.35
7413	.35	7483	.50	74155	.75	74247	1.25
7414	.55	7485	.65	74156	.65	74248	1.85
7416	.25	7486	.35	74157	.55	74249	1.95
7417	.25	7489	4.95	74159	1.65	74251	.75
7420	.19	7490	.35	74160	.85	74259	2.25
7421	.35	7491	.40	74161	.70	74265	1.35
7422	.29	7492	.50	74162	.85	74273	1.95
7423	.29	7493	.49	74163	.85	74276	1.25
7425	.29	7494	.65	74164	.85	74279	.75
7426	.29	7495	.55	74165	.85	74283	2.00
7427	.29	7496	.70	74166	1.00	74284	3.75
7428	.45	7497	2.75	74167	2.95	74285	3.75
7430	.19	74100	1.00	74170	1.65	74290	.95
7432	.29	74107	.30	74172	5.95	74293	.75
7433	.45	74109	.45	74173	.75	74298	.85
7437	.29	74110	.45	74174	.89	74351	2.25
7438	.29	74111	.55	74175	.89	74365	.65
7440	.19	74116	1.55	74176	.89	74366	.65
7442	.49	74120	1.20	74177	.75	74367	.65
7443	.65	74121	.29	74178	1.15	74368	.65
7444	.69	74122	.45	74179	1.75	74376	2.20
7445	.69	74123	.55	74180	.75	74390	1.75
7446	.59	74125	.45	74181	2.25	74393	1.35
7447	.69	74126	.45	74182	.75	74425	3.15
7448	.69	74128	.55	74184	2.00	74426	.85
7450	.19	74132	.45	74185	2.00	74490	2.55

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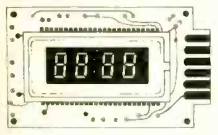
National Semiconductor Clock Modules



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MA1003 Module (3.05"Lx1.75"Hx.98"D) . **$16.95**

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TRANSFORMERS

102-P20 Xformer for MA1023, 1043 & 5036 Mods.	3.49
102-P22 Xformer for MA1026 Clock Modules	3.49
102-P24 Xformer for MA1010 Clock Modules	3.49

National Semiconductor RAM SALE

STATIC RAMS

MM2114N-2 4K (200NS) . . . . . **$2.49 each**
(8 EACH $16.95/lot) (100 EACH $195.95/lot)

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MM2147N 4K (70NS) . . . . . **$4.95 each**
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MM6116P-4 16K (200NS) . . . . . **$14.95 each**
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(8 EACH $19.95/lot) (100 EACH $225.00/lot)

MM5290N-4 16K (250NS) 4116 . . . . . **$1.95 each**
(8 EACH $14.95/lot) (100 each $175.00/lot)

EPROM Erasing Lamp

- Erases 2708, 2716, 1702A, 5203Q, 5204Q, etc.
- Erases up to 4 chips within 20 minutes.
- Maintains constant exposure distance of one inch.
- Special conductive foam liner eliminates static build-up.
- Built-in safety lock to prevent UV exposure.
- Compact – only 7-5/8" x 2-7/8" x 2"
- Complete with holding tray for 4 chips.

UVS-11EL Replacement Bulb $16.95

UVS-11E $79.95

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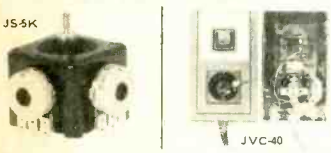

JS-5K	5K Linear Taper Pots	$5.25
JS-100K	100K Linear Taper Pots	$4.95
JVC-40	40K (2) Video Controller in case	$4.95

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MU2A1 . . . . $9.95 ea.

NEW! JE215 Adjustable Dual Power Supply

General Description: The JE215 is a Dual Power Supply with independent adjustable positive and negative output voltages. A separate adjustment for each of the supplies provides the user unlimited applications for IC current voltage requirements. The supply can also be used as a general all-purpose variable power supply.

FEATURES:
- Adjustable regulated power supplies, pos. and neg. 1.2VDC to 15VDC.
- Power Output (each supply): 5VDC @ 500mA, 10VDC @ 750mA, 12VDC @ 500mA, and 15VDC @ 175mA.
- Two, 3-terminal adj. IC regulators with thermal overload protection.
- Heat sink regulator cooling
- LED "on" indicator
- Printed Board Construction
- 120VAC input
- Size: 3-1/2"w x 5-1/16"L x 2"H

JE215 Adj. Dual Power Supply Kit (as shown) . . $24.95

(Picture not shown but similar in construction to above)

JE200 Reg. Power Supply Kit (5VDC, 1 amp) . .	$14.95
JE205 Adapter Brd. (to JE200) ±5, ±9 & ±12V.	$12.95
JE210 Var. Pwr. Sply. Kit, 5-15VDC, to 1.5amp.	$19.95

MICROPROCESSOR COMPONENTS

8080A/8080A SUPPORT DEVICES

INS8080A-4	CPU	4.95
DP8212	8-Bit Input/Output	3.25
DP8214	Priority Interrupt Control	5.95
DP8216	Bi-Directional Bus Driver	3.49
DP8224	Clock Generator/Driver	2.95
DP8226	Bus Driver	3.49
DP8228	System Controller/Bus Driver	4.95
DP8238	System Controller	5.95
INS8243	I/O Expander for 48 Series	9.95
INS8250	Asynchronous Comm. Element	16.95
DP8251	Prog. Comm. I/O (USART)	5.95
DP8253	Prog. Interval Timer	8.95
DP8255	Prog. Peripheral I/O (PPI)	5.95
DP8257	Prog. DMA Control	9.95
DP8259	Prog. Interrupt Control	8.95
DP8275	Prog. CRT Controller	39.95
DP8279	Prog. Keyboard/Display Interface	9.95
DP8303	System Timing Element	6.95
DP8304	8-Bit Bi-Directional Receiver	3.95
DP8307	8-Bit Bi-Directional Receiver	3.95
DP8308	8-Bit Bi-Directional Receiver	3.95
DP8310	Octal Latched Peripheral Driver	5.25
DP8311	Octal Latched Peripheral Driver	5.25

6800/6800 SUPPORT DEVICES

MC6800	MPU	7.95
MC6802CP	MPU with Clock and RAM	14.95
MC6810API	128x8 Static RAM	4.95
MC6821	Peripheral Inter. Adapt (MC6820)	7.49
MC6828	Priority Interrupt Controller	17.95
MC6828L8	1024x8-Bit ROM (MC68A30-8)	14.95
MC6850	Asynchronous Comm. Adapter	6.95
MC6852	Synchronous Serial Data Adapter	6.95
MC6860	0-600bps Digital MODEM	10.95
MC6862	2400bps Modulator	12.95
MC6880A	Quad 3-State Bus Trans. (MC8T26)	2.25

MICROPROCESSOR CHIPS

Z80 (780C)	CPU (MK3880N) (2MHz)	11.95
Z80A (780-1)	CPU (MK3880N-4) (4MHz)	13.95
CDP1802	CPU	19.95
2650	MPU	16.95
IDM2901ADC	CPU—4-Bit Slice (Com. Temp. Grade)	19.95
MCS6502	MPU w/Clock (65K Bytes Memory)	11.95
INS8035N-6	MPU—8-Bit (6MHz)	7.95
INS8035N-6	CPU—Sgl. Chip 8-Bit (128 Bytes RAM)	9.95
INS8040N-6	CPU (256 Bytes RAM)	24.95
INS8070N	CPU—Serial Bytes RAM	24.95
INS8073N	CPU w/Basic Micro InterPreter	29.95
P8085	CPU	9.95
TMS9900JL	MPU—16-Bit	39.95

SHIFT REGISTERS

MM500H	Dual 25-Bit Dynamic	.50
MM503H	Dual 50-Bit Dynamic	.50
MM506H	Dual 100-Bit Static	.50
MM510H	Dual 64-Bit Accumulator	.50
MM1402N	256-Bit Dynamic	2.95
MM5013N	1024-Bit Dynamic/Accumulator	1.95
MM5016H	500/512-Bit Dynamic	1.95
MM5034N	Octal 80-Bit	9.95
MM5035N	Octal 80-Bit	9.95
2504V (1404A)	1024-Bit Dynamic	1.95
2518N	Hex 32-Bit Static	3.95
2522V	Dual 132-Bit Static	2.95
2524V	512-Bit Dynamic	.99
2525V	1024-Bit Dynamic	2.95
2527V	Dual 256-Bit Static	2.95
2528V	Dual 250-Bit Static	4.00
2529V	Dual 240-Bit Static	4.00
2532N	Quad 80-Bit Static	2.95
3341PC	Fifo (Dual 80)	6.95

DATA ACQUISITION

AF100-1CN	Universal Active Filter 2.5%	5.95
AF121-1CJ	Touch Tone Low Band Filter	19.95
AF122-1CJ	Touch Tone High Band Filter	19.95
LM308CH	Super Gain Op Amp	1.15
LM334Z	Constant Current Source	1.30
LM335Z	Temperature Transducer	1.40
LF356N	JFET Input Op Amp	1.10
LF398N	Sample & Hold Amplifiers	3.95
LM399H	Temp. Comp. Prec. Ref. (.5ppm/C°)	5.00
ADC0804LCN	8-Bit A/D Converter (1 LSB)	4.95
DAC0806LCN	8-Bit D/A Converter (0.78% Lin.)	2.25

DATA ACQUISITION (CONTINUED)

ADC0809CCN	8-Bit A/D Converter (8-Ch. Multl.)	5.25
ADC0817CCN	8-Bit A/D Converter (16-Ch. Multl.)	10.95
DAC1000LCN	10-Bit D/A Conv. Micro. Comp. (0.05%)	13.95
DAC1008LCN	10-Bit D/A Conv. Micro. Comp. (0.20%)	8.95
DAC1020LCN	10-Bit D/A Converter (0.05% Lin.)	8.49
DAC1022LCN	10-Bit D/A Converter (0.20% Lin.)	5.95
DAC1222LCN	12-Bit D/A Converter (0.20% Lin.)	9.95
CD4051N	8-Channel Multiplexer	1.19
AY-5-1013	300 BAUD UART	6.95

RAM'S

1101	256x1 Static	1.49
1103	1024x1 Dynamic	.99
2101 (8101)	256x4 Static	3.95
2102	1024x1 Static	1.75
2L102	1024x1 Static	1.95
2111 (8111)	256x4 Static	3.95
2112	256x4 Static MOS	4.95
2114	1024x4 Static 450ns	2.25
2114L	1024x4 Static 450ns Low Power	2.49
2114-2	1024x4 Static 200ns	2.49
2114L-2	1024x4 Static 200ns Low Power	2.95
745200	256x1 Static	6.95
4116N-4 (UPD416)	16K Dynamic 250ns (MM5290N-4)	1.95
4164N-3	64K Dynamic 200ns	14.95
MM2147N	4096x1 Fast 70ns	4.95
5101	256x4 Static	7.95
MM5261	1024x1 Dynamic Fully Decoded	.99
MM5262	2Kx1 Dynamic	.49
MM5280/2107	4096x1 Dynamic	4.95
MM5290N-2 (4116)	16K Dynamic 150ns (UPD416C-3)	2.95
MM5298J-3A	8K Dyn. 200ns (lower w/g of MM5290J)	1.95
HM6116-4	16K (2K x8) Static 200ns	14.95
82S25	64 Bit RAM (16x40C)	3.49
UPD414/MK4027	4K Dynamic 16-pin	4.95
TMS4044-45NL	4K Static	9.95
TMS4045	1024x4 Static	9.95

PROMS/EPROMS

1702A	2K UV Erasable PROM	5.95
2708	8K EPROM	2.95
TMS2716	16K EPROM (-5V, +5V, +12V)	9.95
2716Intel(2516)TI	16K EPROM (Single +5V)	8.95
2732Intel TI	32K EPROM	17.95
2758	8K EPROM (450ns) (Single +5V)	7.49
2764Q	64K EPROM (Hitachi HN462764)	49.95
5203	2048 PROM	14.95
82S23(74S188)	32x8 PROM (Open Collector)	3.95
82S115	4096 Bipolar PROM	14.95
82S123(74S288)	32x8 Tri-State Bipolar PROM	3.95
82S185	8K PROM	16.95

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ROM'S

2513(2140)	Character Generator (Upper Case)	9.95
2513(3021)	Character Generator (Lower Case)	9.95

NMOS READ ONLY MEMORIES

MCM6670P	128x9x7 ASCII Shifted w/Greek	13.50
MCM66740P	128x9x7 Math Symbol & Pictures	13.50
MCM66750P	128x9x7 Alpha. Control Char. Gen.	13.50

MICROPROCESSOR MANUALS

M-Z80	User Manual	7.50
M-CDP1802	User Manual	7.50
M-2650	User Manual	5.00

SPECIAL FUNCTION

DS0025CN	Dual MOS Clock Driver (SMZ)	3.50
DS0026CN	Dual MOS Clock Driver (SMZ)	1.95
INS1771N-1	Floppy Disc Controller	24.95
INS2651N	Communication Chip	19.95
MM58167N	MicroProcessor Real Time Clock	8.95
MM5837N	MicroProcessor ComPatible Clock	11.95
COP402N	Microcontroller with 64-Digit RAM and Direct LED Drive	6.95
COP402MN	Microcontroller with 64-Digit RAM & Direct LED Drive w/N Buss Int.	7.49
COP470N	32-Seg. VAC Fluor. Driver (20-pin pkg.)	3.25

TELEPHONE/KEYBOARD CHIPS

AY-5-9100	Push Button Telephone Dialer	14.95
AY-5-9200	Repertory Dialer	14.95
AY-5-9500	CMOS Clock Generator	4.95
AY-5-2376	Keyboard Encoder (66 keys)	11.95
HD0165-5	Keyboard Encoder (66 keys)	7.95
74C922	Keyboard Encoder (16 keys)	5.49
74C923	Keyboard Encoder (20 keys)	5.75
MM53190N	Push Button Pulse Dialer	7.95
MM57499N	96/144-Key Serial Keyboard Encoder	8.95

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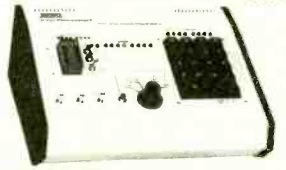
- Terminals on .100 x .300 (2.54 x 7.62) centers • PCB or dip socket mountable • Positive cleaning/wiping action with gold contact • Total seal and bottom seal

2400-10

Part No.	Pos.	Configuration	Socket	Price
2400-2	2	12	8 pin	.79 - 10/ 6.95
2400-3	3	123	8 pin	.89 - 10/ 7.95
2400-4	4	1234	8 pin	.99 - 10/ 8.95
2400-ABCD	4	ABCD	8 pin	.99 - 10/ 8.95
2400-5C	6	C54321	14 pin	1.09 - 10/ 9.95
2400-6	6	123456	14 pin	1.09 - 10/ 9.95
2400-7	7	1234567	14 pin	1.19 - 10/10.95
2400-8	8	12345678	16 pin	1.29 - 10/11.95
2400-9	9	123456789	18 pin	1.39 - 10/12.95
2400-10	10	0123456789	20 pin	1.49 - 10/13.95

JE608 PROGRAMMER
2704/2708 EPROM PROGRAMMER



GENERAL APPLICATIONS:
- To program EPROMS 2704 and 2708.
- Developmental system for microcomputer circuits
- To read the contents of a pre-programmed EPROM
- To compare EPROM(s) for content differences
- To emulate a programmed EPROM
- To store program in RAMS for alterations
- Three separate Display Registers: 8 LED's for Hex Key entries, 10 LED's (2^5) for address Register and 8 LED's for Data Memory Register. The Data Memory Register displays the content of the RAMs from the EPROM Chip. Development of microprocessor systems by means of a ribbon cable from the programmer panel test socket to the EPROM socket on the microprocessor board. Rapid checking verification of programmed data changes. User may move data from a master to RAM's or write into RAM's with keyboard entries. Allows manual stepping manipulation (up and down) at any address location. Stand-alone EPROM Programmer consisting of: A 19-key Hexadecimal Keyboard assembly. Programmer Board assembly with 4 power supplies and a LED/Test Socket Panel Board assembly. The Test Socket is zero force insertion type. Power requirements: 115VAC, 60Hz, 8W. Compact desk-top enclosure: Color-coordinated designer's case with light tan panels and molded end pieces in mocha brown. Size: 3¼"H x 11"W x 8¾"D. Weight: 5 lbs.

The JE608 EPROM Programmer is a completely self-contained unit which is independent of computer control and requires no additional systems for its operations. The EPROM can be programmed from the Hexadecimal Keyboard or from a pre-programmed EPROM. The JE608 Programmer can emulate a programmed EPROM by the use of its Internal RAM circuits. This will allow the user to test or pretest a program for a system, prior to programming a chip. Any changes in the program can be entered directly into the memory circuits with the Hexadecimal Keyboard so that rewriting the entire program will not be necessary. The JE608 Programmer contains a Programmer/Board w/25 IC's & includes power supplies of: -5V, +5V, +12V and +26V. The Hexadecimal Keyboard and LED/Test Socket Panel board are separate assemblies within the system.

JE608K Kit $399.95

JE608A Assembled and Tested $499.95

JE608-16K ADAPTER BOARD
FOR 2716/2758 EPROMS

GENERAL DESCRIPTION:
The JE608-16K Adapter Board allows the JE608 Programmer to be modified for the additional programming of the 2716 and 2758 EPROMS. The adapter provides for adding an address switch for the 2^11 bit and also for selecting the proper power and timing pulses to be applied to the EPROM. Programming and emulating the 2716 (16K) EPROM is done separately to each half (1024x8) of the EPROM because of the existing 8K RAM capacity in the JE608 Programmer.

JE608-16K	Adapter Board Kit	$29.95
JE608-Upgrade	(Send assembled JE608 to factory for adapter installation of the JE608-16K Adapter Board Kit)	$99.95
JE608A-16K Mod.	Assembled JE608 w/Adapter (JE608-16K) Installed	$599.95

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BOOKS

National Semiconductor — Intersil — Intel

30001	National CMOS Data Book (640 pages) 74C, CD4000, and A/D Converters	$5.95
30002	National Interface Data Book (704 pages) DP, DS8000, DS3600, DS75000, etc.	$5.95
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30004	National Series 80 — Board Level Computer (224 pages)	$4.95
30005	National TTL Logic Data Book (624 pages) 7400, LS, L, H, S, and DM8000 Series	$8.95
30006	Buy above (3) 30001, 3, 5 as a set	$19.95/lot
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010400	Intel Component Data Catalog Full data sheets for Intel's products incl. memory devices, microproc., peripherals & indust./mil. products (1328 pages)	$10.00
205610	Intel Peripheral Design Handbook Full data sheets, appl. notes for Intel peripheral device components (644 pages)	$7.50

AC and DC Wall Transformers

With Universal Plug and 9V Battery Snap

Selective voltages: 6,9,12VDC. Polarity selection (+/-), six-foot line from adapter to plugs — six-inch line from adapter to battery snap. 120V/60Hz. 300mA.

Part No.	Input	Output	Price
AC 250	117V/60Hz	12VAC 250mA	$3.95
AC 500	117V/60Hz	12VAC 500mA	$4.95
AC1000	117V/60Hz	12VAC 1 amp	$5.95
AC1700	117V/60Hz	9VAC 1.7 amp	$3.95
DC6912 (above)	120V/60Hz	6,9,12VDC 300mA	$9.95
DV9200	117V/60Hz	9VDC 200mA	$3.25
DC900	120V/60Hz	9VDC 500mA	$3.95
DC1200	120V/60Hz	12VDC 300mA	$3.95

CONNECTORS

DB25P	D-Subminiature Plug	$2.95
DB25S	D-Subminiature Socket	$3.50
D20418-2	Screw Lock Hdwr. (2) DB25S/P	2/$.99
DB51226	Cover for DB25P/S	$1.75
22/44SE	P.C. Edge (22/44 Pin)	$2.95
UG88/U	BNC Plug	$1.79
UG89/U	BNC Jack	$3.79
UG175/U	UHF Adapter	$ .49
SO239	UHF Panel Recp.	$1.29
PL258	UHF Adapter	$1.60
PL259	UHF Plug	$1.60
UG260/U	BNC Plug	$1.79
UG1094/U	BNC Bulkhead Recp.	$1.29

TRS-80 16K Conversion Kit

Expand your 4K TRS-80 System to 16K
Kit comes complete with:
- 8 ea. MM5290 (UPD416/4116) 16K Dyn. Ram (*ns)
- Documentation for conversion

TRS-16K2 *150ns	19.95
TRS-16K3 *200ns	16.95
TRS-16K4 *250ns	14.95

JE610 ASCII Encoded Keyboard Kit

The JE610 ASCII Keyboard Kit can be interfaced into most any computer system. The kit comes complete with an industrial grade keyboard switch assembly (62-keys), IC's, sockets, connector, electronic components and a double-sided printed wiring board. The keyboard assembly requires +5V @ 150mA and -12V @ 10 mA for operation. Features: 60 keys generate the 126 characters, upper and lower case ASCII set. Fully buffered. Two user-define keys provided for custom applications. Caps lock for upper-case-only alpha characters. Utilizes a 2376 (40-pin) encoder read-only memory chip. Outputs directly compatible with TTL/DTL or MOS logic arrays. Easy interfacing with a 16-pin dip or 18-pin edge connector. Size: 3½"H x 14½"W x 8¾"D

JE610/DTE-AK (After assembled as pictured above) . . . **$124.95**

JE610 Kit 62-Key Keyboard, PC Board, & Components (no case). . . . **$ 79.95**

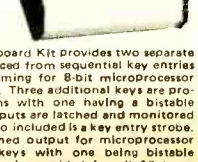
K62 62-Key Keyboard (Keyboard only) . . . **$ 34.95**

DTE-AK (case only — 3¼"Hx11"Wx8¾"D) **$ 49.95**

NEW! **JE212 — Negative 12VDC Adapter Board Kit for JE610 ASCII KEYBOARD KIT**
Provides -12VDC from incoming 5VDC . . . **$9.95**

JE600 Hexadecimal Encoder Kit

FULL 8-BIT LATCHED OUTPUT 19-KEY KEYBOARD



The JE600 Encoder Keyboard Kit provides two separate hexadecimal digits produced from sequential key entries to allow direct programming for 8-bit microprocessor or 8-bit memory circuits. Three additional keys are provided for user operations with one having a bistable output available. The outputs are latched and monitored with 9 LED readouts. Also included is a key entry strobe. Features: Full 8-bit latched output for microprocessor use. Three user-define keys with one being bistable operation. Debounce circuit provided for all 19 keys. 9 LED readouts to verify entries. Easy interfacing with standard 16-pin IC connector. Only +5VDC required for operation. Size: 3½"H x 8¾"W x 8¾"D

JE600/DTE-HK (After assembled as pictured above) . . . **$99.95**

JE600 Kit 19-Key Hexadec. Keyboard, PC Board & Cmpnts. (no case) . . . **$59.95**

K19 19-Key Keyboard (Keyboard only) . . . **$14.95**

DTE-HK (case only — 3½"Hx8¾"Wx8¾"D) **$44.95**

7400

SN7400N	.20	SN7472N	.29	SN74156N	.79
SN7401N	.20	SN7473N	.35	SN74157N	.69
SN7402N	.25	SN7474N	.35	SN74160N	.89
SN7403N	.25	SN7475N	.49	SN74161N	.89
SN7404N	.25	SN7476N	.35	SN74162N	.89
SN7405N	.29	SN7479N	5.00	SN74163N	.89
SN7406N	.35	SN7480N	.50	SN74164N	.89
SN7407N	.35	SN7482N	.99	SN74165N	.89
SN7408N	.29	SN7483N	.69	SN74166N	1.25
SN7409N	.29	SN7485N	.89	SN74167N	2.79
SN7410N	.25	SN7486N	.35	SN74170N	1.95
SN7411N	.29	SN7489N	1.75	SN74172N	4.95
SN7412N	.35	SN7490N	.49	SN74173N	1.39
SN7413N	.40	SN7491N	.59	SN74174N	.99
SN7414N	.69	SN7492N	.45	SN74175N	.89
SN7416N	.29	SN7493N	.45	SN74176N	.79
SN7417N	.29	SN7494N	.69	SN74177N	.79
SN7420N	.25	SN7495N	.69	SN74179N	1.49
SN7421N	.29	SN7496N	.69	SN74180N	.79
SN7422N	.45	SN7497N	3.00	SN74181N	2.25
SN7423N	.29	SN74100N	1.49	SN74182N	.79
SN7425N	.29	SN74104N	.89	SN74184N	2.49
SN7426N	.29	SN74105N	.89	SN74185N	2.49
SN7427N	.25	SN74107N	.35	SN74190N	1.25
SN7428N	.49	SN74109N	.39	SN74191N	1.25
SN7430N	.25	SN74116N	1.95	SN74192N	.89
SN7432N	.29	SN74121N	.39	SN74193N	.89
SN7437N	.25	SN74122N	.55	SN74194N	.89
SN7438N	.40	SN74123N	.59	SN74195N	.69
SN7439N	.25	SN74125N	.49	SN74196N	.89
SN7440N	.20	SN74126N	.49	SN74197N	.89
SN7441N	.89	SN74132N	.75	SN74198N	1.49
SN7442N	.59	SN74136N	.75	SN74199N	1.49
SN7443N	1.10	SN74141N	.99	SN74221N	1.25
SN7444N	1.10	SN74142N	3.25	SN74251N	.99
SN7445N	.89	SN74143N	3.49	SN74276N	1.95
SN7446N	.79	SN74144N	3.49	SN74279N	.79
SN7447N	.69	SN74145N	.79	SN74283N	1.49
SN7448N	.79	SN74147N	1.95	SN74284N	3.95
SN7450N	.20	SN74148N	1.29	SN74285N	3.95
SN7451N	.20	SN74150N	1.25	SN74365N	.69
SN7453N	.20	SN74151N	.69	SN74366N	.69
SN7454N	.20	SN74152N	.69	SN74367N	.69
SN7459A	.25	SN74153N	.79	SN74368N	.69
SN7460N	.20	SN74154N	1.25	SN74390N	1.49
SN7470N	.29	SN74155N	.79	SN74393N	1.49

74LS

74LS00	.29			74LS192	1.15
74LS01	.29			74LS193	1.15
74LS02	.29	74LS92	.75	74LS194	1.15
74LS03	.29	74LS93	.75	74LS195	1.15
74LS04	.35	74LS95	.99	74LS197	1.19
74LS05	.35	74LS96	1.15	74LS221	1.19
74LS08	.35	74LS107	.45	74LS240	1.49
74LS09	.35	74LS109	.45	74LS241	1.49
74LS10	.35	74LS112	.45	74LS242	1.49
74LS11	.39	74LS113	.49	74LS243	1.49
74LS12	.35	74LS114	.49	74LS244	1.49
74LS13	.59	74LS122	.89	74LS245	2.95
74LS14	.99	74LS123	1.25	74LS247	1.19
74LS15	.35	74LS125	.59	74LS248	1.19
74LS20	.35	74LS126	.59	74LS249	1.19
74LS21	.35	74LS132	.99	74LS251	.99
74LS22	.35	74LS133	.89	74LS253	.99
74LS26	.35	74LS136	.49	74LS257	.89
74LS27	.35	74LS138	.89	74LS258	.69
74LS28	.35	74LS139	.89	74LS260	.69
74LS30	.35	74LS151	.89	74LS266	.69
74LS32	.35	74LS153	.89	74LS273	1.95
74LS33	.59	74LS154	1.75	74LS279	.89
74LS37	.45	74LS155	.89	74LS283	.89
74LS38	.39	74LS156	.89	74LS290	.99
74LS40	.35	74LS157	.89	74LS293	.99
74LS42	.89	74LS158	.89	74LS298	1.25
74LS47	.89	74LS160	1.15	74LS352	1.29
74LS48	1.15	74LS161	1.15	74LS353	1.29
74LS49	1.15	74LS162	1.15	74LS365	.69
74LS51	.35	74LS163	1.15	74LS366	.69
74LS54	.35	74LS164	1.15	74LS367	.69
74LS55	.35	74LS165	1.15	74LS368	.69
74LS73	.45	74LS168	1.19	74LS373	1.95
74LS74	.45	74LS169	1.19	74LS374	1.95
74LS75	.59	74LS170	1.95	74LS375	.89
74LS76	.45	74LS173	.99	74LS386	.69
74LS78	.49	74LS174	.99	74LS393	2.49
74LS83	.89	74LS175	.99	74LS399	2.49
74LS85	1.25	74LS181	2.95	74LS670	2.49
74LS86	.49	74LS190	1.25	81LS95	1.95
74LS90	.69	74LS191	1.25	81LS97	1.95

74S

74S00	.45			74S243	3.25
74S02	.45			74S244	3.25
74S03	.45	74S124	3.95	74S251	1.45
74S04	.55	74S133	.55	74S253	1.45
74S05	.55	74S134	.69	74S257	1.35
74S08	.50	74S135	1.19	74S258	1.35
74S09	.50	74S136	1.75	74S260	.79
74S10	.45	74S138	1.35	74S280	2.95
74S11	.45	74S139	1.35	74S287	3.25
74S15	.45	74S140	.79	74S288	2.75
74S20	.45	74S151	1.35	74S373	3.49
74S22	.45	74S153	1.35	74S374	3.49
74S30	.45	74S157	1.35	74S387	2.95
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74S38	1.25	74S160	2.95	74S472	10.95
74S40	.50	74S174	1.59	74S473	10.95
74S51	.45	74S175	1.59	74S474	12.95
74S64	.50	74S188	2.95	74S475	12.95
74S65	.50	74S194	1.95	74S570	5.95
74S74	.75	74S195	1.95	74S571	5.95
74S86	.79	74S196	1.95	74S572	9.95
74S112	.79	74S240	2.95	74S573	9.95
74S113	.79	74S241	2.95	74S940	3.15
74S114	.79	74S242	3.25	74S941	3.15

CA–LINEAR

CA3010H	.99			CA3089N	3.75
CA3013H	2.15	CA3060N	3.25	CA3096N	3.95
CA3023H	3.25	CA3080H	1.25	CA3130H	1.39
CA3035H	2.49	CA3081N	2.00	CA3140H	1.25
CA3039H	1.35	CA3082N	2.00	CA3160H	1.25
CA3046N	1.30	CA3083N	1.60	CA3401N	.59
CA3059N	3.25	CA3086N	.85	CA3600N	3.50

CD–CMOS

CD4000	.39			CD 4098	2.49
CD4001	.39			CD4506	.75
CD4002	.39			CD4507	.99
CD4006	1.19	CD4041	1.49	CD4508	3.95
CD4007	.25	CD4042	.99	CD4510	1.39
CD4009	.49	CD4043	.89	CD4511	1.29
CD4010	.49	CD4044	.89	CD4512	1.49
CD4011	.39	CD4046	1.79	CD4514	3.95
CD4012	.25	CD4047	2.50	CD4515	2.95
CD4013	.49	CD4048	1.35	CD4516	1.49
CD4014	1.39	CD4049	.49	CD4518	1.79
CD4015	1.19	CD4050	.69	CD4519	.89
CD4016	.59	CD4051	1.19	CD4520	1.29
CD4017	1.19	CD4052	1.19	CD4526	1.79
CD4018	.99	CD4053	1.19	CD4528	1.79
CD4019	.49	CD4056	2.95	CD4529	1.95
CD4020	1.19	CD4059	9.95	CD4543	2.79
CD4021	1.39	CD4060	1.49	CD4562	11.95
CD4022	1.19	CD4066	.79	CD4566	2.79
CD4023	.29	CD4068	.39	CD4583	2.49
CD4024	.79	CD4069	.45	CD4584	.75
CD4025	.23	CD4070	.55	CD4723	1.95
CD4026	2.95	CD4071	.49	CD4724	1.95
CD4027	.69	CD4072	.49	MC14409	17.95
CD4028	.89	CD4073	.39	MC14410	18.95
CD4029	1.49	CD4075	.39	MC14411	15.95
CD4030	.49	CD4076	1.39	MC14412	15.95
CD4034	3.49	CD4078	.55	MC14419	7.95
CD4035	.99	CD4081	.39	MC14433	15.95
CD4040	1.49	CD4082	.39	MC14538	2.49
		CD4093	.99	MC14541	1.95

Bulova Quartz Ladies Watches

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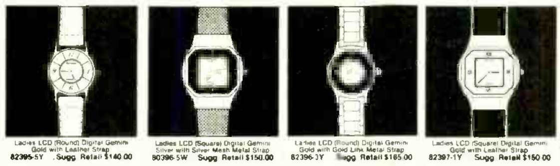
ONE YEAR FACTORY WARRANTY



Ladies LCD (Round) Digital Gemini Gold with Leather Strap 82395-5Y Sugg. Retail $140.00 · Ladies LCD (Square) Digital Gemini Silver with Silver Mesh Metal Strap 80396-5W Sugg. Retail $150.00 · Ladies LCD (Round) Digital Gemini Gold with Gold Link Metal Strap 82396-3Y Sugg. Retail $165.00 · Ladies LCD (Square) Digital Gemini Gold with Leather Strap 82397-1Y Sugg. Retail $150.00

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LITRONIX Stick Display Sale

WHILE THEY LAST! · SALE!

MULTI DIGIT REFLECTOR ARRAYS FOR CLOCKS

Part Number/Color	Char Ht (in.)	Polarity	Description Segment/Digit	Overall Size Length x Height x Depth	Light Output (mcd) Typ	Min	@mA	Forward Voltage Segment (V) Typ	Max	Continuous Forward Current per Segment (mA) Max	Price	2 FOR SALE
DL-[illegible] (Red)	.50	C.C. MPX / C.C. non MPX	With Colon and Auxiliary Indicators	[illegible]	[illegible]	[illegible]	10	1.7	2.0	30	1.80	2/2.95
DL-[illegible] (Red)				[illegible]		1.0					1.78	2/2.95
DLG-[illegible] (Grn)				[illegible]	[illegible]	[illegible]					4.95	2/7.95
DL-[illegible]A (Red)				[illegible]							2.40	2/2.95

MULTI DIGIT REFLECTOR ARRAYS

Part Number/Color	Char Ht (in.)	Polarity	Description	Overall Size	Typ	Min	@mA	Typ	Max	Max	Price	2 FOR SALE
DL-[illegible] (Red)	.30	C.C. MPX	7 Seg. 2 Digit RHDP	13/16" x 7/8" x 1/4"	1.5	1.1	20	1.7	2.0	30	.79	2/.99
DLG-[illegible] (Grn)	.30	C.A. MPX	9 Seg. 2 Digit	1-5/16" x 1 1/8" x 5/16"		2.0	20		3.5	25	[illegible]	2/1.19
DL-[illegible] (Red)	.30	C.C. MPX	9 Seg. 4 Digit RHDP	2" x 1-5/16" x 5/16"	[illegible]	[illegible]	10	1.7	2.0	30	1.40	2/1.95
DL-[illegible] (Red)	1.0	C.A. MPX	7 Seg. 2 Digit RHDP	2-3/4" x 1-13/16" x 5/16"	1.5	1.0	[illegible]	1.4	[illegible]	30	2.25	2/3.49

NATIONAL Stick Display Sale

LIMITED QUANTITY! · SALE!

LED NUMERIC ARRAYS

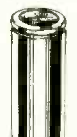
Part No	Digit Size (Red)	Format	Drive Comm. Cathode/Comm. Anode	Overall Size	Price	
NSA196	100 (9 Bubble Stick)	888888	C C 6 Digit Multiplexed	2" L x .72" H x .27" D	$ .50	2/.99
NSA198	100 (9 Bubble Stick)	888888888	C C 8 Digit Multiplexed	2" L x .72" H x .27" D	[illegible]	2/.99
NSA298	100 (9 Bubble Stick)	888888888	C C 9 Digit Multiplexed	1.[illegible]" L x .72" H x .27" D	[illegible]	2/.99
NSA1140	100 (3 Bubble Stick)	88 88	C C 4 Digit Multiplexed	2" L x .72" H x .27" D	.40	2/.79
NSA1150	100 (3 Bubble Stick)	8 88 88	C C 5 Digit Multiplexed	2" L x .72" H x .27" D	.40	2/.[illegible]
NSA15[illegible]	140 (9 Bubble Stick)	88888888	C C 8 Digit Multiplexed	2.3 8" L x .72" H x .27" D	.60	2/1.19

MULTI-DIGIT LED NUMERIC DISPLAYS

Part No	Digit Size (Red)	Format	Drive	Overall Size	Price	
NSN373	.3 No Decimal	88	C C 2 Digit Direct	.80" L x .80" H x .226" D	$.[illegible]	2/.79
NSN374	.3 No Decimal	88	C A 2 Digit Direct	.80" L x .80" H x .226" D	.70	2/.99
NSN601	.6 No Decimal	88	C A 2 Digit Direct	1.40" L x 1.14" H x .32" D (7.16 pins)	.69	2/1.49
NSN602	.6 No Decimal	88	C A 2 Digit Direct	1.40" L x 1.14" H x .32" D (7.16 pins)	.69	2/1.49
NSN581	.5	8.8	C C 2 Digit Multiplexed	1" L x 1.06" H x .38" D	[illegible]	2/1.79
NSN583	.6	8.8	C C 2 Digit Direct	1" L x 1.06" H x .38" D	[illegible]	2/1.79
NSN781	.7	88	C C 2 Digit Multiplexed	1.2" L x 1.35" H x .3" D	1.19	2/1.95
NSB2100	.3	88*88+8888	C C 8 Digit (10 Spaces)	4" L x .80" H x .280" D	.75	2/.[illegible]
NSB3001	.3	8888	C C 4 Digit Multiplexed	1.58" L x .80" H x .25" D	.75	2/.[illegible]
NSB3[illegible]	.3	888	C A 3½ Digit Multiplexed	1.60" L x .80" H x .225" D	.90	2/1.[illegible]
NSB3411	.3	88 88	C C 4 Digit – Colon PM Indicator	1 9/16" L x 13/16" H x 3/16" D	[illegible]	2/1.19
NSB3[illegible]2	.3	8 '88 88	C C 6 Digit – AM/PM Failure Ind	3" L x 1.10" H x 7/32" D	2.[illegible]	2/3.95
NSB3[illegible]4	.3	88888888	C A 8 Digit Multiplexed	3" L x 1 3/32" H x 3/16" D	2.[illegible]	2/3.95
NSB3[illegible]1*	.3	8888	C C 4 Digit Multiplexed	1.58" L x .80" H x .225" D	2.[illegible]	2/4.[illegible]
NSB3[illegible]2*	.3	8888	C A 4 Digit Multiplexed	1.[illegible]" L x .80" H x .225" D	2.[illegible]	2/4.[illegible]
NSB5[illegible]2*	.5	888	C A 3½ Digit Multiplexed	1.99" L x 1.00" H x .28" D	3.40	2/5.[illegible]
NSB6441	.5	88 88	C C 4 Digit AM/PM, Colon Ind	3.00" L x 1.10" H x .282" D	2.[illegible]	2/3.95
NSB5[illegible]1*	.5	8888	C C 4 Digit Multiplexed	[illegible]" L x 1.00" H x .280" D	3.[illegible]	2/6.[illegible]
NSB5[illegible]2*	.5	8888	C A 4 Digit Multiplexed	[illegible]" L x 1.00" H x .280" D	3.[illegible]	2/6.95
NSB6[illegible]18	.5	+ 8888	C C 3½ Digit Multiplexed	3.00" L x 1.10" H x .282" D	2.[illegible]	2/3.49
NSB6[illegible]22	.5	88888	C A 5 Digit Multiplexed	3.00" L x 1.10" H x .282" D	2.[illegible]	2/3.49
NSB7923	.7	888888	C C 6 Digit Multiplexed	3.60" L x 1.36" H x .282" D	3.[illegible]	2/4.95

*Standard Stocked items only pin out specifications available on non stocked items

COMPUTER GRADE CAPACITORS



MFD	WVDC	PRICE	MFD	WVDC	PRICE	MFD	WVDC	PRICE
250	150	1.95	10,000	15	2.95	24,000	20	2.95
500	200	2.49	10,000	16	3.95	27,000	10	2.95
1,250	3	.99	11,000	10	4.95	32,500	25	4.95
1,500	25	1.95	11,000	55	5.49	40,000	25	5.95
1,500	50	2.95	11,000	60	5.95	43,000	10	5.95
2,000	10	2.95	13,000	16	2.95	50,000	20	7.95
2,250	100	3.95	14,000	13	2.95	52,000	20	5.95
2,300	33	2.95	14,000	35	3.95	55,000	15	5.95
2,500	15	2.95	18,000	10	3.95	58,000	20	5.95
3,000	25	1.95	20,000	20	2.95	65,000	10	7.95
3,600	40	3.95	20,000	55	3.95	73,800	5	7.95
4,500	50	3.95	21,000	15	3.95	80,000	15	9.95
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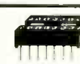
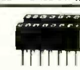


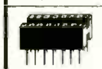
	1-24	25-49	50-100
8 pin LP	.17	.16	.15
14 pin LP	.20	.19	.18
16 pin LP	.22	.21	.20
18 pin LP	.29	.28	.27
20 pin LP	.34	.32	.30
22 pin LP	.37	.36	.35
24 pin LP	.38	.37	.36
28 pin LP	.45	.44	.43
36 pin LP	.60	.59	.58
40 pin LP	.63	.62	.61

SOLDERTAIL STANDARD (TIN)



	1-24	25-49	50-100
14 pin ST	.27	.25	.24
16 pin ST	.30	.27	.25
18 pin ST	.35	.32	.30
24 pin ST	.49	.45	.42
28 pin ST	.99	.90	.81
36 pin ST	1.39	1.26	1.15
40 pin ST	1.59	1.45	1.30

SOLDERTAIL (GOLD) STANDARD



	1-24	25-49	50-100
8 pin SG	.39	.35	.31
14 pin SG	.49	.45	.41
16 pin SG	.54	.49	.44
18 pin SG	.59	.53	.48
24 pin SG	.79	.75	.69
28 pin SG	1.10	1.00	.90
36 pin SG	1.65	1.40	1.26
40 pin SG	1.75	1.59	1.45

WIRE WRAP SOCKETS (GOLD) LEVEL #3

	1-24	25-49	50-100
8 pin WW	.59	.54	.49
10 pin WW	.69	.63	.58
14 pin WW	.79	.73	.67
16 pin WW	.85	.77	.70
18 pin WW	.99	.90	.81
20 pin WW	1.19	1.08	.99
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ASST. 4	5 ea.	3.3K 3.9K 4.7K 5.6K 6.8K / 8.2K 10K 12K 15K 18K	50 pcs.	$1.95
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ASST. 7	5 ea.	1M 1.2M 1.5M 1.8M 2.2M / 2.7M 3.3M 3.9M 4.7M 5.6M	50 pcs.	$1.95
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7107EV/Kit*	IC, Circuit Board, Display	29.95
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7117CPL	3½ Digit A/D LED Dis. HLD.	17.95
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7205IPG	CMOS LED Stopwatch/Timer	12.95
7205EV/Kit*	Stopwatch Chip, XTL	19.95
7206CJPE	Tone Generator	5.15
7206CEV/Kit*	Tone Generator Chip, XTL	12.95
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7209IPA	Clock Generator	3.95
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22 pf	.08	.06	.05	.0047µF	.08	.06	.05
47 pf	.08	.06	.05	.01µF	.08	.06	.05
100 pf	.08	.06	.05	.022µF	.09	.07	.06
220 pf	.08	.06	.05	.047µF	.09	.07	.06
470 pf	.08	.06	.05	.1µF	.15	.12	.10

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.0022mf	.12	.10	.07	.047mf	.21	.17	.13
.0047mf	.12	.10	.07	.1mf	.27	.23	.17
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.22/35V	.39	.34	.29	3.3/25V	.53	.47	.37
.33/35V	.39	.34	.29	4.7/25V	.63	.56	.45
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1.0/50V	.19	.16	.12	.47/50V	.16	.14	.13
3.3/50V	.17	.15	.11	1.0/16V	.15	.13	.12
4.7/25V	.18	.15	.11	1.0/25V	.16	.14	.13
10/25V	.18	.15	.11	1.0/50V	.17	.15	.14
10/50V	.19	.16	.12	4.7/16V	.15	.13	.12
22/25V	.19	.16	.12	4.7/25V	.16	.14	.13
22/50V	.24	.20	.18	4.7/50V	.17	.15	.14
47/25V	.25	.21	.19	10/16V	.15	.13	.12
47/50V	.29	.25	.23	10/25V	.16	.14	.13
100/25V	.28	.24	.22	10/50V	.17	.15	.14
100/50V	.41	.37	.34	47/50V	.25	.21	.19
220/25V	.39	.34	.33	100/16V	.21	.17	.14
220/50V	.49	.45	.41	100/25V	.25	.23	.21
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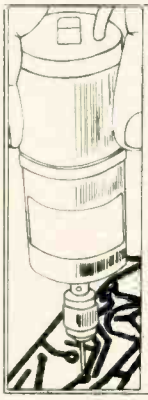

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(cont'd from p. 111)

various baud rates to a computer terminal. Using the familiar ASCII system as the common packet language, a UART (Universal Asynchronous Receiver/Transmitter) chip interconverts from parallel to serial and times the data as they are received or transmitted so that they arrive in discrete packets. The authors describe this process thoroughly, but simply. They also discuss the types of software that are suited to packet radio.

Published by TAB Books, Blue Ridge Summit, PA 17214. Soft cover. 304 pages. $11.95.

Android Design

by Martin Bradley Weinstein

Author Weinstein presents a comprehensive look at the tools, materials, and techniques necessary for designing a robot (a cyborg of any shape) or android (a man-like cyborg). The book is useful as a guide and reference if you've already worked out the specs for the cyborg you want to create; Weinstein doesn't present any construction projects. He does, however, give some helpful advice for the usual elements of cyborg construction—including software for speech synthesis and stochastic programming. It's well-written, too.

Published by Hayden Book Co., Rochelle Park, NJ. Soft cover. 248 pages. $11.95.

The Complete Guide to Car Audio

by Martin Clifford

This is a guide both for those who have some experience with car audio systems and those who know nothing about it but would like to learn. It covers 20 different setups, ranging from a two-speaker system with AM receiver to a four-speaker system with AM/FM. Also discussed are such car audio products as antennas, power amps, tape players, equalizers, etc. The author supplies practical information on installation, noise suppression, and theft protection.

Published by Howard W. Sams & Co., Indianapolis, IN 46368. Soft cover. 232 pages. $9.95.

Microprocessors for Measurement and Control

by David M. Auslander and Paul Sagues

The authors of this text assume that the reader has had some experience with scientific programming in FORTRAN, BASIC, Pascal, or C, although they claim that prior exposure to microprocessor hardware, or to machine and assembly language programming, is not necessary in order to complete the projects they outline. Using relatively simple machinery that can be easily interfaced to a microprocessor, the projects are intended to illustrate the more common problems encountered in the control of a machine's operation, and in the real-time evaluation of its performance.

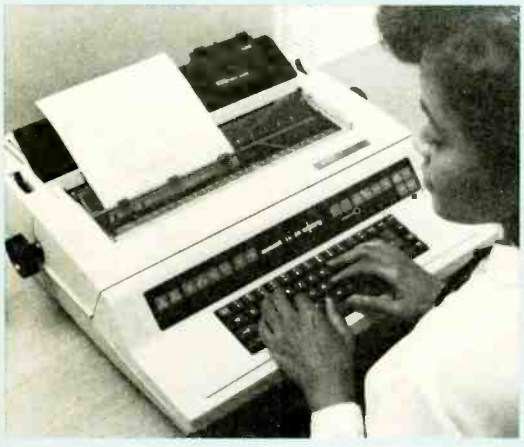
Published by Osborne/McGraw-Hill, Berkeley, CA. Soft cover. 310 pages. $16.00.

ELECTRONICS WORLD®

Personal Electronics News

IN-FLIGHT TELEPHONE SERVICE will probably start within a year, pending FCC approval. The service, utilizing single-sideband transmission, will operate on frequencies far removed from aircraft communications so as not to cause interference. One of the first suppliers of in-flight telephone equipment is Page America Communications, a beeper-rental company, which has tested its Sky-Tel system aboard DC10 aircraft on transcontinental routes. When a passenger wishes to call a party on the ground, he accesses the phone by inserting a credit card into a machine, which bills him automatically. Cost will be about $7.50 for three minutes at first, but is expected to fall once the system becomes more widely available.

APPLE III COMPUTERS, including those with Apple's five megabyte ProFile Winchester hard disk, can now be intermixed with Apple IIs as workstations in Nestar's Cluster/One Model A distributed computing and communications system. The Apple IIs, now being used as file, print, and communications servers, will continue in that role—with the Apple IIIs performing the more sophisticated functions in both word processing and financial analysis. Connecting an Apple III to the Nestar system is said to require the addition of an internal interface card plus cabling. A maximum of 65 stations is foreseen for each Cluster/One network.



XEROX ENTERS THE ELECTRONIC TYPEWRITER MARKET with four Memorywriter models. All have a touch-sensitive control panel just above the keyboard for setting up a particular job. They also use the same keyboard, daisywheel printer and case. The features common to the models include: intelligent print-wheels for automatic adjustment to any standard pitch, bold printing, correction memory for automatic erasing, battery back-up for the memory, a print intensity control, phrase recall, and automatic table layout. The 610 is the basic model; higher-end Memorywriters offer greater memory (to 19,300 characters) and word-processing capability, and can also be interfaced to the Xerox Ethernet network.

TELECOMMUNICATOR FOR THE DEAF has been developed by Dr. Harry Levitt, a hearing and speech professor at the City University of New York, winning First Prize of $10,000 in the Johns Hopkins University First National Search for Applications of Personal Computing to Aid the Handicapped. The device, a programmed off-the-shelf portable pocket computer with memory and logic, can be connected to a private or public telephone for instant communication between the deaf and those with normal hearing. Messages stored in the memory can be transmitted instantly, or the user can send a message via a pocket keyboard. A compact line printer or audio cassette, can be interfaced to the unit.

SERVICING INDUSTRIAL ROBOTS PAYS WELL according to Robotics Today. In one study, students from Macomb County Community College in Warren, MI, were earning an average salary of $23,000 to $24,000 upon graduation from the school's three-year-old robotics program. Some more experienced technicians were earning in the $50,000 range.

TELETEXT MARCHES ON. Time Inc. has joined AT&T, CBS, NBC, and Knight-Ridder in adopting the North American Broadcast Teletext Standard for its national, satellite-distributed, full-channel teletext service. This technical specification addresses itself to the coding and display of teletext pages. The standard also describes the transmission technique for delivery of teletext pages through video circuits employed by satellites and cable television systems, as well as by over-the-air broadcasters. Time Inc. will make use of all characteristics of the standard, including the advanced Picture Description Instructions, or PDIs, which is a compact and sophisticated method of encoding high-resolution graphics. Also to be used is a character display format of 20 rows, each with 40 characters. The service will be made available to selected homes in San Diego, CA, in the Spring of 1982.

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611/18

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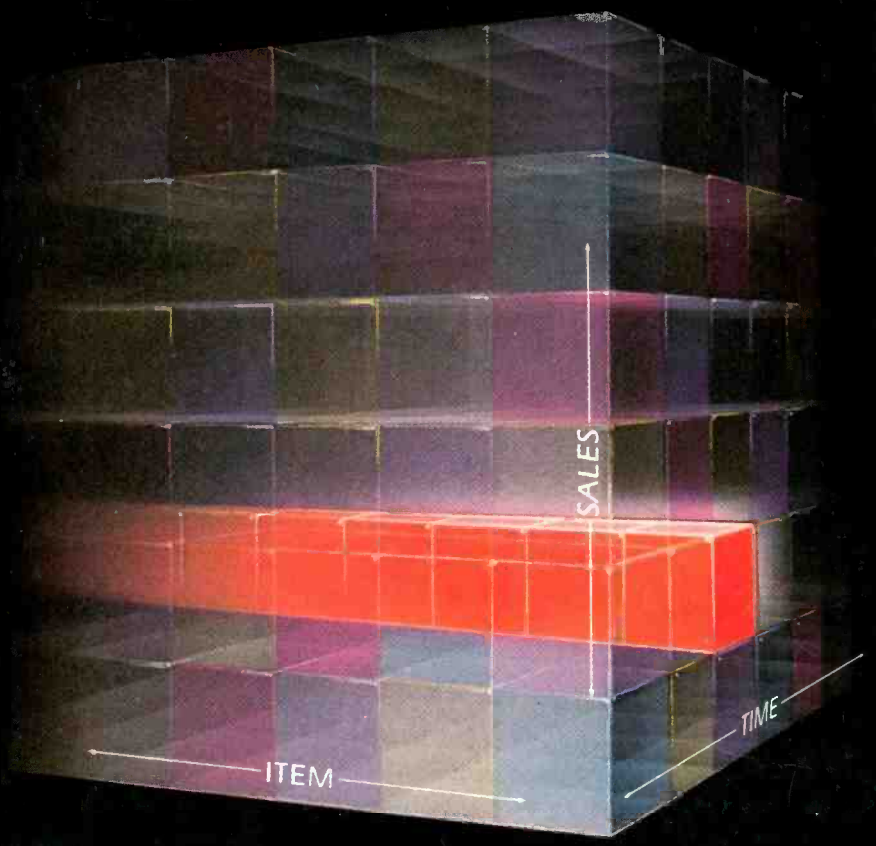

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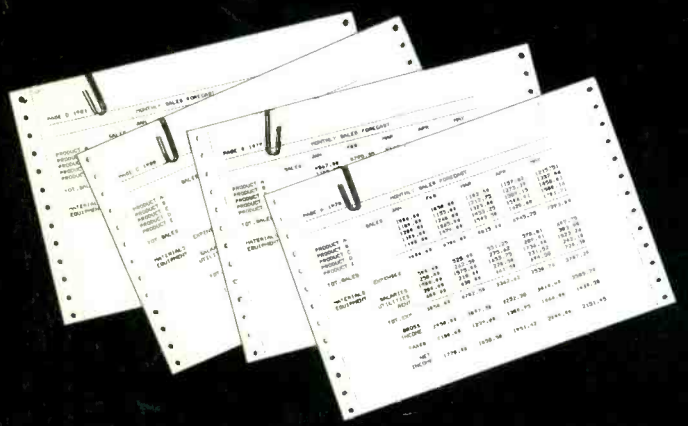
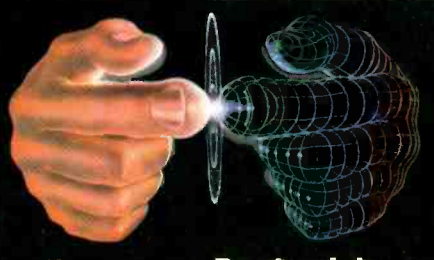


Sample printout showing use of X, Y, and Z axes.



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