Computers & Electronics

DECEMBER 1982

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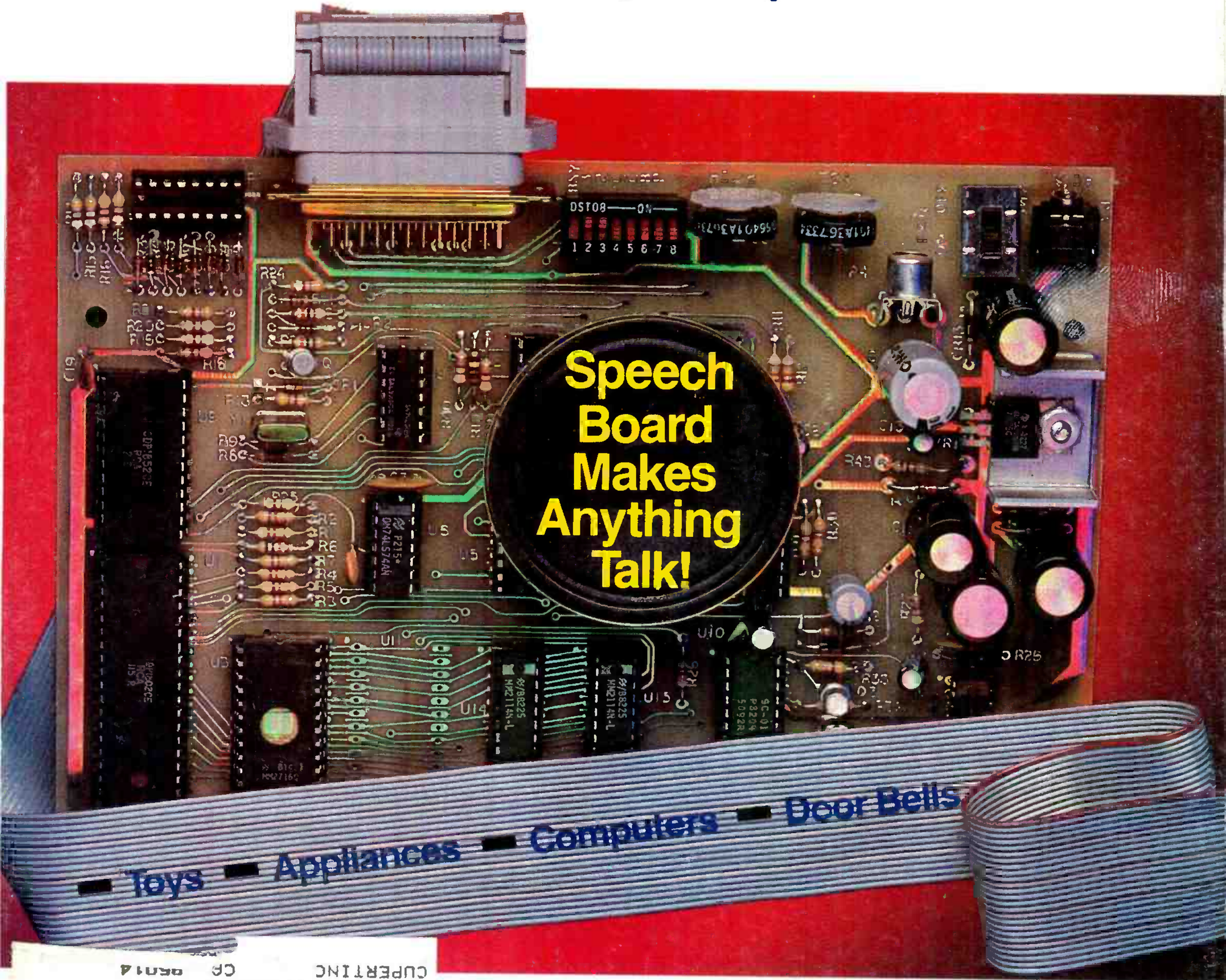
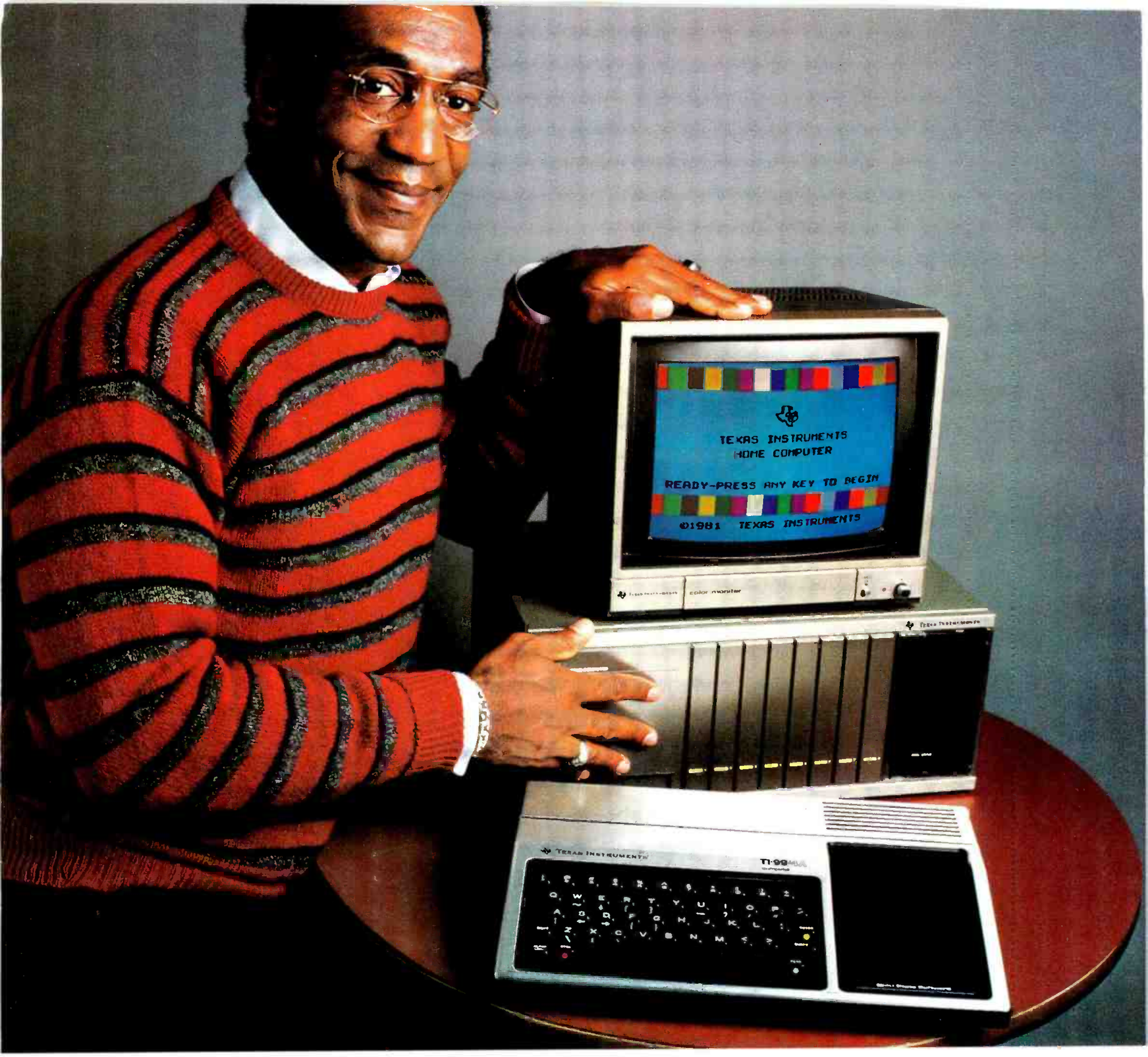
A Guide to Hard-Disk Technology
New Optimized Audio Graphic Equalizer
Comparing Hewlett-Packard's Latest Desktop Computers



Tested in This Issue:
asonic 2.6" Color TV Portable
V-95RX Stereo Cassette Deck
Fluke 8060A Digital Multimeter



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HAYES	
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MICROLINE 80	359
MICROLINE 82A	489
MICROLINE 83A	739
MICROLINE 84A	1179

SOFTWARE

CP/M ★ IBM

MICROPRO	
★ WORDSTAR	279
★ SUPERSORT	154
★ MAILMERGE	89
★ DATASTAR	239
★ SPELLSTAR	149
★ CALCSTAR	189
MICROSOFT	
BASIC COMPILER	299
BASIC 80	279
COBOL 80	559
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muSIMP/muMATH	199
MULTIPLAN	219
ASHTON-TATE	
★ dBASE II	529
FOX & GELLER	
★ QUICKCODE	249
★ dUTIL	68
SORCIM	
★ SUPERCALC	189
FORCE II	
MATHSTAR	99
ISA	
★ SPELLGUARD	189
OASIS	
★ WORDPLUS	149
MICROSTUFF	
★ CROSSTALK	117

SOFTWARE

APPLE

VISICORP	
★ VISICALC	184
★ VISIDEX	184
VISIPLOT	158
★ VISITERM	79
★ VISITREND	239
VISIFILE	184
DESKTOP PLAN II	184
★ DESKTOP PLAN III	184
MICROPRO	
WORDSTAR	224
SUPERSORT	119
MAILMERGE	79
DATASTAR	189
SPELLSTAR	129
CALCSTAR	139
MICROSOFT	
TASC APPLESOFT COMPILER	149
TIME MANAGER	119
FORTRAN 80	149
COBOL 80	539
A.L.D.S.	99
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DECEMBER 1982

VOLUME 20, NUMBER 12

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CONSTRUCTION ARTICLES

EQUIPMENT REVIEWS

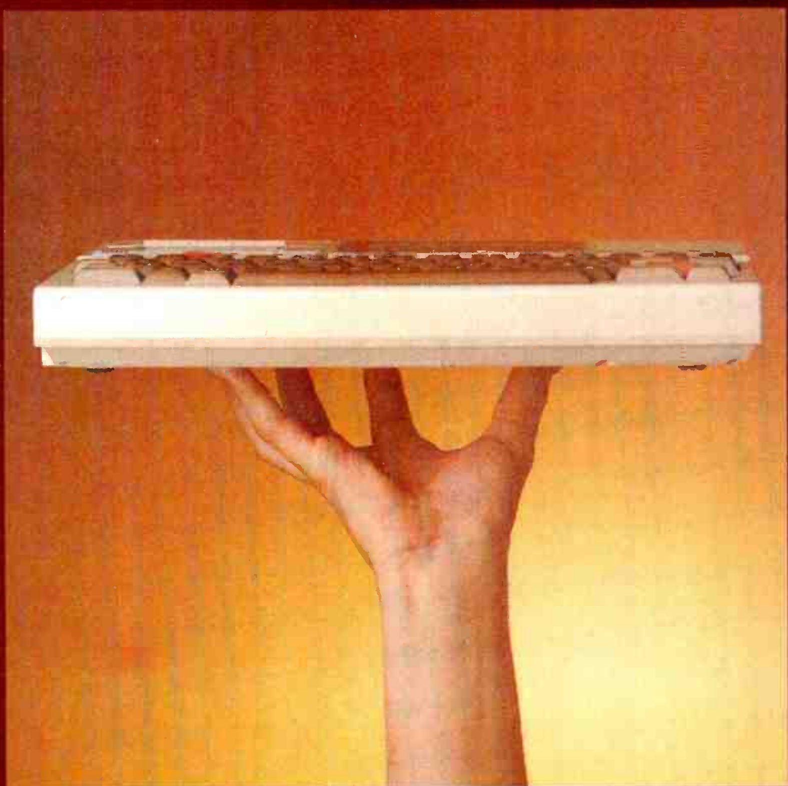
COVER PHOTO BY JAY BRENNER

COLUMNS

DEPARTMENTS

 Computers & Electronics (ISSN 0032-4485) December 1982, Volume 20, Number 12 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 97, Canada, $20 97, all other countries, $23 97 (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 trademark 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 POSTMASTER: Send address changes to COMPUTERS & 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.

How to tell an Epson HX-20 from an ordinary computer.



EPSON

CIRCLE NO. 25 ON FREE INFORMATION CARD

Actua

The size, of course, is a dead giveaway. But don't let the size fool you. The HX-20 is not a toy. Or a glorified calculator.

It's a computer.

A real computer, with 16K RAM (optionally expandable to 32K), and 32K ROM (optionally expandable to 64K), RS-232C and serial interfaces, a full-size ASCII keyboard, a built-in printer, a scrollable LCD screen, and sound generation. A micro-cassette and ROM cartridge are available as options.

Viva la différence!

In fact, the only differences between the Epson HX-20 and an ordinary computer are:

1) The HX-20 is small enough to fit inside your briefcase;
2) It'll run on its own internal power supply for 50-plus hours, and fully recharge in less than eight;
3) It gives you up to 10 program functions at the punch of a button;
4) It lets you interface with peripherals like the MX Series printers for correspondence quality output, the CX-20 Acoustic Coupler for remote communications, a barcode reader for inventory control, and an audio cassette for loading and saving programs;
5) It lets you shut the whole unit off while preserving all programs in RAM; and, last, but far from least,
6) It costs less than $800. That's right—less

The perfect traveling companion. With the Epson HX-20 and the optional RAM expansion, you'll be able to compute just about anywhere. Because its nickel-cadmium batteries and a low-power, all-CMOS memory keep the HX-20 running for over 50 hours. And even if you shut the HX-20 off, a low-voltage system maintains all programs you have in RAM.

Little screen, big picture. The HX-20's unique scrollable LCD screen is the ultimate answer to the question, "How do you get a big screen in a small space?" You just show part of it at a time.

l size.

Optional Microcassette

So with the HX-20, you can do programming, word processing and data entry just like you've got a big screen, up to 255 characters wide, with easy-to-read upper and lower case letters, numbers and punctuation and any 20 column by four line part of it visible by user command.

Built in hardcopies.
The HX-20's built-in 24 column dot matrix impact microprinter hands hardcopies to you at 42 LPM, in a crisp, precise 5x7 matrix. It even has bit addressable graphics to give you a pint-sized sales chart, and enough international symbols to print most Western languages.

Epson makes more and better printers than anyone else in the world. Need we say more?

The best is yet to come.
When you hold an HX-20 in your hand, you're not only holding a lot of capacity, you're holding a lot of expansion.

There's a standard cassette interface, a cartridge interface, the RS-232C and serial interfaces, and a system bus that lets you expand RAM and ROM capabilities. There's even a floppy disc drive for maxi capacity in a mini package.

The Epson edge.
Surprised that a computer like the HX-20 should come from Epson? You shouldn't be. Because we've been building computers in Japan since 1978. And we've been practicing ultra-high-quality precision manufacturing for a lot longer than that.

We didn't jump right into the American microcomputer market. We could afford to bide our time; to wait for the product that was going to stand America on its ear.

This is it.

The Epson HX-20.

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EDITORIAL

Omens for 1983

The end of any year is an appealing time to think about what happened during the past 12 months and what it portends for the following year. Here are some brief reflections on this that quickly come to mind.

With sales of home personal computers alone expected to grow very substantially in 1982—by more than 400 percent to over $1-billion according to the Yankee Group, a Boston market-research company—1982 might be considered to be the "Take-off Year" for low-cost computers.

Mass-market retailers entered the computer sales fray this year, with major chains such as Sears, Toys-R-Us, and others selling low-end home computers, too, as are independent retailers who normally sold only calculators and typewriters, and video specialists who had sold and rented only VCRs, video games and video tapes.

Given this happening, I anticipate many more sales outlets to be established in the coming year for low-cost personal computers that can meet or beat the price of programmable video games. And as sales of machines grow, expect software to do likewise in leaps and bounds.

It's obvious, too, that BASIC does not have a lock on programming languages. LOGO is eating away at it in some small computers, while Pascal and COBOL display growing strength in larger machines. UNIX has a bright future in operating systems for 16-bit and 32-bit machines, as does CP/M-86, while CP/M continues as a power for 8-bit machines.

* * *

With the FCC giving a go-ahead for direct-broadcast satellite (DBS) systems, the march is on toward beaming of multiple channels of TV programming to homes via satellite with subscribers receiving the signals via two-foot dish antennas.

In another area of communications, the FCC issued a Notice of Inquiry in 1979 requesting comment on whether a new personal radio system should be established. General Electric responded in 1982 with a proposal for a Personal Radio Communications Service in the 900-MHz band that provides two-way communication that will enable a user to connect to the public telephone network from his automobile and vice versa. With a five-mile range, extended to 15 miles with a repeater station, and at an approximate price equipment of $400, this could be a boon to many motorists who can't afford costlier present-day mobile telephone services and don't have amateur radio licenses.

* * *

There's a critical shortage of university-level teachers in electrical engineering and computer sciences. Among the major reasons for this sad state is the high cost of acquiring a Ph.D., so necessary to be a full-time teacher in these fields. A few months ago, Hewlett-Packard announced an innovative program as a move toward alleviating the problem. It is offering selected students fully paid tuition plus a living stipend totalling $36,000 over a four-year degree program. Half of the funds will be provided in the form of forgivable loans at the rate of 20 percent per year for the first two years of teaching and fully forgiven after the third year of teaching. A $50,000 H-P equipment grant will also be issued to each university where a program participant elects to teach. So 1982's announcement promises a good 1983 for some bright students.

* * *

There's no end to what manufacturers are squeezing into electronic wristwatches these days. The latest end-of-year novelty I've been made aware of through a press release is from Casio, Inc., which will offer three wristwatch models that display temperature in both Fahrenheit and Centigrade, as well as the more common time signals, stopwatch, world time, calendar, et al. Imagine someone stopping you next year and asking, "Pardon me, do you have the correct temperature?"

* * *

And finally, a "passenger" on an American Airlines flight from Chicago to New York was removed from the box it was encased in while resting on a seat just the other night. Opening the case, the airline attendants surrounding it were astonished to hear it say, "Boy, am I glad to be out of this box!" This 1982 event will be featured in the January 1983 issue of COMPUTERS & ELECTRONICS. It's a talking, moving, clutching, microcomputer-controlled ROBOT. Until then, Season's Greetings and Happy New Year.

Art Salsberg

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Editorial correspondence: COMPUTERS & ELECTRONICS, 1 Park Ave., New York, NY 10016. Editorial contributions must be accompanied by return postage and will be handled with reasonable care; however, publisher assumes no responsibility for return or safety of manuscripts, art work, or models submitted.

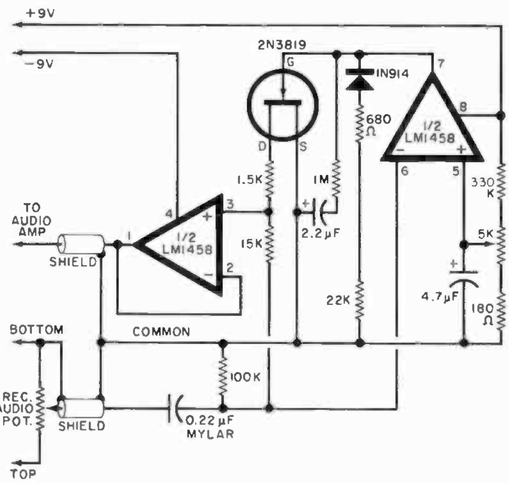
LETTERS

NO BLACK FLASH BEFORE TV COMMERCIALS

In the "Video Accessories" article in your October issue, the authors stated that the FCC requires broadcasters to precede and follow each commercial with a brief flash of black. This could then be used to trigger a commercial killer. To my knowledge, and I have also checked with the FCC, there is no such requirement. While it is true that modern television production techniques often result in a brief period of black before and/or after a commercial, it is not the rule. Many of the video transitions or wipes currently used result in uninterrupted video, without so much as a frame of black between segments. On the other hand, scene-to-scene dissolves within a feature can contain enough black to confuse the commercial killers. So, while units that look for black do remove some commercials, they may also remove some of the program.—*E. F. Arbuckle, III, WPIX, New York, NY.*

USES AUDIO GATE FOR SHORTWARE

I thought the circuit used in "Simple Audio Gate Expands Dynamic Range" (July 1982) might be useful in my shortwave receiver so I made a few modifications and hooked it up as shown in the diagram here.



Changes were made to allow long-life battery operation. Since no input buffer, preamplifier, nor LED were required, a dual op amp was used instead of the quad op amp. The results are most promising—there is marked quieting for S/N ratios of 5 dB or more. In the presence of fading, however, the noise level pot has to be set to a value lower than the optimum.—*C. H. Harry, Bowie, MD.*

LIKES OPERATION ASSIST

Your "Operation Assist" department has proven to be a worthwhile effort for me twice. Once I got five answers to a request for schematics; and the second, I received eight answers with three complete assembly manuals and schematic diagrams.—*F. N. Lockwood, WA6UCP, Santa Rosa, CA.*

A New Approach To Automobile Stereo Systems

By Leonard Feldman

THE acoustic environment inside an automobile is often described as "hostile." At first glance, high-fidelity sound reproduction inside a car seems like an impossible achievement: the car's upholstery absorbs a lot of the treble frequencies; road and wind noises seem to drastically limit dynamic range (the difference between softest and loudest musical passages); and positioning of the driver and passengers would seem to rule out satisfactory perception of stereo separation and so-called imaging.

Despite all of these problems, car stereo systems have become very popular in recent years, with many music enthusiasts installing systems whose costs represent a fairly high percentage of the total cost of the automobile. They have traditionally snubbed the "factory equipped" radio-tape player combinations available from the automobile maker, preferring to install (or have installed) other systems.

A recent development may change this attitude, however. Some 1983 General Motors automobiles will include the option of a car stereo system that is custom-designed for a specific automobile acoustic environment. This was achieved through a cooperative effort between General Motors and the Bose Corporation.

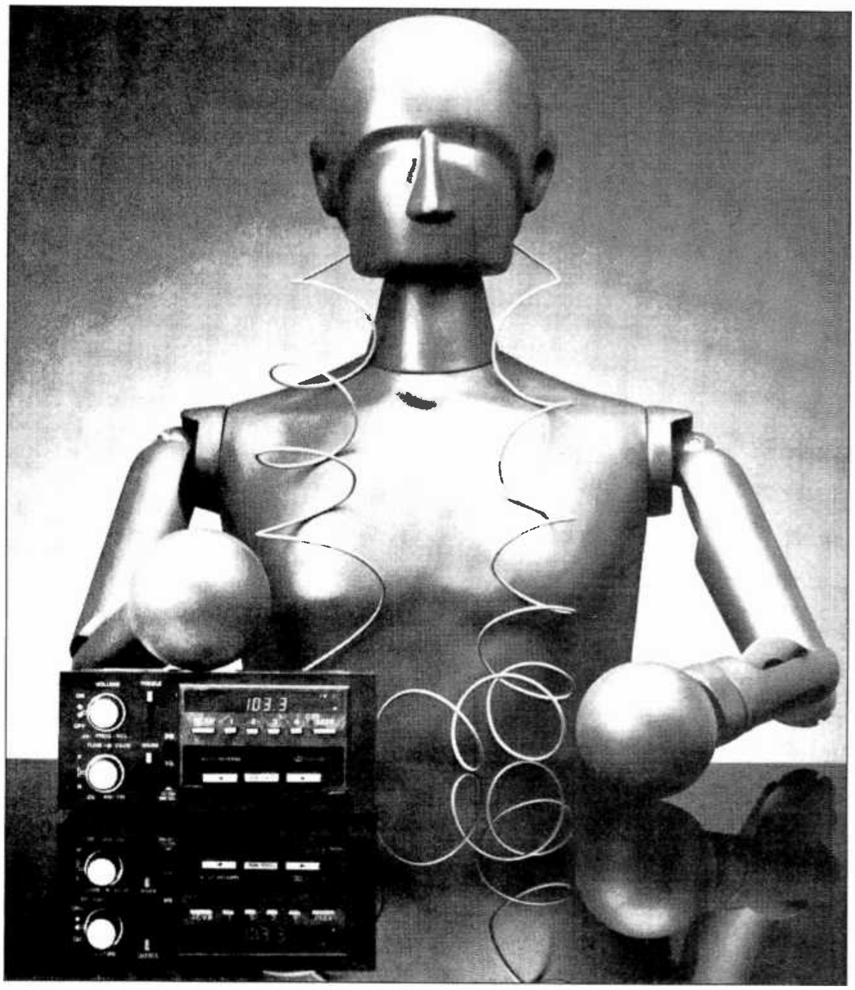


Fig. 1. Morgan's microphone/ears helped in the design of the new Delco-GM Car Stereo Systems for top-model 1983 cars.

Elements of the System. The first consideration in designing the system, after ensuring that the car's interior would be free of unacceptable resonances, was to determine where to put the speakers. If they were located in the most convenient area, the driver would hear mostly the left speaker, while the passenger in the front seat would hear mostly the right speaker. No balance control can provide proper stereo reproduction for both listeners!

The solution required a great many acoustic measurements, modeling, and much trial-and-error. One of the techniques used in making these measurements involved the use of "Morgan," whose photo is shown in Fig. 1. This "acoustic listener," equipped with a pair of sensitive microphone/ears, enabled Bose engineers to determine the acoustic characteristics of any vehicle model. Sounds picked up by the instrumentation microphones in Morgan's ears were processed through a digital computer and studies were made using a computer program called "Interval" (Interpretive Visual Analysis Language). This aid-

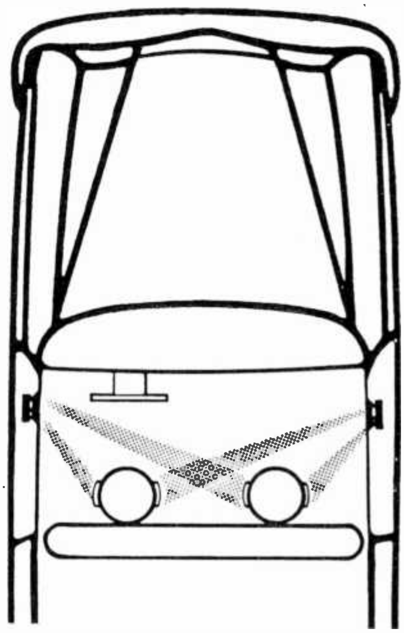


Fig. 2. Precise positioning of speakers creates proper balance.

ed the engineers to develop high-performance speaker/amplifier modules for what has come to be known as the Delco-GM/Bose Music System.

Figure 2 shows how the placement and directional characteristics of the speakers were chosen so that the driver is closer to the left-hand speakers but also directly on the radiation axis of the righthand speaker. Thus, only a front-rear balance control is said to be required; there is no left-right balance control in any of these new automobile systems.

Especially useful were the "Interval" computer-aided design techniques employed to study the acoustic requirements of the various car models. Among them: the fast-Fourier transform (permitting meaningful frequency measurements in the actual environment of the car's interior) and interaural cross-correlation measurements (when and how sounds arrive at each ear).

Equalization—A Key Element. Bose was among the earliest speaker manufacturers to incorporate fixed equalization into home speakers. That approach was put to good use in the design of the Delco-GM/Bose Music System. The strategy here was to carefully measure the response of the system within the car's environment and then to apply active equalization to remove some of the anomalies in response caused by the car's acoustics. To illustrate this principle, consider the "car response" shown in Fig. 3, taken without any equalization. By combining this less-than-impressive response with the active equalization curve of Fig. 4, the result in Fig. 5 can be obtained.

Equalization was only one aspect of the system design. The tuner had to be matched to the antenna. The loudness control could be optimized only with a knowledge of what sound pressure level would be created by a given audio signal. Overload protection circuitry had to be tailored to the maximum output of the power amplifiers. The

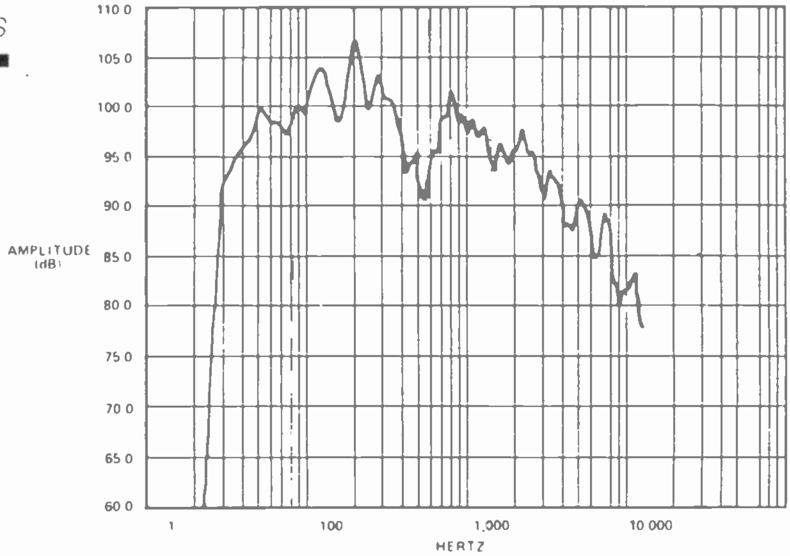


Fig. 3. Response measured in a car without equalization.

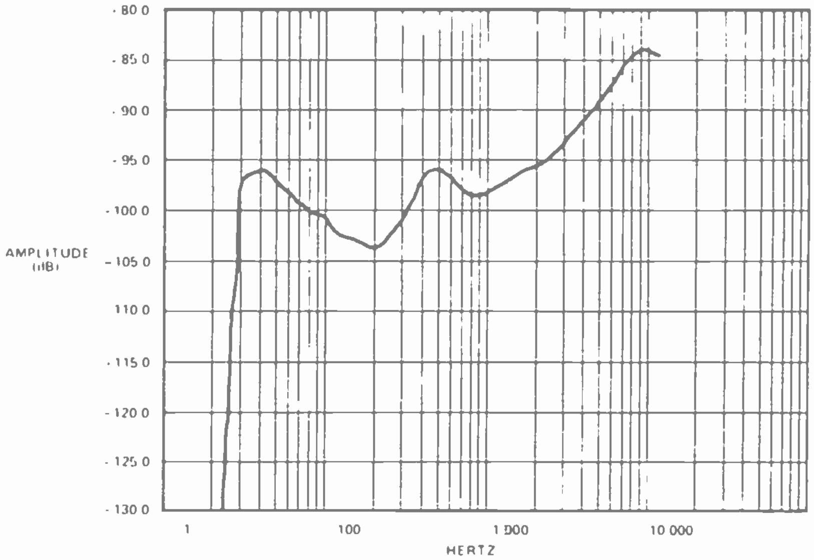


Fig. 4. Equalization curve to be used on response.

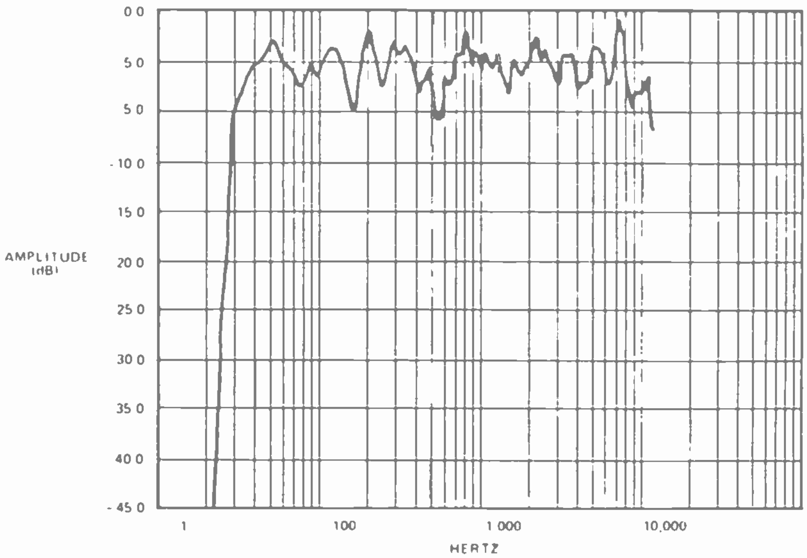


Fig. 5. Response of car with equalization applied.

special digital circuitry in the power amplifiers must not interfere with tuner performance. After all these design tasks were completed, there were still many problems to solve. Frequency response affected the perceived directional characteristics of the speakers so the speaker locations had to be changed after equalization was complete. Selection of grille material to match upholstery required yet another round of equalization. Even the wiring harness in the car caused performance changes that had to be evaluated before freezing the final design.

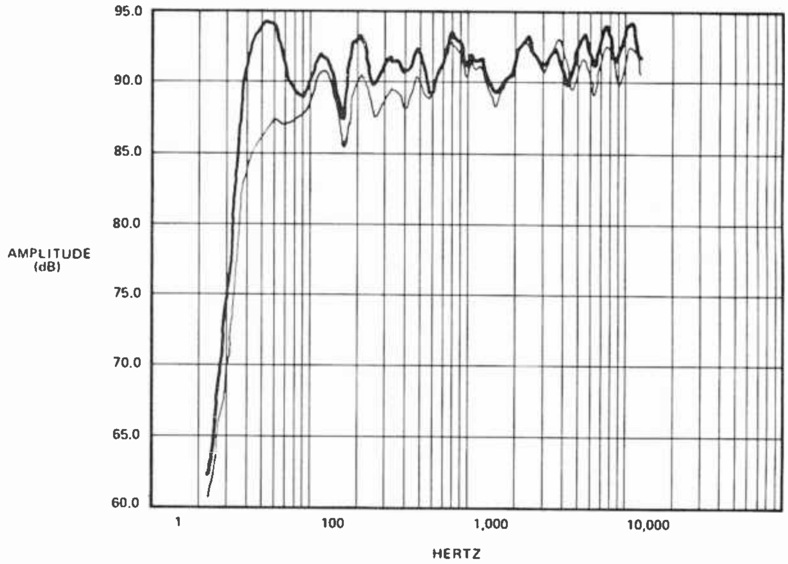


Fig. 6. Response of a standard car with (heavy line) and without a tuned enclosure.

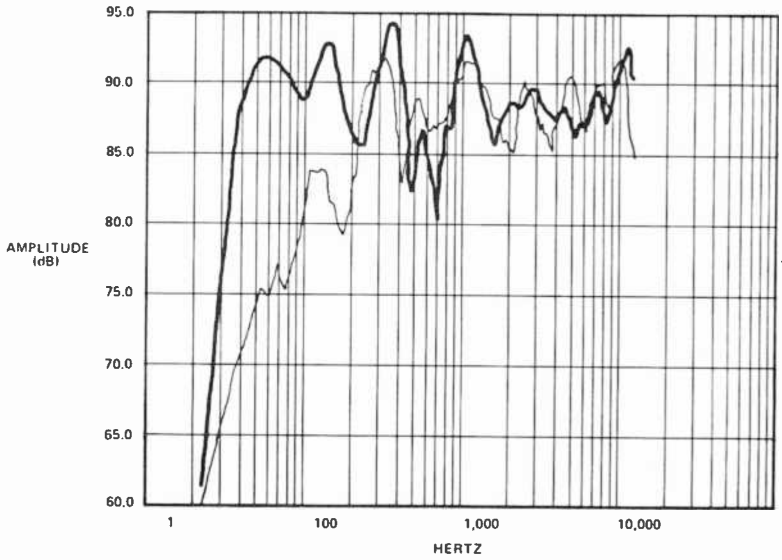


Fig. 7. Effect of a tuned enclosure (heavy line) in a compact car.

Speaker Enclosures. To determine whether speaker enclosures would be required, Bose measured a single speaker system mounted in the door panels of several cars with an enclosure and without one. Had the door panels been perfect enclosures (properly sealed, etc.), there would have been little difference.

Figure 6 shows the results in a 1983 Cadillac Seville. With the speaker enclosure, there is a 5-dB improvement in response at 50 Hz. Figure 7 shows the results in a compact car. Here, the potential improvement at that frequency was 15 dB. In other words, it would have taken 30 times more amplifier power at that frequency to get the same bass output without the enclosure. The use of specifically designed enclosures offers many benefits besides better bass. The most obvious of these is consistency from one unit to the next. In addition, protection against such hazards as water inside doors or foreign objects tossed into trunks is another obvious advantage. Perhaps the greatest benefit of all in using an enclosure, however, is the opportunity to include more complex acoustic elements in the design, such as a carefully tuned port to allow better low-frequency output.

The Electronics. The first step in the signal-processing chain of the Delco-GM/Bose Music System is Delco's Electronically Tuned Receiver (ETR) with its integrated cassette player. Low-level signals from the receiver are converted to sound by the four speaker modules. A typical module is shown in Fig. 8. One module is installed in the lower section of each front door, and the other two are installed in the rear package shelf. Each module contains three separate components: a reflex enclosure specifically designed for each car model, a helical-voice-coil wide-range speaker driver, and a 25-watt power amplifier, the latter using a new circuit that employs "two-state modulation," as discussed below.

The amplifiers had to be small despite the 25-watt power output requirement. Furthermore, the car itself had to be assembled in such a way that no direct "heat sinking" to the car body was used to cool the amplifier. Known as two-state amplifiers, these systems operate by switching very rapidly between two "states," with the output transistors either fully on or completely off.

When a transistor is fully on, load current flows but no voltage appears across the transistor; hence no power is dissipated in the transistor itself. When the transistor is off, voltage appears across it but no current flows, so again no power is dissipated. While this description also fits earlier "switching" or Class D amplifiers, one of the chief differences is that earlier units operated in an "open loop" manner without any negative feedback. In this design, negative feedback is used to ensure flat response and low distortion, just as in conventional high-fidelity solid-state amplifiers. Since virtually no power is dissipated in the output stages of these amplifiers, they are ideally suited to this new application. The on-off switching in a two-state amplifier is essentially digital in nature, hence the designation "digital mode."

In addition to power amplification, the active equalizatiion circuits included with the amplifier provide the audio-signal processing needed to match the acoustic requirements of a specific model car with the requirements of a particular location within the car. The sig-

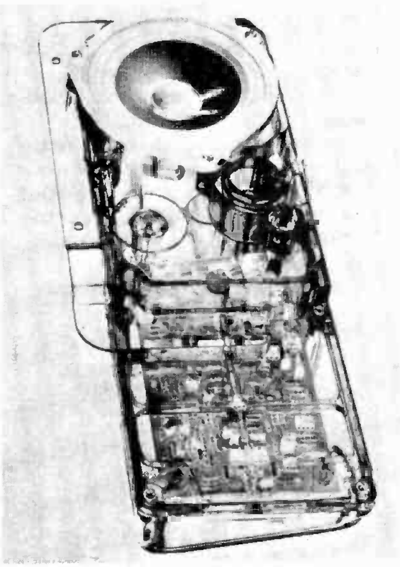


Fig. 8. Speaker modules are designed for specific locations.

nal processing circuits are actually different between the front and rear amplifiers.

Check out this option in a 1983 Cadillac Seville or Eldorado, Buick Riviera, or Oldsmobile Toronado, the first cars to employ this integrated car stereo system. It may well shatter several myths and misconceptions concerning the limitations thought to be inherent in car stereo. ◊

PERSONAL COMPUTER WITH DISK DRIVE

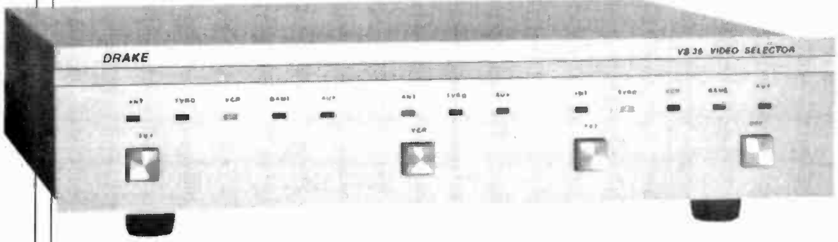
Morrow Designs' new Micro Decision computer is for personal and small business use. The 8-bit unit is structured around the Z80A and includes 64K bytes of RAM, two RS232 ports, a smart terminal with detachable keyboard, and a single-sided $5^1/_4$" drive with 200K bytes of formatted capacity. A second drive is optional. It uses CP/M 2.2, permitting access to more than 2000 business programs. Other software included are Microsoft Basic 80, BaZic, Wordstar, Correct-It, and LogiCalc. Features include a menu-driven front end that provides a "road map" through CP/M and read/write capability for Osborne, IBM and Xerox 820. $1790 with CRT and one floppy-disk drive; second drive, $350.

Circle No. 93 on Free Information Card

MICROPHONE WITH ECHO PROVISION

Sony introduces its Echo Mic (F-V7ET), a high-Z dynamic cardioid vocal microphone, designed to produce vibrato and echo effects. It has a "Unimatch" plug to be compatible with home tape recorders. A switch controls speed of the desired effect. Frequency range is rated at 100 to 12,000 Hz. It measures approx. 2" × 8½" and weighs 6.7 oz. Comes with stand. $65.

Circle No. 95 on Free Information Card



VIDEO SWITCHER

The R.L. Drake Co. has announced the new VS35 video selector, a switcher designed to select the desired input to a TV or VCR. Five input sources, e.g. antenna/cable, satellite receiver, VCR, game, disc player, etc., can be directed to two TV sets (or monitors) and three of the inputs can be sent to the VCR. Pushbuttons effect operation, and LEDs indicate operating status. Isolation between the inputs is given as 60 dB. Dimensions are 9½" D × 13" W × 3". $160.

Circle No. 92 on Free Information Card

HEAVY-DUTY DMM

The HD-110 from Beckman is a portable multimeter with a fire-retardant plastic case said to protect the unit from drops, overloads, water, and dust. The "large area" LCD and 9-V battery are shock-mounted to resist damage from impact. Ranges are to 1500 V dc, 1000 V ac, 10 A ac and dc, and 20 megohms. Dc accuracy is rated at 0.25%. Has continuity checking. $189.

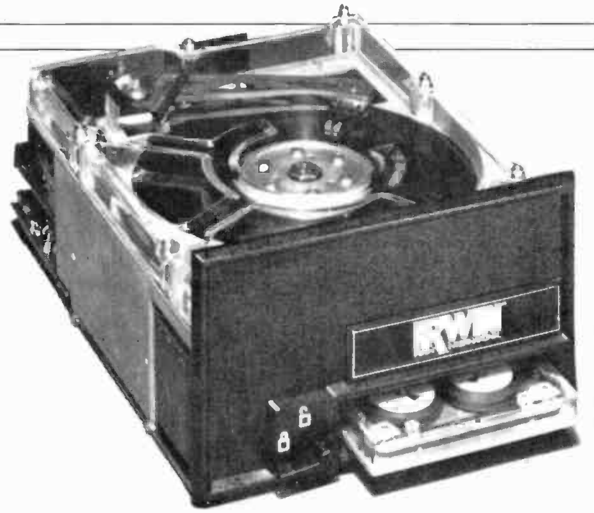
Circle No. 94 on Free Information Card

HIGH-PERFORMANCE JOYSTICK

For those who want to avoid (or at least postpone) the ignominy of being devoured by ghastly video monsters, Discwasher has introduced its PointMaster Competition Joystick. Designed as a replacement for Atari, Sears, Vic 20, and other joysticks, the PointMaster has one-handed action with the fire button at the top of a contoured hand grip. There's an additional benefit of this design for left-handed people since most other controls are for "righties." A five-foot cord permits players to move farther back from the TV screen than most joysticks allow. $17 each.

Circle No. 91 on Free Information Card

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 manufacturer at the address given.



WINCHESTER DRIVE FOR THE E'LITE

The Irwin 510 is a 5¼" Winchester disk drive with built-in cartridge tape backup and 12.2 megabytes unformatted capacity (10.0 megabytes, formatted) on a single platter. Average positioning time is given as 33 ms. Measuring 3¼" H × 5¾" W × 8" D, it is primarily for use in the E'lite microcomputer from Barrington Corp. The E'lite is intended for use by small businesses and includes 64K of RAM, 2K of ROM and a new 8-bit Z80B processor operating at 6 MHz. The E'lite offers a file-oriented backup program so that individual and groups of disk files disk files can be copied and restored. Capacity is expandable to more than 100 megabytes in 10-byte increments, using the 510. The physical design of the 510 is such that it can be used with other systems. $2575.

Circle No. 97 on Free Information Card

60-MHz DUAL-TRACE SCOPE

The V-650F from Hitachi has a 6" square CRT with an internal graticule. An improved metal-backed phosphor is said to make its new 10-kV tube as bright as the older 15-kV CRT. Vertical sensitivity is rated at 5 mV/div over the full bandwidth and 1 mV/div to 10 MHz. Display modes are Ch1, Ch 2 (normal or invert), chopped, or added. Horizontal deflection system consists of the main time base (22 calibrated sweep positions from 50 ns/div to 50 μs/div in 1-2-5 sequence) and the delayed time base. Dimensions are 12" W × 7" H × 16" D. $1195.

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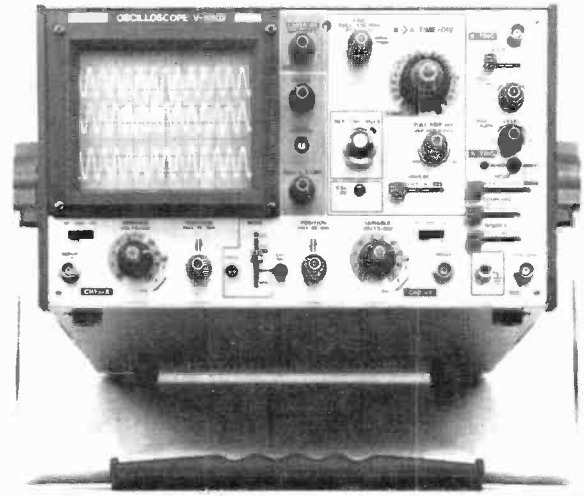

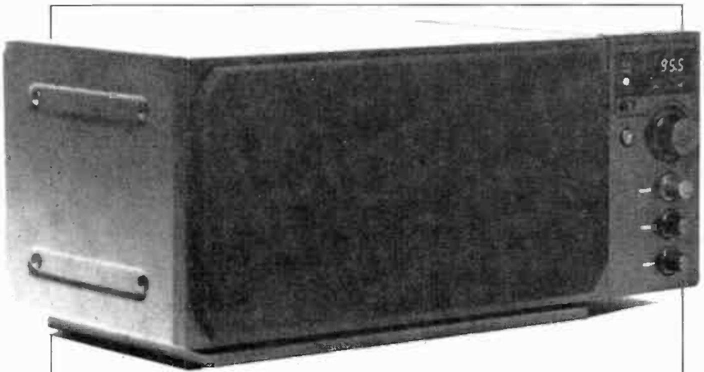

EXPANDABLE TABLE-TOP RADIO

Proton Corp. has introduced a table-top AM/FM receiver called *the* Radio. It is claimed to have an improved way of capturing over-the-air signals (the Schotz Variable-Bandwidth PLL Detector) that eliminates multipath distortion. Stereo performance is achieved by adding a speaker system measuring 7" H × 11" W and containing its own amplifiers for the bass and treble speakers. Together, the amplifiers add 25 W and up to 10 powered speakers can be connected to the receiver at once. Specs for the FM tuner include a rated sensitivity of 1 μV, selectivity of 60 dB, S/N (stereo) of 77 dB, and THD of 0.15%. The amplifier section has a rated frequency range of 60 to 10,000 Hz and a THD of 0.03%. The receiver and attached speaker measure 7" H × 14" W. $280. Optional speaker system, $150.

Circle No. 96 on Free Information Card

NEW WALKMAN DESIGN

The Sony Walkman 5 is descended from the Walkman II and looks like it, only smaller. Dimensions are 4¼" H × 3⅛" W × 1⅛" D (slightly larger than a standard audio cassette). It has all the features of the original, including metal tape capability, auto shut-off at end of tape, fast forward and reverse, and two stereo headphone jacks (playback only). The Model 5 has the new featherweight MDR-30 headphones that adjust to hug the wearer's head. $130.

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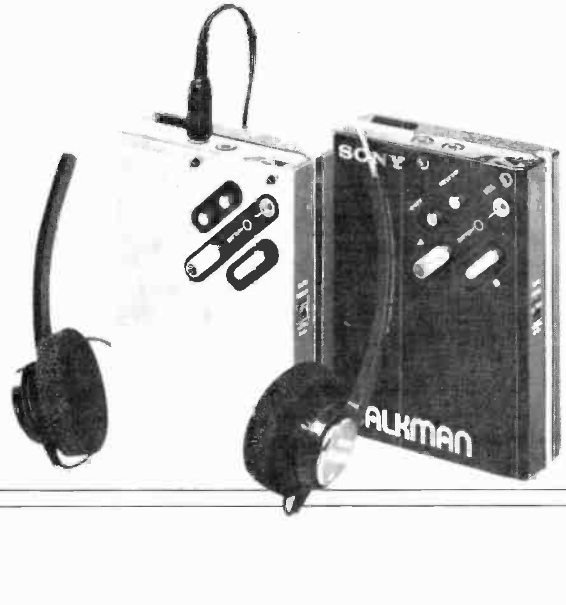


Panasonic Model CT-3311 Micro Color TV

A SPATE of tiny-screen portable TV receivers has reached dealer shelves from many manufacturers. You can choose from among TV/AM-FM radio/cassette recorder combo models or a mini-TV by itself. Furthermore, you also have a choice of black-and-white or color models. Panasonic has produced the smallest-screen models yet, both black-and-white and color types. I've examined Panasonic's smallest-screen color unit for this report—the model CT-3311 Micro Color TV. It features a 2.6" diagonally measured screen, weighs only $3\frac{5}{16}$ lb, and has overall dimensions that enable it to fit into the palm of your hand. It operates on ac, car battery or with an optional rechargeable battery. Owing to its audio and video inputs provisions, it can also serve as a video cassette recorder color monitor. Suggested retail price is $500 plus $50 for the optional battery pack.

General Description. Most of the model's 3⅜" × 4½" front panel (depth is 9⅛") is taken up by the CRT, of course. This leaves room for an on-off switch, volume control, channel indicator switch, vhf/uhf selector, and twin channel tuning search buttons. At the top of the set are an automatic-manual tuner slide switch, a recessed one-inch disc for manual tuning, a telescoping monopole antenna, and a loudspeaker grille.

When the power switch is turned on, it takes about 30 seconds until the screen lights. The automatic-search tuning buttons cause an illuminated vertical bar to be displayed that scans across the screen and stops at the first clear signal captured by the model's electronic synthesized tuner; it then disappears for clean picture viewing.

When vhf (channel 2 through 13) is selected, the bar is a thin red vertical line; with uhf selection (channels 14 through 82) the line is a greenish-blue color. Location of the color line with respect to the channel indication "dial" at the bottom of the screen identifies the channel tuned in. Channel 2 starts at the left of the screen with numbers running up to Channel 13 at the extreme right. Similarly, uhf Channel 14 is at left and Channel 82 is at right. The dial is always illuminated when in the automatic position. For manual tuning the dial indicator must be depressed. At the bottom right of the set are two pushbuttons with arrows indicating the direction the automatic channel indicator should move.

Manual tuning can be accomplished by rotating the recessed disk at the top of the set while observing position of the vertical line on the screen in relation to the channel markings on the illuminated dial. Manual channel selection, however is tricky; it's easier to use the automatic tuning.

Five recessed adjustment buttons that can be rotated with a finger nail or, more conveniently, with a screw driver, are located in a row at the lower right of the cabinet. These include the vertical hold; the "Panabright" control, which simultaneously adjusts contrast color to balance with brightness levels; the regular master brightness control; the tint control; and the master color control.

At the rear of the set you find the input for the external antenna, an ear phone jack, the 12-V dc power input, the video monitor controls, and jacks.

Power is supplied from an optional 12-V dc battery pack (with carrying handle) that snaps into the base of the unit, or from the ac line via a built-in adapter that also serves as a battery charger.

A video input and output, as well as two inputs and outputs for audio, are also located on the rear panel. This makes it possible to use the Panasonic CT-3311 as a color video and audio monitor when operating a portable video cassette recorder and camera.

The model we tested was one of the first released and we were unable to obtain detailed troubleshooting instructions. When we opened up the cabinet, we quickly realized that packing a complete color TV receiver into this small space does not make for accessibility. The main PC board is located horizontally, at the bottom of the chassis. All remaining space within the cabinet, however, is taken up by other pc

boards and components. We could not gain access to the convergence controls for the color picture tube nor could we reach the horizontal oscillator or many other test points. As in other compact electronic equipment, detailed manufacturer instructions are required for proper disassembly, alignment adjustment and troubleshooting.

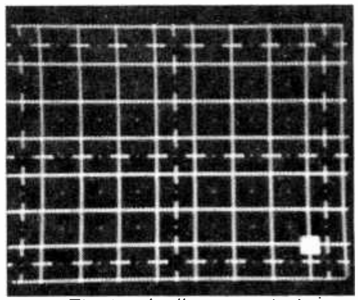
In order to properly view the set's 2⅛" by 1⅝" color image, the viewer should be no farther away then 18", the standard distance for normal reading. Panasonic supplies an enlarging lens as an option, but this means that you have to be directly in front of the screen in order to avoid bad distortion at the edges. Another factor, illustrated by the grid test pattern of Figure 1, is that the amount of information that can be contained by this size image is substantially less than what you would see on a 12" to 19" TV screen. Although a moving color picture looks quite good, a test pattern, carefully analyzed, shows some of a small screen's limitations.

Laboratory Measurements. Our tests confirm that the Panasonic CT-3311 micro color TV set performs amazingly well as a color receiver and video monitor. Owing to its size, however the receiver portion, including the tuner and i-f section does not provide the kind of sensitivity or signal-to-noise ratio that can be expected from a full-size color TV receiver. But the difference is relatively small. While the −52 dBM vhf sensitivity and the corresponding 12-dB noise figure do not make the set an outstanding candidate for deep-fringe reception, it will perform quite adequately in the near-fringe range when relatively noise-free signals of 15 or 20 microvolts are received. The uhf performance is, relatively speaking, slightly better.

We were pleasantly surprised at the 3.1-MHz video bandwidth. We did not expect that such great resolution, the usual bandwidth for 19" color receivers, would be available. Although the grid test pattern pictured provides only an approximate indication of this bandwidth, it is clear that the screen can display quite a bit of fine detail for its size.

R-f oscillator stability, measured with the automatic frequency control locked in, is good. The figures for agc dynamic range and dc restoration were comparable to the performance figures of a 19" set, and the bright, true colors we saw on the screen were similarly comparable. Horizontal and vertical linearity could not be determined by our usual method of measurement because the screen was too small. The photograph of the electronically generated raster on the screen, however, shows that linearity was excellent, both horizontally and vertically. We found a bit of misconvergence along the top of the screen, but that was not apparent when a color bar test pattern or an actual color scene was observed.

The audio quality from the 3" speaker, while not subjected to measurements, sounded adequate and comparable to that obtained from most portable radios.



Electronically generated test pattern shows good linearity.

In summing up, we conclude that the Panasonic CT-3311 performs as well as most color TV receivers, though on a measurement basis, less well in deep-fringe areas.

User Comments. The quality of the color pictures obtained on the Panasonic CT-3311 was excellent. Whether used as a receiver, on both vhf and uhf bands, or as a video monitor, we had the distinct impression that we were getting a great deal of perfomance from a handful of electronics.

The small size of the TV screen also has some limitations, naturally. When credits for a TV film appear, for example, or when a video camera is focused on relatively small lettering, we find that what would be legible on a 13" or 19" screen is simply too small to read. Panasonic does offer an optional enlarging lens that can be mounted in front of the screen. But owing to the inevitable side view distortion, the use of the set is limited to a single viewer who must watch it from directly in front. Even with the enlarging lens, the small screen presents a definite limitation when the set is used for computer alphanumeric display.

However, for those who would like to carry a color TV set along on their travels, or who go backpacking and cannot stay away from their favorite TV shows, the Panasonic 3311 provides good performance with maximum portability. For outdoor video recordists, the set will enable you to judge color quality while you're recording.

—*Walter Buchsbaum*

CIRCLE NO. 102 ON FREE INFORMATION CARD

PANASONIC CT-3311 MICRO COLOR TV

Parameter	Measurement
Video bandwidth to CRT (−6 dB):	3.1 MHz
Dc restoration:	95%
Horizontal linearity:	*
Vertical linearity:	*
Sensitivity, vhf (Ch. 3):	−52 dBm
Sensitivity, uhf (Ch. 20):	−50 dBm
Noise figure, vhf (Ch. 3):	12 dB
Noise figure, uhf (Ch. 20):	18 dB
Oscillator stability (Ch. 3): (105 to 130 V ac, 2 hr)	0.1 MHz**
Oscillator Error (Ch. 3):	**
Convergence:	75% at worst
Voltage regulation:	Battery
High-voltage regulation:	**
Power requirement:	9.5 W

*Appear good but screen too small to measure.
**Test points not accessible.

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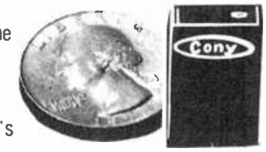
The Dyna-Mike Transmitter

It's smaller than a quarter. But DYNA-MIKE will transmit every sound in a room to an FM radio tuned to the proper unused frequency, from ⅓ mile to 2 miles away.



If you're at a neighbor's home a block from your own, you can hear your baby's cry, or you can tell the instant your spouse comes home. If two of you are driving tandem in two cars, one or both of you can communicate with the other even if other cars drive between you.

DYNA-MIKE has as many uses as your imagination can think of. For a business conference, let the tiny microphone sit unobtrusively on the table or concealed on a shelf, and you'll be able to record every word. For businesses, you can put an FM receiver in a warehouse or remote office and "broadcast" instructions or orders to be filled.

Public speakers never had a better friend than the DYNA-MIKE. No wires or setup — just turn on one or more radios and your speech will come through with perfect fidelity. Put one on the front porch. If you hear a suspicious sound, turn on the radio and you'll hear the doorbell or the ring of the telephone.

Choose Your Model

New Horizons is introducing three models of the DYNA-MIKE supersensitive broadcast microphone. Model IC-18 is the world's smallest micorphone — it's a miracle of electronic miniature power, with a high-fidelity range of 1800 feet. Introductory price is $129.95 (two for only $119.95 each).

Model X-18 is the longest-range microphone, with an unbelievable two-mile range. Introductory price is $149.95 (two for only $139.95 each).

Model X-3 is the most sensitive microphone. It broadcasts perfect-quality sound even from low-levels or whispers, up to 1,500 feet. Introductory price is $99.95 (two for only $89.95 each).

Each microphone is fully wired, complete with standard HC-1.35v. battery, good for 100 hours of continuous use and easily and inexpensively replaceable.

Of course you're protected by the New Horizon guarantee: use any DYNA-MIKE transmitter microphone for 30 days, with the right to return it for a full refund if you're not delighted.

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The Super-Ear

You'll hear it all.

Effortlessly, you can hear not just a baby's cries, but quiet breathing, through a concrete wall a foot thick. Put the SUPER-EAR earphone in your ear and place the speaker on the wall. That's all there is to it.

SUPER-EAR hears everything, and even more astounding, hears it clearly. It's as though the wall weren't there. If you're coming home late at night and think intruders are in your residence, let SUPER-EAR find out for you. Want to know if the meeting is over in the room with the closed door? SUPER-EAR will tell you in a second.

SUPER-EAR is undetectable from the other side of the wall. The quality of sound has amazing fidelity—good enough to record, and SUPER-EAR has its own built-in recorder jack.

Because SUPER-EAR is the ultimate listening device, you can use it to pinpoint hidden squeaks in your car or the source of mysterious engine noises. Construction experts use it to check for flaws or cracks in buildings.

It Works Anywhere!

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The Phone Answerer Recorder

The PHONE ANSWERER/RECORDER connects in seconds between any tape recorder and your telephone. When you're away it automatcally delivers a message up to 20 seconds to anyone who calls: when you'll return, when to call back, where you are.

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It recoros both sides of the conversation with astonishing clarity, giving you a permanent record of every call, preventing unauthorized use of your phone, and eliminating misunderstandings over what was said. It's specially wired to extend recording time on your tape recorder. Needs no batteries - it's always "alive"

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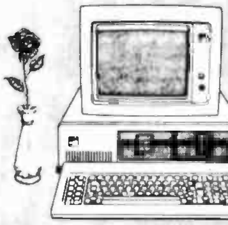

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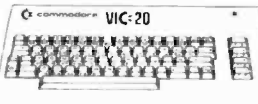

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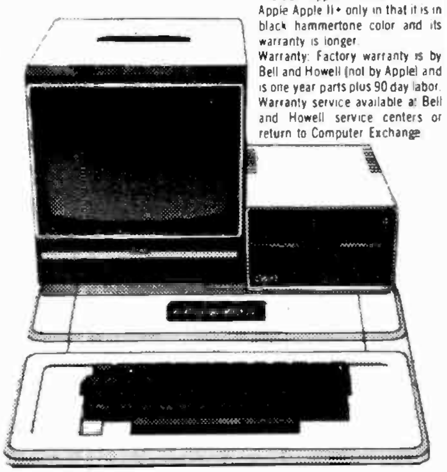

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FOR APPLE II/II+

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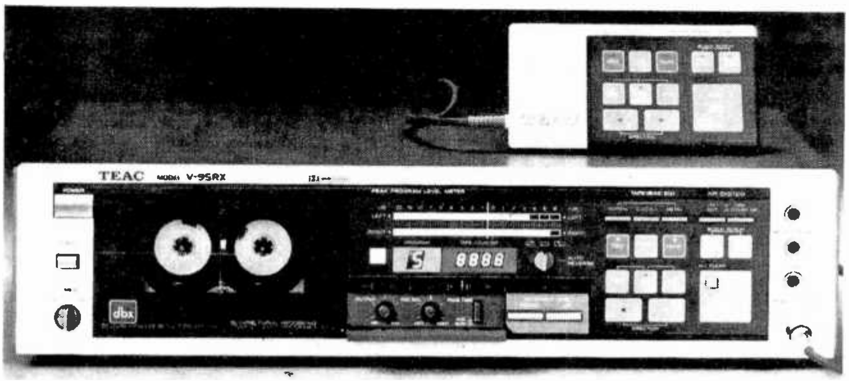
Teac Model V-95RX Cassette Deck



THE Teac V-95RX is a unique cassette deck, with bidirectional recording and playback, built-in Dolby B and dbx noise reduction, and a flat panel membrane keyboard containing a number of novel control features. The attractively styled deck is furnished with a remote control accessory that plugs into a front panel jack. Dimensions are $17\frac{1}{4}$" W x $11\frac{3}{4}$" D x $4\frac{1}{2}$" H, and weight is just under 14 pounds. The remote control unit is $5\frac{1}{2}$" x $2\frac{3}{4}$" x $\frac{7}{16}$" and is fitted with a 16.5′ cable and DIN plug. Suggested retail price is $625.

General Description. Functionally, the Teac V-95RX is a "two head" machine whose single four-track combined record/playback head serves for both directions of tape travel. This is unlike some recorders in which separate heads are switched, or a single head is physically moved, for direction changes.

The V-95RX uses a single servo motor to operate two capstans that turn continuously in opposite directions. They are brought into contact with the tape by separate pinch rollers that drive it in either direction. The change is so rapid (0.15 seconds) that Teac calls it "Real Time Reverse," and the reversal is initiated by an infrared sensor that detects the point where the leader is attached. (A piece of adhesive sensing foil can be attached to any point on the tape to make it reverse wherever desired, according to Teac instructions.)

In addition to the capstan drive motor, the Teac V-95RX has a second dc motor to drive its tape-reel hubs, a third motor that shifts the head assembly into contact with the tape, and a fourth motor to adjust the recording level under the control of front-panel pushbuttons (for smooth level changes or fades).

The program level indicators (for both recording and playback) are two horizontal rows of fluorescent bars, colored green from −30 to −1 dB, and red from 0 to +10 dB. A "peak hold" circuit retains the highest reading (in the red section of the display) for a couple of seconds to aid in monitoring peak program levels. Large numerical indicators serve as a 4-digit index counter.

Small pushbuttons set the bias and equalization for "normal" ferric tapes, high bias CrO_2 tapes, and metal-coated tapes. Similar buttons activate the noise reduction systems, and select either dbx or Dolby. Larger pushbuttons switch the power and open the cassette door. Other controls set up the timer for unattended operation and program the transport for conventional "single pass" recording or playback, complete play (or recording) of a tape in both directions with automatic reversal, and continuous repetition in the playback mode. A small hinged door on the panel conceals knobs for recording channel balance and playback level adjustment, as well as a button that selects high or low speeds for the motor-driven record level.

The membrane keyboard's transport controls are multi-colored for easy identification, and several of them have small LEDs to show that they have been engaged. The basic functions for play, record, pause, and fast speeds are provided, with some duplication because of the bidirectional design of the machine. In addition, the REC MUTE control inserts a four-second silent portion automatically before stopping the tape (for subsequent operation of the CPS feature). STOP is a large square button, easily distinguished from the others. Within it is a smaller ALL CLEAR button that resets all special operating modes and returns the index counter to 0000.

Between the two fast-speed buttons and linked to them by panel markings is one marked CPS (Compumatic Program System). To use this, the PAUSE and PLAY controls are pressed, followed by the CPS control. Each time one of the fast-speed buttons is pressed, the digit appearing in a window to the left of the index counter increases or decreases by one, and the two fast controls can be operated sequentially to set in any number from 0 to 15. (Above 9, a digit from 0 to 5 appears in the window with a dot to its upper left to represent the numbers 10, 11, 12, 13, 14, and 15.)

As the tape moves at high speed, the number decrements by one each time a silent portion is passed. When it reaches zero, the tape stops and commences playing the selection starting at that point (in either direction, according to the initial control settings).

Another useful feature is the "Block Repeat," operated by the START MEMO and STOP MEMO buttons. These can be set to repeat any segment of tape whose limits are set by pressing the buttons. It is noteworthy that in all the operating modes of the V-95RX, the two directions of tape travel are considered as one, and the transition between them is made without any action by the user.

Laboratory Measurements. The record/playback response of the Teac V-95RX was measured by recording a slowly sweeping sine wave and playing back the tape into the automatic frequency response plotting module of a UREI measurement system. We used several tapes, and found that differences between generally similar formulations were minor. We finally selected TDK D as our "normal" tape, TDK SA as the CrO_2 tape, and TDK MA as the metal tape.

The response at a −20-db recording level (relative to the machine's own level indicators) with TDK D was ±1 dB from 60 to 12,000 Hz, falling to −3 dB at 38 and 14,000 Hz. At a 0-dB recording level, the response was quite flat to beyond 5000 Hz, falling to −3 dB at 7000 Hz and intersecting the −20-dB curve at 11,500 Hz. TDK SA gave almost identical results, ±1 dB from 60 to 12,500 Hz, and −3 dB at 37 and 14,000 Hz. At 0 dB its response was down 3 dB at 7500 Hz.

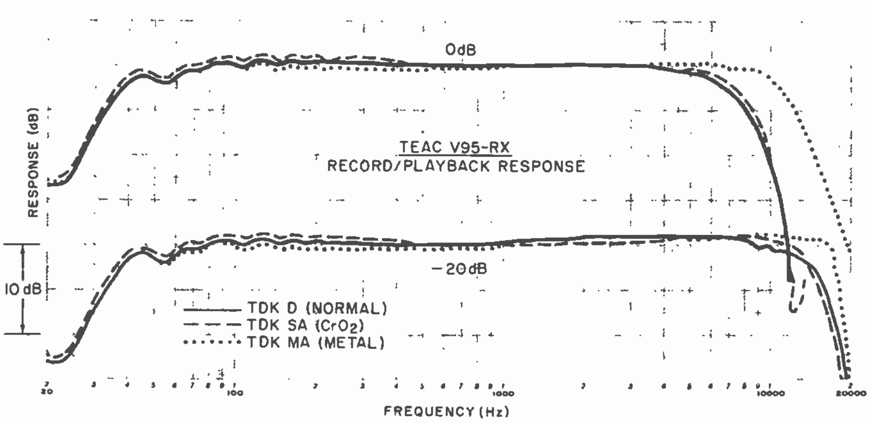
Metal tape gave the expected improvement. The response varied ±1 dB from 60 to 17,000 Hz, and was down 3 dB at 38 Hz and just over 17,000 Hz. (It fell off very rapidly at high frequencies.) The 0-dB response was almost flat to 10,000 Hz and down 3 dB at 11,000 Hz. It remained well above the −20 dB response up to 20,000 Hz.

The playback equalization and response of the V-95RX was measured with BASF New Standard test tapes. The 120-μs response fell off above 10,000 Hz to −6 dB at 14,000 Hz, which led us to suspect a slight azimuth misalignment of the head. However, the 70-μs response was down less than 3 dB at the 18,000 Hz upper limit of the tape, which indicates a probable error in the recorder's 120-μs equalization characteristic. In both cases the response was flat within 1 dB from 50 to 10,000 Hz, and was −4 dB at 31.5 Hz.

The Dolby "tracking" was measured by plotting the record/playback response with TDK MA tape at levels from 0 to −40 dB, with and without the Dolby system in operation. The first measurable error occurred at −20 dB, where the Dolby raised the output above 10,000 Hz, to +2 dB at 14,000 Hz. The peak became more pronounced at lower levels, reaching almost 5 dB at −30 dB and between 6 and 7 dB at −40 dB. Since most of the change took place above 10,000 Hz, it had little effect on the audible performance.

A similar procedure was followed with the dbx system. Here the principal difference was a level shift, with the overall output increasing about 3 or 4 dB when the dbx was switched on (all else being constant). There was a small high-frequency boost, most pronounced at lower levels and at frequencies above 10,000 Hz, but it was much smaller than we found with the Dolby system. The dbx circuit also reduced the very low frequency response sharply (below 40 or 50 Hz), but this, too, had a negligible effect on the overall sound.

Maximum playback output level depended on the tape used, from a



Frequency responses for three different types of tape.

CONTROLS AND INDICATORS

FRONT PANEL:

Knobs:

TIMER: Prepares recorder for playback or recording when power is applied from an external timer switch.

AUTO REVERSE: Arrows show tape direction programming.

REC BAL: Adjusts L-R balance of recording signal.

OUTPUT: Adjusts playback output level (including headphone level).

Pushbuttons:

POWER: On/Off power control.

EJECT: Opens cassette door.

RECORDING LEVEL UP and DOWN buttons vary recording level.

TAPE SELECTOR: NORMAL, Co(CrO_2), and METAL buttons for type of tape used.

NR SYSTEM: IN/OUT button turns on a noise reducing system. dbx/DOLBY NR chooses type of system.

ALL CLEAR: Small square button in STOP portion of keyboard resets all special functions and index counter to zero when tape is stopped.

FADE SPEED: FAST or SLOW setting for motor-driven recording-level adjustment.

Operating Keys:

DIRECTION: Lighted arrows show direction of tape movement.

FAST SPEEDS: Double arrows show direction of fast tape movement.

CPS: Lighted button turns Compumatic Program System on and off.

REC: Lighted button must be pressed with one of direction controls to make a recording.

REC MUTE: Momentary pressure interrupts recorded signal, recording 4 seconds of silence before stopping tape in pause mode. Longer pressure increases length of silence as desired, stopping tape when released.

PAUSE: Lighted button stops and restores tape motion in record or playback. Does not interrupt record mode setting.

BLOCK REPEAT: START and STOP MEMO buttons with lights select end points for automatic repetition of any tape segment.

STOP: Stops tape and deactivates recording.

Indicators:

PEAK PROGRAM LEVEL METER: Parallel rows of light segments indicate recording level from −30 to +10 dB.

TAPE COUNTER: Index counter (four digits) for tape position.

CPS PROGRAM: Single digit shows number of 4-second intervals to be skipped before playing a selection in CPS mode.

Jacks:

MICROPHONE: LEFT and RIGHT jacks replace rear line inputs when plugs are inserted.

PHONES: Headphone jack.

REMOTE CONT: DIN socket for accessory.

Back Panel:

Four phono jacks for line input and output.

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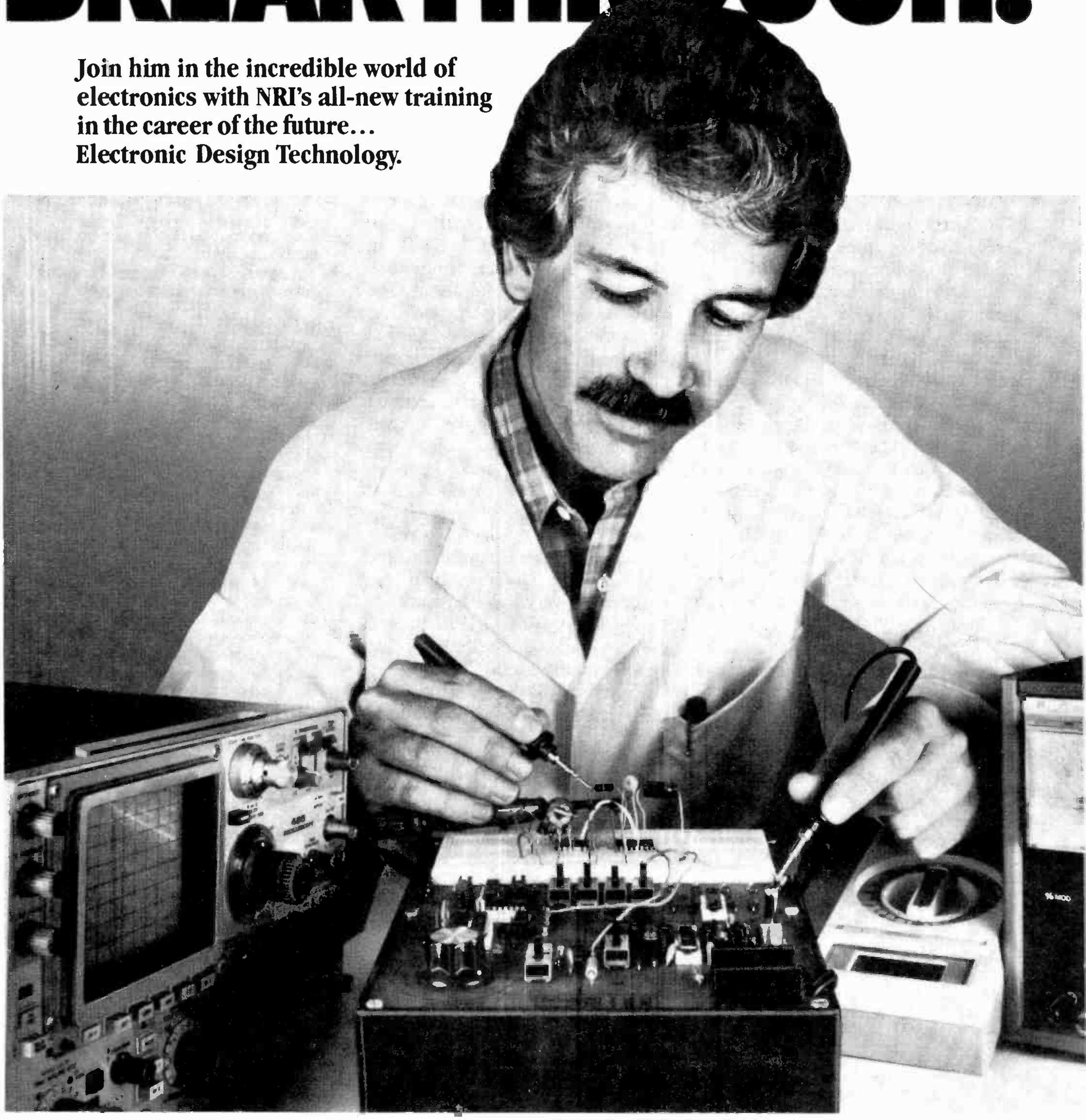

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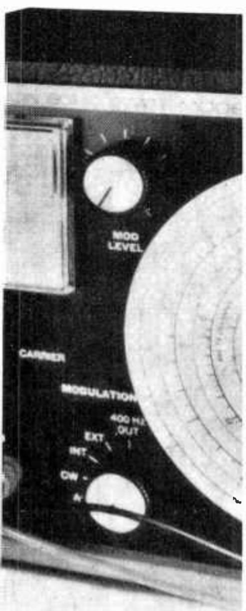

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low of 0.535 (from 0 dB) with TDK SA to about 0.6 volts with the other two tapes. At that level, the third harmonic playback distortion at 1000 Hz was 1% with D and MA tape, and only 0.3% with SA. In order to develop the 3% reference distortion in playback, a recording level of +3 to +4 dB was needed with each tape.

Relative to the "3% distortion" level, the unweighted S/N was 52.5 dB with D, 53.5 dB with SA, and 55.5 dB with MA. Using the Dolby system, and with CCIR/ARM weighting in the measurement, the S/N readings were, respectively, 61.5, 63.8, and 65.2 dB for the three tapes.

Maximum recording level is greatly increased by the compression of the dbx system. In fact, it is limited by overload of the recorder's electronic circuits rather than by tape saturation, and thus is independent of the tape. (In this machine, overload occurred at +12 dB.) The respective S/N readings (also with CCIR/ARM weighting) were 85.2, 87.7, and 85.5 dB. The reason for the slightly different ranking of the tapes with Dolby and dbx is not clear; but at noise levels in the range of −85 to −90 dB, these small distinctions matter little!

The playback flutter, measured with a TDK test tape, was 0.065% with JIS weighting (wrms) and ±0.09% weighted peak (CCIR). The tape speed was 0.6% fast at the start of a cassette and 0.15% fast at its end. In fast speeds, a C-60 cassette was handled in 67 to 68 seconds. The crosstalk (between tracks recorded in opposite directions) was −44 dB at 1000 Hz.

User Comment. It should be obvious that the Teac V-95RX is an unusual recorder, and not one that can be used with full effectiveness without careful study of the instructions. Anticipating some problems with impatient users, Teac has included a section on the first page of its manual called "How To Play A Pre-recorded Cassette Right Away." Afterward, the reader is advised to study the entire manual carefully. We agree heartily with that advice.

In most respects, this is an easy machine to get used to, especially if one has had previous experience with cassette recorders. Teac emphasizes the quiet operation of its tape transport, in contrast to the usual solenoid-equipped deck. True, it is notably free of "clunks," but the soft "whirr" or "buzz" of the motor that follows most control operations is equally audible, if not quite so obvious. Actually this sound is desirable in lieu of tactile feedback from the machine's membrane keyboard.

We did not find the motor-driven recording-level controls as convenient to operate as knobs, and their utility as faders is diluted by the absence of an easy reference setting to return to on an "up-fade." (There are panel calibrations, but practice is needed in using the buttons to avoid over- or under-shoot.)

On the plus side, the V-95RX offers features, for those who take the trouble to master them, that work with impressive smoothness and precision. For example, the CPS was very effective in locating sections of a multi-work tape.

The "Real Time Reverse," however, though it was fast, had some of its advantage negated by the long quiet sections often left on one side of a cassette so that the recording on the other side could begin at the beginning. We also found that it did not always reverse before the end of the leader was reached.

Also, the remote control accessory, which is about the size and shape of a thin pocket calculator, is rendered less useful by having no indication for the operating status of the controls. (The lights on the panel of the recorder are too small to be seen from most viewing angles.)

Considered purely as a cassette deck, the V-95RX is a fine example of a competently designed, well-constructed two-head machine. Although a combination record/playback head rarely approaches the ultimate performance of separate heads, this is not needed in most cases. The outstanding dynamic range and total lack of noise afforded by the dbx system should more than compensate for any minor headroom deficiencies at the higher frequencies. —*Julian D. Hirsch*

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STAN VEIT ON COMPUTER SOFTWARE

Software for Holiday Giving

THIS holiday season a popular gift will likely be the Timex Sinclair 1000 computer, the lowest-priced full-featured computer on the market. Like other small computers, the success or failure of this little package of computing power depends upon the independent software companies and their products. For the public to continue to use this machine after the first flush of novelty wears off, there must be a continuous flow of software packages. The manufacturer alone cannot meet the demand for software for its popular computer. The Sinclair machine has been out long enough for us to examine some of the representative software dedicated to the Timex Sinclair.

The first release I'd like to discuss is called the Krakit Treasure Hunt from International Publishing & Software (PO Box 1654, Buffalo, NY) and International Publishing and Software, Inc. (3952 Chesswood Dr., Downsville, Ont., Canada M3J 2W6). It includes a real treasure for the finder that's said to be $20,000, with this treasure lode continually increased as time (and sales) pass.

The Treasure Hunt is played by running the program on a Timex Sinclair 1000 computer and a video display, and discovering 12 hidden clues. These clues consist of a country, city, or town. Using these clues can allow the user to learn where the prize is located and how to claim it. If necessary, two airplane tickets to the prize location will be provided. Since it is estimated that at least 500,000 Timex Sinclair computers have been sold, the contest should prove to be very popular. Krakit Treasure Hunt officially started on November 15, 1982. To keep contestants fully informed on the status of the contest and the prize money to be won, a 24-hour answer line will be set up once the contest is underway. The Krakit cassette sells for $19.95 plus $1.50 for handling and shipping. It will also be sold at dealers.

Softsync, Inc., formed by Susan Currier, keeps ahead of the Timex Sinclair software market by having its products developed in the United Kingdom, where the little wonder computer comes from. British programmers have been working with the Sinclair longer than anyone else, of course, and they have produced things you wouldn't believe possible to do with the 1000. The games are fast, with detailed graphics, just like an arcade game. The nongame software is complete and useful to a level far beyond where you would believe this small machine could go. Many of the games require at least 16K of memory. Here are my "hands on" experiences with some of them.

Mazogs (16K, $19.95) to my mind is the most graphically elaborate and fiendish game for the 1000. The game takes you into a complicated maze where the fearsome Mazogs live. You are out to get their treasure and they, of course, are out to get you. Once you fight your way through to the treasure, you have to fight your way back out. Having fought the creatures in Morlocs Tower on a TRS-80, my confidence level was high, but the Mazogs gave me a hard time. I recommend it to all you adventurous 1000 owners.

This is not the only exciting game Softsync has. The line includes a game similar to "Invader" and "Red Alert," in which you fight aliens from your rocket ship and dodge mountains as well as the aliens. "Meteorites" is another arcade game, as is "Space Raid." All of these are for 16K machines, but they also have some games for 2K and even 1K machines. For the Timex programmers there is the "Toolkit," full of routines to make life easier when you write your own programs. For the graphic programmer there is the "Graphics Kit," which is used to compose graphics for games or graphs.

From the price and size of the Timex Sinclair you might not think that it is much good for business programs, but it has definite applications for the business person. Softsync's Financial Manager and Record Keeper tracks a year's income and expenses. It can also project future expense vs. income for planning and budgeting purposes. Data is input on a month-to-month basis and the program maintains a running tabulation. A full screen grid gives you a view of all 19 categories, the current data, and the percentage of each expenditure compared to the total. Financial Manager is menu driven and permits the user to enter or change the starting month and year of the record, retitle the categories, and review, change, or update data in the records.

Softsync also offers "The Stock Market Calculator" for the 1000. This 16K, $14.95 program is made up of two sections: MKT1 and MKT2. The first of these calculates commissions on stock and option investments and provides total dollar costs to buy or net from sale. MKT2 repeats the net price worksheet and adds the "write unwrapper." This program is said to be unique for the stock market field. It can be used by option-writing investors. This stock market software was designed by an experienced stock-market executive.

The Artist from KSoft (845 Wellner Rd., Naperville, IL 60540) is a $10-program for a 16K Timex Sinclair 1000 that has more than 20 commands to help create drawings and paintings on the screen. Fea-

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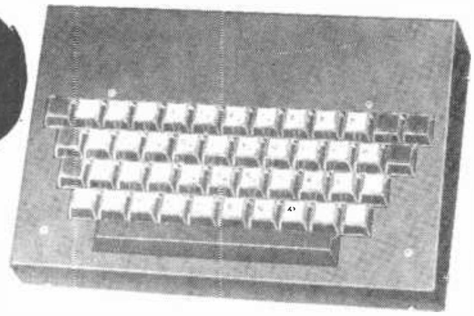

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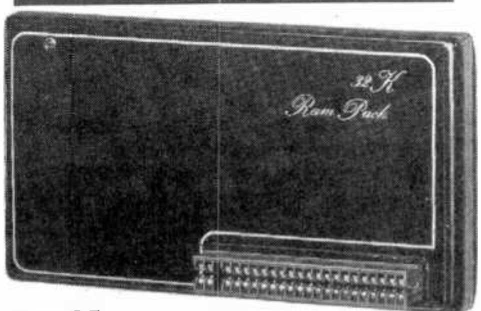
A full-sized professional keyboard for the ZX81 Features 47 keys and a full-sized space bar. Connects to the ZX81 with no soldering required, via a plug-in flexible connector. You can purchase the keyboard only, or the optional metal case that holds both keyboard and ZX81. Expansion devices (i.e. RAM packs, etc) connect to the ZX81 edge-connector which extends from the rear of the cabinet.
A professional keyboard makes program entry easier and less error-prone.

Assembled Keyboard $85.00
Optional metal case $25.00

32K RAM



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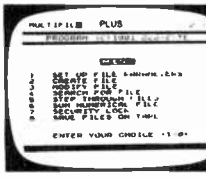

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An amazingly versatile multi-purpose filing system for the 16K ZX81. The program is menu-driven, and number, size and headings of files are user-definable. Both string and numerical files are catered for. Files may be created, modified, replaced, and searched, and are protected by an ingenious foolproof security system. Output to the ZX printer is also provided. The program comes on cassette, together with three quality data cassettes for file storage, and comprehensive documentation, describing a host of applications for both business and personal use. Supplied in an attractive storage case. If your ZX81 is bored with playing games, then this program will give it plenty to think about!

ZX FORTH

Simplicity of BASIC with the Speed of Machine Code

A complete implementation of the FORTH language for the ZX81 and TS1000 computer.
FORTH's most distinctive feature is its flexibility. The basic unit is the word — the programmer uses existing words to define his own which can then be used in further definitions. FORTH is a compiled language so programs run very fast (typically five times faster than BASIC).
ZX-FORTH is supplied on cassette and is accompanied by extensive documentation:
56-page Users Manual
8-page Editor Manual **$29.95**

ASSEMBLER

This Machine Code program occupies 7K of memory and locates itself at the top of memory. The program is a full Editor/Assembler and Monitor. Labels may be used instead of any string. The features include Line Insertion/Delete, Insert Characters, Auto Repeat on all keys. The monitor has facilities to inspect memory, registers and run machine code programs. **$14.95**

ZX BUG Machine Code Monitor & Disassembler

ZXBUG is a powerful tool for machine language programming. It is 4K long and uses memory from 71EO to the top memory. ZX BUG works in hexa-decimal (base 16), not decimal, so all addresses are a maximum of 4 Hex bits long. Provides a total of 28 commands. **$14.95**

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RENUMBER. This routine renumbers a program in any step and from any line up to 9999
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FIND. Will find any string of up to 255 characters and list each line containing that string.
REPLACE. Replaces any string of up to 255 characters by any other string.
SAVE. Transfers program in computer to below RAM-TOP.
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*Add shipping: $3.00 first hardware item, $1.50 each additional. $1.50 first software item, 50¢ each additional. 90 day limited warranty all items. **Dealer inquiries are invited** tures include user's choice of backgrounds and the ability to mix graphics and alphanumerics. It permits a user to specify lines or circles and to store patterns and reproduce them anywhere on the screen. The artwork can be saved on cassette tape or be printed.

ZX-Panding (PO Box 25, Newton, NC 28658) sells a 16K program for checkbook, income tax, and budget organizer for $13.75 plus $1.25 postage and handling. With 16K, this program can record 90 transactions. With the 64K Memotech Memory, the system can handle over 1000 transactions.

Savage Software (PO Box 892, New Smyrna Beach, FL 32069) offers a cassette with ZX-81 Monopoly that lets up to six players use the computer as the game board, banker, and score keeper. If a game is not finished, it can be saved and continued at a later time—a feature that all Monopoly games should have!

Here is a program for Timex Sinclair that I wish I had had when I was struggling to learn the Morse Code: Metro Technology (313 Vaughn, Ft. Walton Beach, FL 32548) has produced a system that gives the 1000 the capability of transmitting and receiving Morse Code. It utilizes a split-screen display for the receive/transmit functions. The software cassette costs $10; a two-board etched-circuit set for the required interface is $12. Metro Technology is also working on programs for RTTY and ASCII to be used with the 1000 computers. Cliff Nunnery, NU4V, author of the software, believes that the 1000 is a natural for computerization of ham radio. Write him for more information.

The Timex Corp., manufacturer and marketer of the Timex Sinclair 1000, has itself provided a fairly large number of programs for the machine. All the following programs will be available from Timex dealers, though I do not know the release date of any of them at this writing.

The Organizer, #03-200, $16.95. This program answers the basic need for an information storage and retrieval program. It can store names, addresses, phone numbers, and dates for various purposes. It has a search and retrieval command.

The Budgeter, #03-2001, $15.95. Keeps track of your budget in 18 categories, such as food, clothing, rent, medical, etc.

The Loan/Mortgage Amortizer, #03-2002, $14.95. Compares cost of loans from different banks. Reviews costs of your mortgage.

The Checkbook Manager, #03-2004, $12.95. Keeps track of bond and CD mature dates and an inventory of this type of investment.

The Car Pooler, #03-2005, $14.95. Whose day is it to drive? Keep track with your Timex 1000.

The Stamp Collector, #03-2006, $16.95. Use your 1000 to inventory up to 600 Scott numbers, showing quantity on hand by major classifications. A collector's must!

The Stock Option Analyzer, #03-2007, $16.95. You can use your Timex TS-1000 to calculate return on investment (ROI), annual net, and net worth of your portfolio.

Inventory Control, #03-1001, $19.95. Perhaps you thought you could not use a really little computer to track your inventory? Well, if you have less than 400 line items, "Stock I," which is part of the system supplied on the cassette, can track inventory levels, suppliers, reorder levels, and types. If you have up to 1200 items, you can still use the Timex 1000 for your inventory control, but the program Stock II that runs it can only track inventory levels.

Manufacturing Control, #03-1002, $19.95. A system that lets you capture labor and material costs for up to 150 products. Written for small manufacturing firms, this system helps a small business control costs by checking all cost factors, monitor work in progress, and keep track of inventory levels and shipments.

Critical Path Analysis, #03-1003, $19.95. This system allows identification of critical activities in a project and scheduling of events for efficiency and economy. The computer does a tabular analysis and identifies the critical path. Activity costs can be entered, compared, manipulated, and printed.

Statistics, #02-1000, $9.95. There are three programs on this cassette: (1) Statistics—includes current, mean, and standard deviation. (2) Regression—calculates the current and standard deviation of the x and y values, and the intercept and slope of the regression line. (3) Trend—calculates the current mean and standard deviation of the x and y values, and the intercept and slope trend lines.

Super Math, #03-3000, $14.95. Addition, subtraction, division, and multiplication with 5 levels of difficulty.

States and Capitals, #03-3001, $12.95. Drills for 50 states and capitals.

The Flight Simulator, #03-3002, $19.95.

Games: All games are $14.95 per cassette. Some have several games on them. Chess, Chess Clock, Backgammon, Dice, Blackjack, Slot Machine.

Entertainment: Grimm's Fairy Tales at $14.95. Mixed Bag, at $9.95, includes Bowling, Robot War, and Bingo Caller.

We have not tested any of these programs yet. Some appear to offer a lot of value for a small price.

The Timex Sinclair 1000 programs mentioned here are just the tip of the iceberg. There is a flood of software coming for this computer. I will mention the pick of the crop as I check it out on a Timex 1000.

Missing Address. A number of readers have requested the address of Quantum Data Inc., which makes expansion units and printer interfaces for the Vic-20. It is: 3001 Redhill Bldg., Costa Mesa, CA 92626 (714-966-6553).

TI Titler. Video Titles I enables users of the Texas Instruments TI 99/4(A) computers to produce their own custom titles for video recordings without the aid of a camera. Features include two character styles, automatic centering, variable spacing, 26 fore/background color combinations, and multiple screen division with scrolling. $24.95. **Address:** J&KH Software, 2820 S. Abingdon St., Arlington, VA 22206 (Tel: 703-820-4131).

(Continued on page 34)

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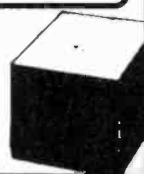

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The Avalon Hill Gang. The Avalon Hill Game Company has released six new microcomputer games for the Christmas season. They are for the Atari 400/800, with Apple II versions to be available before the end of 1982.

Legionnaire is a game based upon ancient warfare between the legions of Julius Caesar and up to 14 barbarian tribes. The game is set in 58 BC, and the player takes command as Caesar. Legionnaire requires only 16K of memory.

Moon Patrol is an arcade-type game with four levels of difficulty. Again, the player is faced with fleets of aliens who must be eliminated before they get him. Also for a 16K Atari 400 or 800. (Apple II disk version due later.) Cassette, $25.

Telengard is a computerized fantasy, a roll-playing game where players descend into a 50-level dungeon and face the horrible monsters that dwell within. Of course, the players really are represented by characters that are chosen for their attributes, such as weapons, intelligence, strength, and experience. If the characters do well in the dungeon, they return with great wealth and power. (When I play, I usually get wiped out in a few minutes: my character is called Klutz.) Telengard is now available on diskette for the Apple II and the TRS-80 Models I and III with 48K of memory for $28. Atari diskette versions will be available later.

GFS Sorceress is the name of a craft in the Galactic Federation Navy (space, that is). Joe Justin is the hero of a continuing series of adventure games. You are Joe himself if you play this game and live this adventure in the year 2582. Good luck! GFS Sorceress is at your command if you have an Atari 400/800, Apple II, or TRS-80 Model III. Cassette, $30; disk version, $35.

Now that Vietnam is some years behind us, perhaps some will want to play a war game based upon that conflict. For these people Avalon Hill presents "V.C.," a war game about a nasty war. For the Apple II with 48K of memory.

An epic adventure is a war game called Andromeda. It is a vast-scale space strategy game of galactic colonizing and conquest, where one to four players compete to form galactic empires. It comes in a 16K cassette for Apple II, TRS-80 Models I and III, and PET CBM; a 32K cassette for Atari 400/800 at $18; and on disks for Apple, Atari 800, and IBM-PC for $23.

Professional Blackjack for IBM-PCs. Intelligent Statements, Inc. (Suite 202, 3109 Poplarwood Ct., Raleigh, NC 27625) introduced Ken Uston's Professional Blackjack at the first PC show sponsored by Personna, the national IBM-PC users group. Appropriately, the show was held at the Golden Nugget in Atlantic City, NJ, where you could try out your blackjack skill downstairs in the casino. This program is no ordinary blackjack game. Rather, it is a complete course based upon Ken Uston's Advanced Point-Counting System that's explained in his book. In addition, the program teaches the user to employ the correct strategy when playing at any of 70 actual gambling casinos, where the rules of the game are different. The player can sit down at his home computer and take any seat at the table. All seven playing positions can be played by real players or by the computer. The game can be shown either in ful color or in monochrome, and it has sound effects to re-create the environment of a real table. The player starts with a stake and either builds it up or loses it, according to how skilled (and lucky) he becomes.

Ken Uston, the author, is a Harvard MBA who left his position in the Pacific Stock Exchange to pursue a career as a professional blackjack player. He is said to have won a fortune by using his systems. For $89.95 you can become a student of his system, and might earn far more than the purchase price (you can also lose, if your luck runs bad, but at least you won't make it worse!). Even if you're not a gambler, this is a real fun game for one or more players.

Apple Adventure. Adventure (Colossal Cave), for the Apple Computer, features over 130 rooms, 15 treasures, and 40 other objects. The entire program loads within 48K under DOS 3.3. No additional disk access occurs during play. $10. **Address:** Frontier Computing Inc., 666 North Main, Logan, UT 84321 (Tel: 801-753-6530).

Pocket Computer Games. Written for the TRS-80 Pocket Computer, Games II (26-3523) includes eight games on two cassettes. The games include Missile Marksman, Baccarat, Blackjack, Aceydeucey, One-Armed Bandit, Pokerslot, Numguess, and Craps. $14.95 at all Radio Shack Computer Centers and stores.

Data Manager for CBM. Jinsam is a menu-driven data base manager for the Commodore Business Machines that can be used to create complex data bases and allows custom data files, reports and labels; keyed random access, multiple search; privacy access codes, wild card search, and the amount of information stored. Its structure and/or the hardware can change but the data will not have to be re-entered. All versions require 32K of memory. Jinsam 1.0 for the CBM2040 drive features encrypted passwords, 3 deep sorts, and .5-to 3-second recall. $195. Jinsam 4.0 for CBM 4000 series has a user accessible machine sort of 1000 records in 15 seconds, automatic list maintenance, unlimited number of fields and record length. $395. Jinsam 8.0 for CBM 8000 series also includes unlimited sort, horizontal format and search by key or record number. $495. Jinsam 8.2 adds search machine language print, format and manipulation routines. **Address:** Jini Micro-Systems, Inc., Box 274, Kingsbridge Stn., Riverdale, NY 10463 (Tel: 212-796-6200).

TRS-80 I and III Adventure. Sea Dragon, a real-time machine language simulation is now available for the disk-based 32K TRS-80 Models I and III. Features a horizontally scrolling seascape, multiple skill levels, high score save, and one or two player capability. **Address:** Adventure International, 507 East St., Box 3435, Longwood, FL 32750. (Tel: 305-862-6917).

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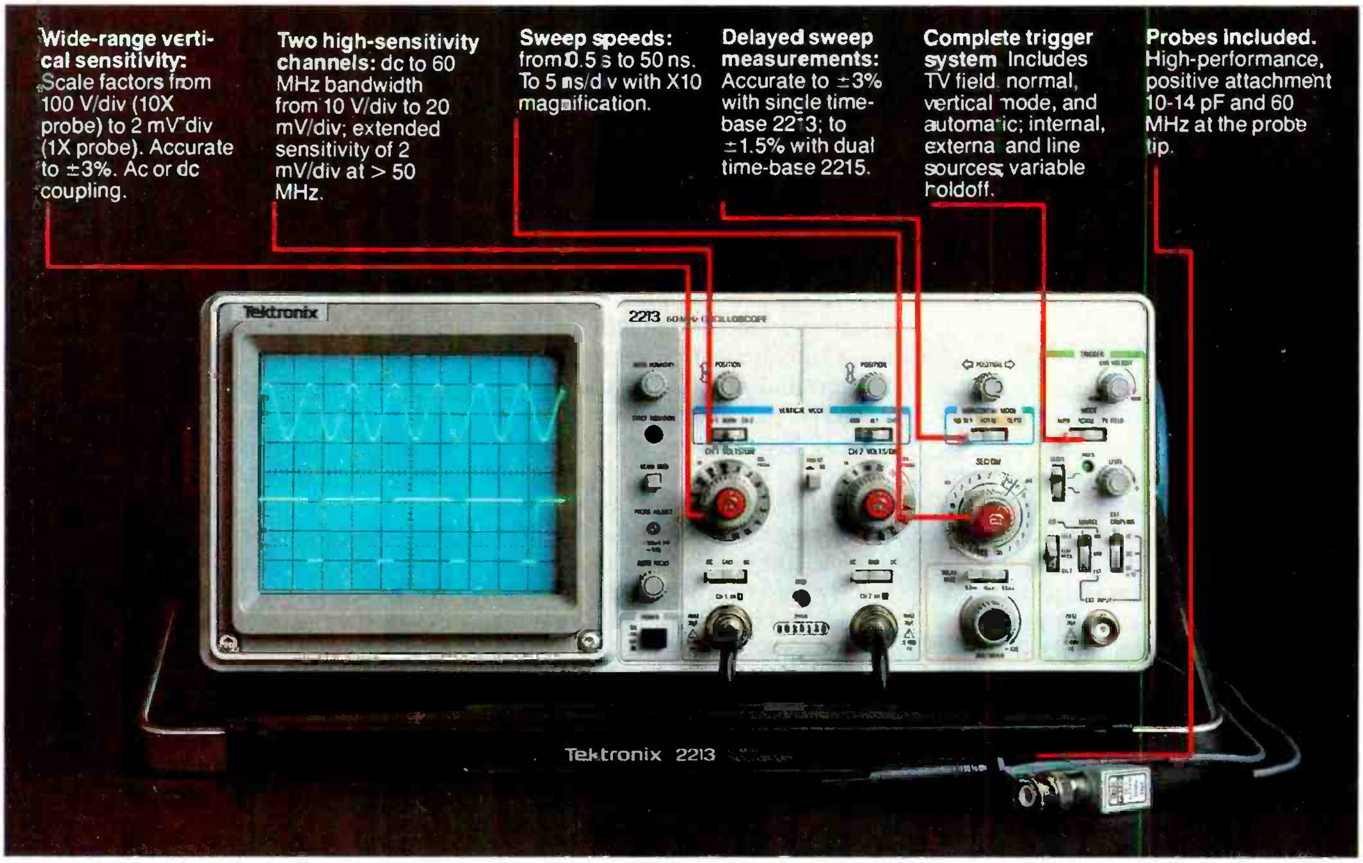

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LES SOLOMON ON COMPUTER HARDWARE

Trying out the new Sinclair Spectrum computer

DURING vacation last summer, wandering down a street in London, England, I decided to drop in on a computer store I chanced on. Besides the usual hardware and software, sitting on a small table was a Sinclair Spectrum—the latest from the people who gave us the ZX80, ZX81, and the Timex 1000. Since this machine will not see the U.S. soon, I decided to play with it for an hour or so. Here is what I found out.

Physically, the Spectrum is about 9″ wide, 5½″ deep, and a small fraction greater than 1″ thick at its highest point at the rear. The rear apron carries the power connector, an expansion bus card edge connector, EAR and MIC connectors for the cassette recorder (operating at 1500 bits about five times faster then the ZX81), and a TV r-f output—in this case set to British TV channel 36. (The color uses PAL, which cannot be used with American TV receivers. I was told that an NTSC chip is being designed.)

Inside, were 14 chips (mostly RAM) as opposed to four in the older machines. The microprocessor, as in the other Sinclair machines, is a Z80, operating at 3.5 MHz. There is a 16K-byte ROM containing an excellent BASIC and an operating system, and 16K bytes of RAM that can be expanded to 32K on board or 48K with a plug-in. The keyboard is quite different from the previous versions, with the 40 keys formed from what appears to be grey rubber with white and red symbol printing. Unlike the membrane keyboards, these keys must be truly depressed. Other than the ENTER, CAPS SHIFT, and SPACE keys, all keys have at least five functions per key, with six keys having six functions! You keep track of the function by a set of unique cursors—actually by which letter appears within the block cursor.

The memory-mapped video display is 256 × 192 pixels that can produce some very effective graphics. There are eight foreground and background colors that can be selected via one function on the upper row of keys. In the alphanumeric mode, the display is 24 lines of 32 characters, with both upper- and lower-case selectable. Like the older models, the screen can be divided into two sections—the top 22 lines for use and the bottom two lines for the Sinclair "reports."

Since the machine contains a sound generator capable of more than a 10-octave range, the BEEP command can be used to create a key-down tone. A built-in speaker can be augmented by an external audio amplifier.

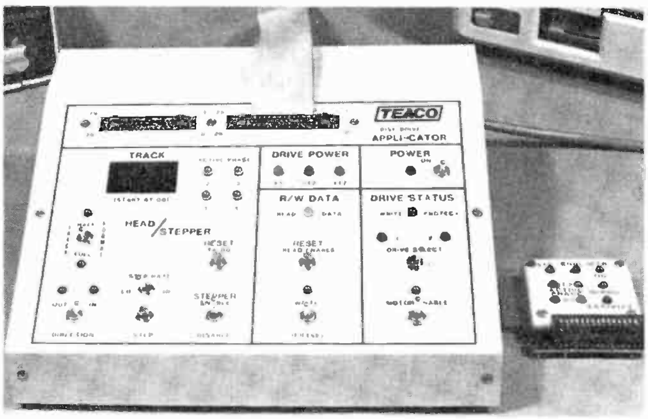
Like the other Sinclair machines, this one also does not use ASCII, but a system I call "Sinclairese." However, the Spectrum is good at graphics since it contains some 16 predefined and 21 user-defined characters based on an 8 × 8 matrix. You can place a character at any screen position and affect color, brightness, or flash it. Text and graphics can be mixed. Sinclair uses terms like INK and PAPER to define character color and background. The OVER command performs an exclusive-OR operation to overwrite anything on the screen. The INVERSE key flips the video over. Other commands such as PLOT, DRAW, and CIRCLE are used for graphics. These allow straight lines, circles, or parts of circles to be drawn onscreen on a 256 × 176 grid.

The BASIC is quite good, and appears to be a superset of that supplied with the older machines. There is even a BIN (binary) function that allows entering 1's or 0's. We also noted a number of new symbols imprinted on the upper row of keys (LINE, OPEN #, CLOSE #, MOVE, ERASE, POINT, CAT, and FORMAT) which leads us to believe that a disk is in the very near future. We heard a rumor that Sinclair is designing a 3″ disk—not the Hitachi, but a new approach!

The expansion connector is to be used to interface with the ZX Printer, an upcoming RS232 module, and, likely, a disk drive. IN and OUT commands are used for PEEK and POKE.

We expect to do a detailed study of this new machine when it arrives in the U.S.

Apple Drive Tester. The AppliCator 4023 Disk Drive Tester-Exerciser handles both Apple II and Apple III drives with tests for all circuits including power, stepper (both



The AppliCator tests both the Apple II and Apple III drives.

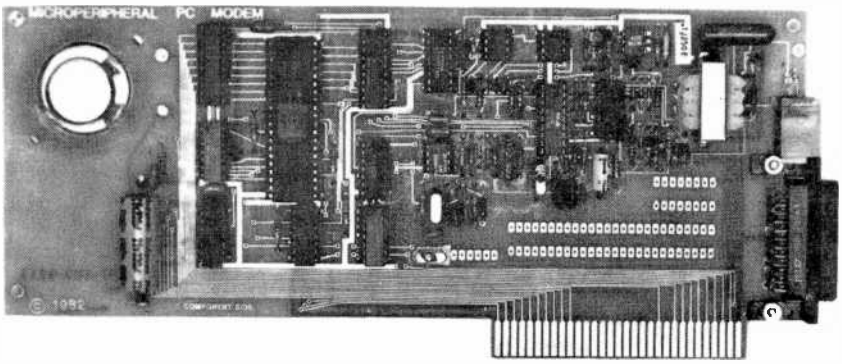
full and half tracks), read, write, erase, write protect, drive select, read enable, and motor enable. LEDs indicate stepper motor phase activity, while a 2-digit counter indicates current track. Basic tests of the entire drive can be performed in less than 2 minutes. Two drives can be compared at the same time. When used with the optional ADASI drive activity monitors, problems can be pinpointed to individual components. $650. **Address:** Computer Center, Div. of Teaco, Inc., POB E, Michigan City, IN 46360 (Tel: 219-874-6234).

Graphics Display. The Spectar III is a packaged graphics display system that features 512 colors, an unlimited amount of moving objects, speech and sound effects, and a 256 × 256 pixel color raster display. Its 80-bit interface allows connection to any 8,16, or 32-bit processors. It features a Z80A, two independent foreground/background systems, hardware display scrolling, and high-speed hardware vector generation with unlimited hardware moving objects. Under $2000. **Address:** Exidy, 390 Java Dr., Sunnyvale, CA 94086 (Tel: 408-734-9410).

IBM PC Modem. The PConnection is a direct-connect, Bel 103/113 compatible modem featuring autodial (Touch Tone or pulse dialing) and auto answer in both originate and answer modes. The modem is treated as an asynchronous card (COM1) by the PC and also contains an RS232 port to expand communications options. A firmware timer manages timer loops for the dialer routine. The modem automatically disconnects from the line in case of failure or carrier loss. It fits inside the PC cabinet leaving the workspace uncluttered. $350. **Address:** Microperipherals Corp., 2643 151st Place, NE, Redmond, WA (Tel: 206-881-7544).

Port Expanders. These port expanders allow single-port units to interface with multiple peripherals or computers. They are compatible with anything having an RS232C or Centronics-compatible interface. Model QS11 allows a single port to talk to one of four output devices, while the Model MO11 allows four peripherals to talk to a common unit. The I/O ports of the expanders are controlled via 128 user-selectable ASCII or EBCDIC codes. Control code and baud rate are switch selectable. $395. **Address:** Advanced Systems Concepts, Inc., PO Box Q, Altadena, CA 91001 (Tel: 213-684-5461).

Ram Card. The SemiDisk can provide 512K-bytes or 1 megabyte on a single S100, TRS-80, or IBM PC board. Using either capacity, up to 8 megabytes can be put into a system. Battery backup is provided. This disk emulator is much faster than a floppy or Winchester. The S100 and TRS-80 should run CP/M 2.2. All data goes through four I/O ports which can be re-addressed to any of 64 locations. Software is provided on standard 8 single-density diskettes, TRS-80 comes on double density, 5" North Star double density, and IBM 5" floppies. Special formats can be provided. 512K bytes is $1995, 1 megabyte is $2995. **Address:** SemiDisk Systems, PO Box GG, Beaverton, OR 97075 (Tel: 503-642-3100).



The PConnection is a direct-connect compatible modem.

Apple Vector Graphics. The Digisolve occupies one slot in the Apple II and provides a monochrome graphics display of 512 by 512 pixels while an on-board vector graphics processor draws lines and characters up to 1.5-million pixels per second. 85 characters by 57 rows of alphanumerics can be displayed. Memory is 64K bytes, and two screen buffer pages are stored. 96 ASCII characters of various sizes and orientation are provided. Other features include lines either solid, dashed, and dot-dashed; variable size blocks for fast area fill; data inversion; screen dump by pixel, and video with European 625 lines. Price is approximately $700. **Address:** Digisolve Ltd., 2/4 Cayton St., London, England EC4 9EH.

Apple Ham Converter. The Terminal for the Apple II allows receiving and transmitting Morse, RTTY, or ASCII. It plugs into the receiver headphone jack for copying Morse, Baudot, or ASCII. Plug it into the CW key jack to send Morse code. Attach a microphone and send Baudot or ASCII using AFSK. No settings or adjustments are needed. Features include multi windows for status displays, six-stage active filter with auto adaptive Morse algorithm and keyboard noise threshold with received code speed displayed on status line, hardware clock, bufferred ASCII parallel printer output, and word mode editing, and both received and transmitted messages may be saved on disk. Requires 48K and disk. $499. **Address:** Macrotronics, Inc., 1125 N. Golden State Blvd., Turlock, CA 95380 (Tel: 209-667-2888).

Morse Code on TRS-80. The MFJ-1210/1212 CW Transceive Program and Hardware Interface for the TRS-80 Model I and III allows sending and receiving CW using the keyboard and split screen. A 3295 character buffer makes sending easy at low speed. Ten 199-character programmable message memories are provided. Speed is adjustable from 12 to 55 wpm. Up to

2200 characters can be stored. The program can receive up to 100 wpm and stores up to five screens of data. The interface plugs between the transceiver and computer. It will key to virtually any tube or solid-state transmitter. LEDs are used as indicators. It requires 9-18 volts dc, and at least 16K of memory. The MFJ-1210 for Model I, and the Model MFJ-1212 for the Model III is $99.95 plus $4 shipping/handling. **Address:** MFJ Enterprises, Inc., PO Box 494, Mississippi State, MS 39762 (Tel: 800-647-1800).

Printer Speed Up. Developed for the TRS-80 Model I and III, SPRINTER allows the printer to run 2 to 3 times faster, with speed selected from 16 commands in BASIC. It automatically slows down for disk and I/O operations, and compensates for slow ROMs. A Z80 is used for high-speed performance. The device plugs into the Z80 socket in the machine and requires no technical skill to install. It can also be used with the PMC-80/81. $99.50. Parallel printer port is $24.50, and a printer cable is $19.50. **Address:** Holmes Engineering, Dept. 17, 3555 South 3200 West, Salt Lake City, UT 84119 (Tel: 801-967-2324).

VIC-20 Expansion. This expansion chassis includes seven slots, internal power supply, detachable cover, support for r-f modulator, and supports all VIC-20 cartridges. The VIC-20 can be locked within the enclosure. The expansion plugs into the VIC expansion slot. $219. **Address:** Arfon Microelectronics, 111 Rena Drive, Lafayette, LA 70503 (Tel: 318-988-2478).

Falcon Unveiled. Now called the C-10, it features an 80 × 24 display, Z80 at 4 MHz, 64K RAM, 12" CRT, DSDD disk, detachable keyboard, serial/parallel port, RS232 modem port. Software includes CP/M, BASIC, a word-processing package, spreadsheet, etc. The C-10 with computer, CRT, serial/parallel port is $995. The keyboard is $195, a 390K byte floppy is $595, and the printer is $895. A second 390K byte floppy is $595. The software is compatible with other Cromemco packages. **Address:** Cromemco, 280 Bernardo Ave., Mountain View, CA 94043 (Tel: 415-964-7400).

Portable Computer. The Teleram T-3000 is a 13" × 9½" × 3", under 10 pound portable computer that features a Z80, 64K of RAM, 8K ROM, a 4 line x 80 character LCD readout that can scroll the full 24 lines, an RS232 port, and operates from an internal rechargeable battery. Memory can be expanded to 128K or 256K of bubble. Options include up to four disk drives, video display, acoustic coupler, TV interface, and printer. Software options include a word processor, spreadsheet, BASIC and other languages, graphics communications, and CP/M. 128K system is $2795. **Address:** Teleram Communications Corp., 2 Corporate Park Drive, White Plains, NY 10604 (Tel: 914-694-9270).

Atari Speaks. The Voice Box is a speech synthesis module for the Atari 400/800 that plugs into the serial port. The 64 phonemes and 4 pitch levels can be used to create a dictionary of up to 5000 words. These can be created and called as desired. A minimum of 16K is required although the diskette and cassette includes both 16K and 32K versions. $169. It is also available for the Apple II at $215 (this version also "sings"). **Address:** The Alien Group, 27 W. 23rd St., New York, NY 10010 (Tel: 212-924-5546).

HPIL Addenda. In June, we discussed the Hewlett-Packard Interface Loop, and made one small booboo—the HP82161A Digital Cassette Drive can store 131K *bytes* instead of the 131K *bits* we gave it. Also, the three items we said would be available in the future—80-character printer, video interface, and GPIO interface, are available now.

TRS-80 Items. The 80-Grafix board gives the TRS-80 Model 1 an effective resolution of 384 × 192 (192 × 192 in 32 character mode) via 128 programmable characters. The characters are formed on a 6 × 12 matrix of dots, and can be called from BASIC or machine language. A lowercase modification is included. The board is supported by over 20 programs/files including Hires81 that allows editing an entire character set one character at a time on an enlarged grid, to create almost any shape desired. $169.85. The CMEMORY-16 is a plug in for the Color Computer that allows adding up to 16K of ROM (four 2732) that occupy address space $C000 to $FEFF (plug-in cartridge space). Without ROM, it is $34.95. 2732 EPROMs (4K) are $24. An 8K version using 2K RAMs or 2716 EPROMs is $24.95. Programming service available. **Address:** Micro Labs, Inc., 902 Pinecrest Drive, Richardson, TX 75080 (Tel: 214-235-0915).

IBM Prototyping. The Prototype Printed Board is used to develop pc boards for the IBM PC. It has room for 88 14-pin DIP sockets and will accept any combination of .3, .4, .6 and .9 sockets and discrete components. An I/O area for any size D-subminiature connector up to DB37, and any ribbon cable to 50 pins is provided. It has a silk screen legend, and uses two-ounce copper double sided. $50 kit, $55 assembled. The Deluxe Extender Board allows working outside of the IBM PC. All address, data, and control signals can be isolated via DIP switches, and test points are provided. $80 kit, $120 assembled. **Address:** Hurricane Labs., Inc., 5149 Moorpark Ave., Suite 105, San Jose, CA 95129 (Tel: 408-257-8678).

Multiple I/O. The Transfer Switches are a line of multi-position RS232 switchers that allow more than one RS232 device to share a common I/O. They switch all signals on the bus. Some come with LED status indicators. Other switches are available to switch shielded cables. Prices range from $99 to $179 dependent on the number/type of switching. **Address:** Innovative Digital Equipment, 4554 Emery Industrial Pkway, Cleveland, OH 44128 (Tel: 216-831-7280).

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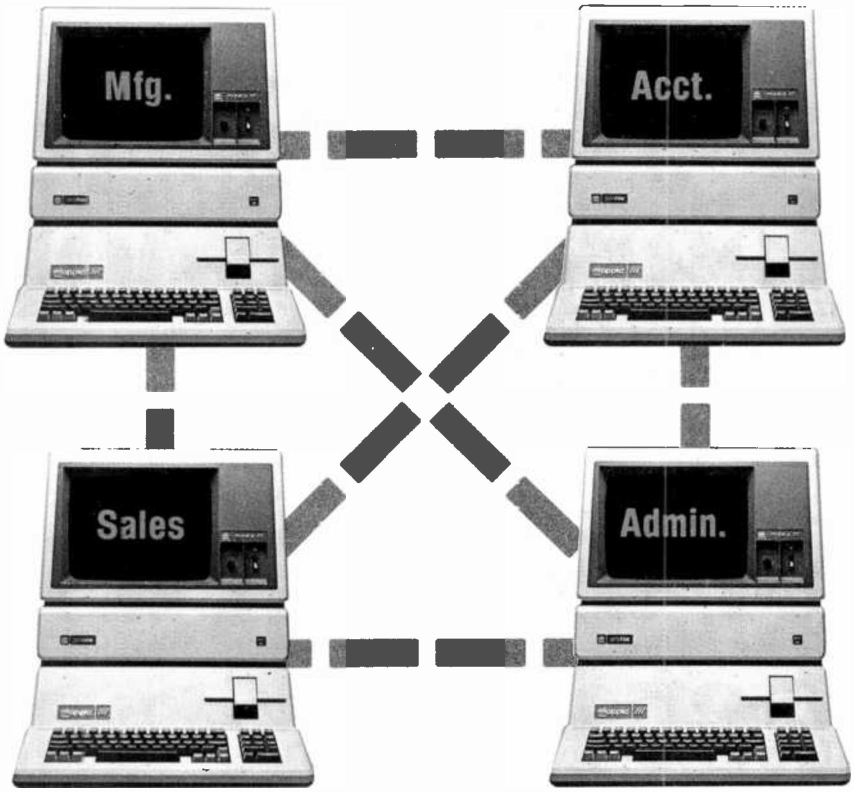

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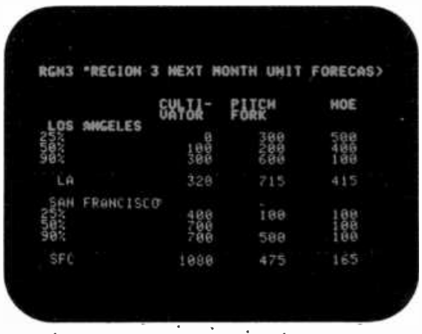

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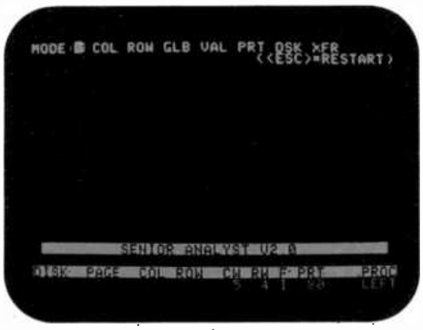

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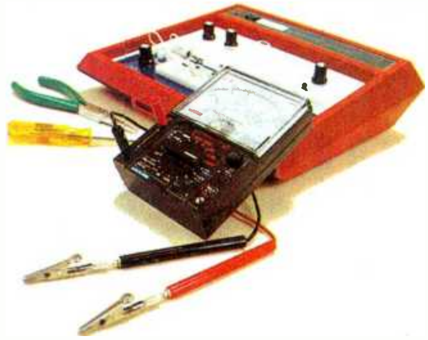

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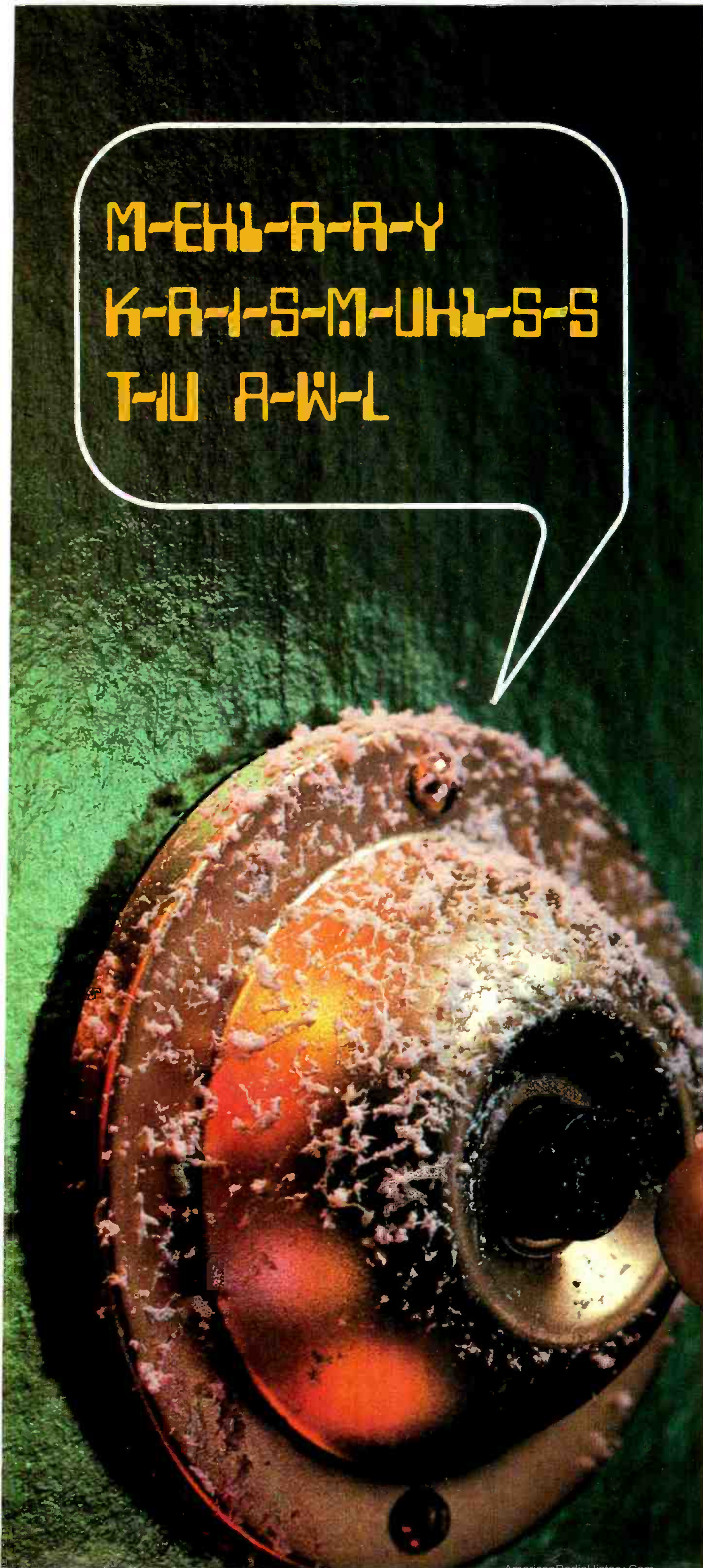

Computers & Electronics
DECEMBER 1982

SPEECH BOARD MAKES *ANYTHING* TALK!

Synthesizer enables you to create speech as a stand-alone device or with virtually any computer

By Ron Reese and Scott Keller

THE "Speak-Easy" synthesized speech system to be discussed here is not limited to use with a computer. It can act as a stand-alone talker for a host of applications—a talking electric train model ("The next stop will be Baldwin"), a talking door-bell responder ("Merry Christmas from the Andersons!"), and so on. It also operates in conjunction with any computer or terminal that has RS232C or parallel input/output ports. (Interfaces

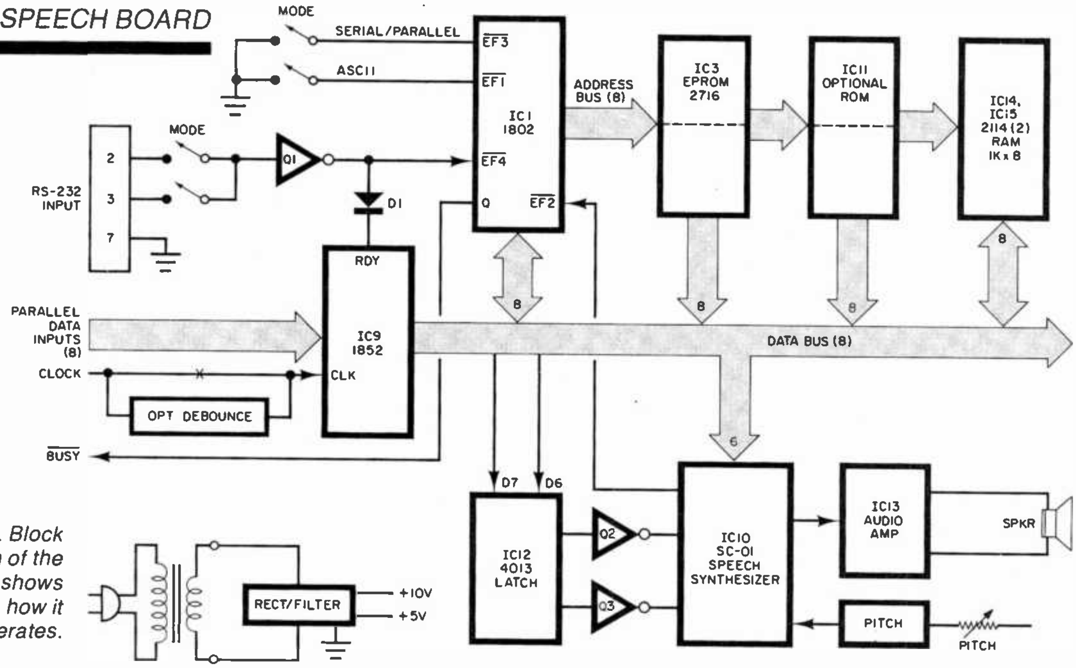

Fig. 1. Block diagram of the system shows how it operates.

to allow major personal computers to use the latter will be published in an upcoming issue.)

A phoneme-oriented approach is used to generate speech that is based on a single CMOS chip, the Votrax SC-01 large-scale IC. The Speak-Easy system uses an 1802 CPU that provides direct phoneme data entry with no code conversions. It also includes a built-in ROM vocabulary of 127 commonly used words, speech inflection control, parallel and serial (RS232C) inputs and automatic baud rate select. It is easily interfaced through any high-level language that includes PRINT, PEEK, or POKE statements (or their equivalents), and can accept binary code via a simple switchbox to be described or ASCII outputted from a computer or terminal.

The block diagram shown in Fig. 1 illustrates circuit operation: Using this approach, phonemes can be directly entered by symbol rather than by hex code. For example, the symbols in the artwork on the first page of this article, which are the phoneme symbols for Merry Christmas . . ., can be directly entered via the RS232 terminal with the 1802 handling the code conversions. Using such mnemonics minimizes chances of making an error. (The phoneme chart with each sound's symbol and hex code is supplied with the speech chip and was published in our past October 1982 issue.) Since the Speak-Easy automatically adjusts for baud rate, any computer-related device operating between 300 and 4800 baud can be used for entry.

Another enhancement of the Speak-Easy is the ability to mix phoneme-constructed words with pre-programmed words (127) stored in the system's ROM. Any message can easily be repeated, and the inflection changed to any of four different levels if required. The input buffer can store up to 1023 characters. A command allows individual words or phonemes to have different pitches to provide variation in speech inflection. Since the EPROM used contains 532 unprogrammed bytes, it is possible for the user to expand the system's vocabulary. Address labels 00 to 75 hex are used by pre-programmed words, with the 40 addresses between 77 to 9F hex available for user-defined words. Although a maximum of only 40 separately referenced words may be stored, each word could consist of a single phoeneme or a group of phonemes in the form of a word or phrase. Conceivably, one label could address a phrase consisting of all 532 bytes. Each new word must be written in phoneme code, not as a word address.

Circuit Operation. The microprocessor (see Fig. 2) is responsible for receiving and interpreting the input signals and providing control for the speech synthesizer chip. The clock oscillator is formed from elements of *IC7* operating at 4 MHz. This is fed to divider *IC6* to drive the clock input of *IC1*. Two flag lines ($\overline{EF1}$ and $\overline{EF3}$) are selected for either serial/parallel or binary/ASCII modes.

The EPROM (*IC3* in Fig. 3) contains the operating system and the pre-programmed words. (Provisions are made for an optional EPROM, *IC11*, for future expansion.) The two RAM chips, *IC14* and *IC15*, provide a 1023-byte buffer with one word reserved for stack and I/O operations. Since the 1802 uses a multiplexed address bus, the upper byte of the address is latched in *IC2* with *IC5* acting as the address decoder that selects either the EPROM or the RAM, depending on the address.

Like most microprocessor-based systems, a power-up reset is required to give the clock oscillator time to stabilize and other elements time to initialize. This power-up circuit consists of *IC4F* and *IC8C*, shown in Fig. 4.

The RS232 inputs at connector *P2* consist of *Q1*, *R22*, and *R23*. The parallel data enters via *P1* and is di-

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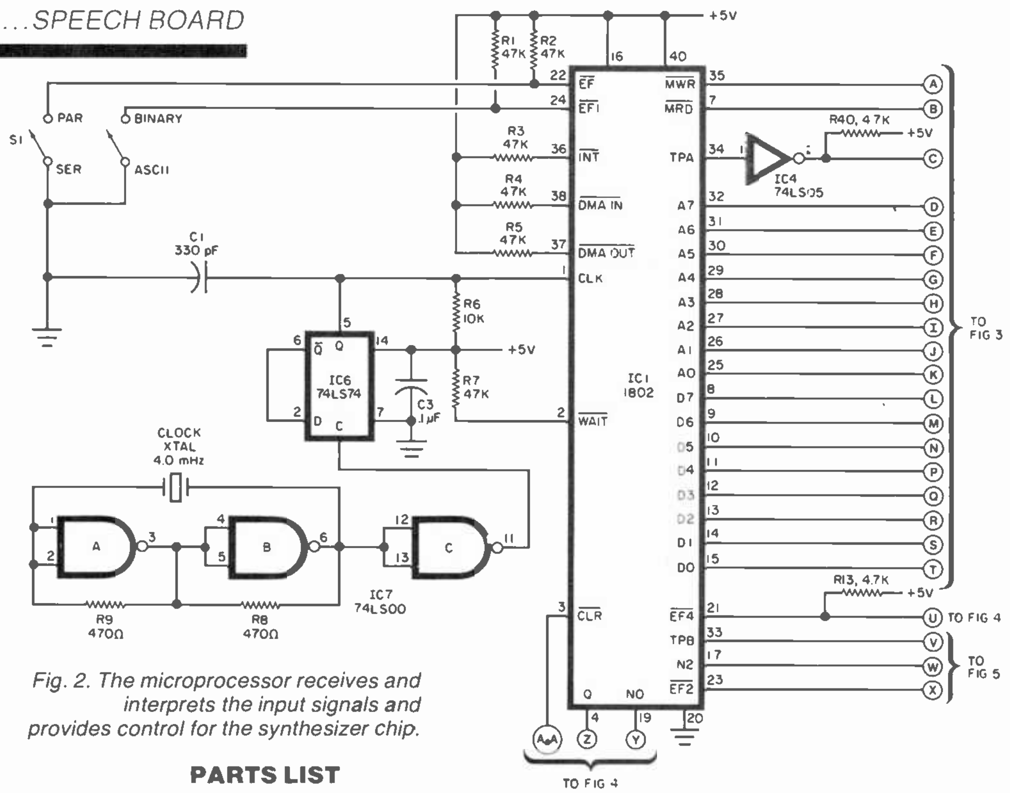


Fig. 2. The microprocessor receives and interprets the input signals and provides control for the synthesizer chip.

PARTS LIST

C1—330-pF disc capacitor
C2,C4,C10,C13—10-µF, 16-V electrolytic
C3,C5,C7—0.1-µF disc capacitor
C6—220-µF, 16-V electrolytic
C8,C9—100-µF, 25-V electrolytic
C11—220-pF disc capacitor
C12—1000-µF, 10-V electrolytic
C15 through C19—0.01-µF disc capacitor
C14,C20—100-µF, 16-V electrolytic
D1 through D11—1N4148
D12,D13,D14,D15—1N4001
D16—1N758, 10-V zener
IC1—1802 CMOS microprocessor
IC2—74LS174 hex latch
IC3—2716 EPROM
IC4—74LS05 hex inverter, open collector
IC5—74LS138 3-to-8 decoder
IC6—74LS74 flip-flop
IC7—74LS00 quad 2-input NAND
IC8—4011 CMOS quad 2-input NAND
IC9—1852 CMOS 8-bit port
IC10—SC-01A Votrax speech synthesizer
IC11—Reserved for expansion
IC12—4013 CMOS flip-flop
IC13—LM386 audio amplifier
IC14,IC15—2114L 1K x 8 RAM
IC16—7805 5-V regulator
P1—16-pin DIP socket
P2—Female DB-25, right-angle connector
Q1,Q2,Q3—2N4384 transistor
The following are ¼-W, 10% resistors unless otherwise noted:
R1 through R7,R11,R12,R30 through R33—47 kilohms
R6,R22,R23,R26,R42—10 kilohms
R8,R9—470 ohms
R10—220 kilohms
R13,R14 through R21,R24,R25,R27,R34,R40,R41, R44—4.7 kilohms
R29—10 ohms
R35—820 kilohms
R36—390 kilohms
R37—22 kilohms
R39—1 kilohm
R43—470 ohms, ½ W
R28,R38—5-kilohm potentiometer
S1 through S6—8-position DIP switch
SPKR—8-ohm speaker
XTAL—4.0-MHz crystal
Misc.—Sockets (1 40-pin, 2 24-pin, 1 22-pin, 2 18-pin, 3 16-pin, and 5 14-pin), power transformer (8.5 V at 200 mA), mounting hardware, etc.

Note: The following is available from Netronics, 333 Litchfield Rd., New Milford, CT 06776: complete kit of parts including double-sided pc board at $149.95 plus $3 postage and handling. Also available separately: pc board at $32 plus postage and handling; Votrax SC-01A at $59.95 plus $2 p/h; cabinet and wall transformer at $9.95, each, plus $2 p/h; source code for the EPROM at $4. On Canadian orders, double postage. Connecticut residents add 7.5% sales tax. Also available free with SASE from the same source are the foil patterns for the pc board.

ode connected to *IC9*. The serial and parallel data ready signal share the same input line (EF4) of the CPU. In the serial mode, this input receives the data stream while in the parallel mode it is used as a signal that a byte of data has been strobed into the parallel port. This port requires a positive-going pulse to latch the data applied to the data input.

While the system is processing a byte of data, or talking, it cannot receive new data. Therefore, a busy signal (active low) is asserted during these times to give the controlling device an indication not to transmit data. Once the speech synthesizer completes its current task, the BUSY line goes high. This drives *IC4G*, which has an open collector that allows it to be shared. *IC4H* and *IC8A* form a de-bouncing circuit used with the manual pushbutton entry system.

As shown in Fig. 5, the speech synthesizer (*IC10*) receives the required data and delivers its output signal to a simple audio signal amplifier (*IC13*). Since *IC10* is a CMOS device, and the data lines are at TTL level, level shifters are required to convert these to the 10-volt level required by the inflection inputs *I1* and *I2*. This shifting is provided by *IC12* and transistors *Q2* and *Q3*. The pitch control is supplied by the *IC4I* circuit.

The power supply shown in Fig. 6 requires the use of a wall-socket-mounted transformer that can deliver 8.5 volts at 200 mA.

Using the Speak-Easy. Operation is simple once a few basic rules

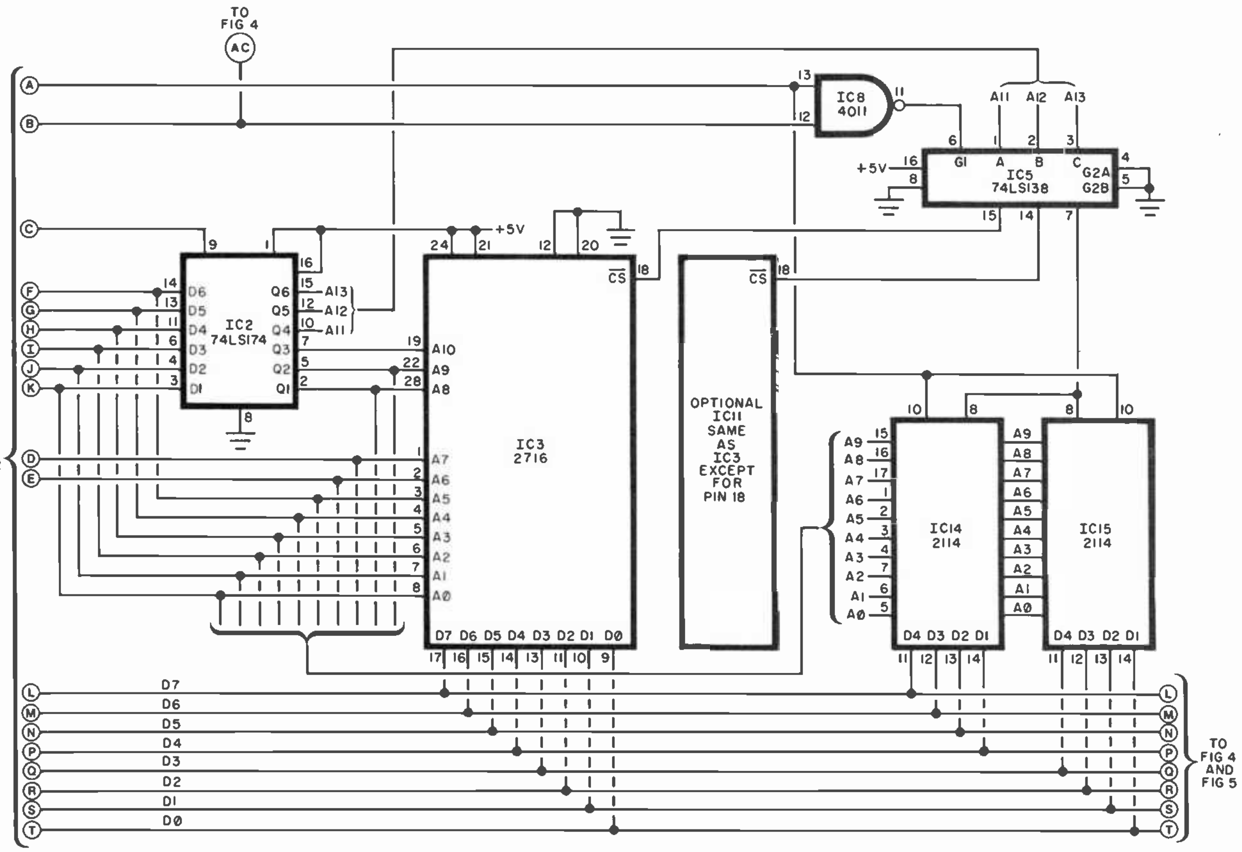


Fig. 3. The EPROM (IC3) contains the operating system and preprogrammed words.

readily be used as a speech-development system owing to the ease and speed with which words and phrases can be constructed. In the ASCII mode, an ASCII keyboard, terminal, or a computer that outputs ASCII can be used. Though a simple serial or parallel ASCII keyboard may be used, an RS232 terminal is advantageous because it provides visual feedback, allowing a user to easily employ the Speak-Easy's error-correction feature.

Before powering up, set mode switches to the settings that match the hardware being connected (serial/parallel, ASCII/binary, RS-232), as shown in Table I. There is only one difference between serial and parallel operation. In the serial mode, the first entry after power-up must be a carriage return (CR). The system uses the CR character to measure the baud rate of the serial transmission. Other than this, the serial and parallel modes are identical in operation. The following discussion applies to both modes.

The Speak-Easy powers up in an off-line mode, which means it must be brought on line before it will respond. This is done by sending the unit a control-A character (press A while the control key is pressed). Each time a message finishes speaking, the unit returns to its off-line state. Therefore, each message or command must be preceded by a CONTROL A.

Messages can be made up of phonemes, pre-programmed words, or any combination of the two. As an example of a message using only the ROM's canned words as listed in Table II, the phrase "How are you" can be generated by entering appropriate ASCII codes (CONTROL A 4C 66 74.). See the BASIC program in Table III.

The CONTROL A brings the system on line, while the 4C is the word label for "How"; 66 is the word label for "are"; 74 is the word label for "you"; and the period "." terminates the message string and starts the speech. To repeat the message simply enter CONTROL A".".

Words may be formed with phonemes too by selecting the appropriate phoneme symbols from an SC-01's table. For example, "Hello" can be generated by doing a "CONTROL A" and entering the following: (H EH1 L L O PA0.). Be sure that the message is preceded by a CONTROL A and terminated by a ".". Furthermore, unlike word labels, every phoneme symbol must be followed by a space, as indicated in the foregoing example. Also notice that a PA0 (pause) is used. Also, a PA1 or PA2 may be used at the end of a phoneme to improve the quality of the last phoneme. As with canned words, the message can be repeated by entering (CONTROL A and ".").

A special feature of the Votrax chip, which has been incorporated in the Speak-Easy, is the four different pitch levels available. Additionally, the speed of the talker can be altered by adjusting the clock frequency control. Four pitch-control characters can be used before indi-

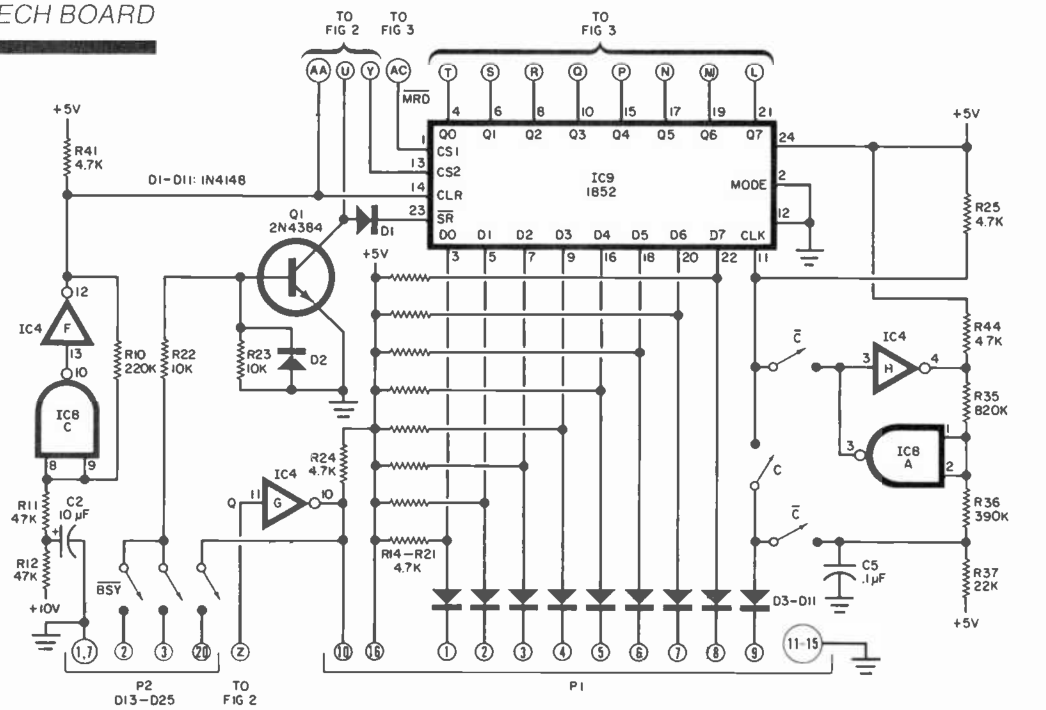
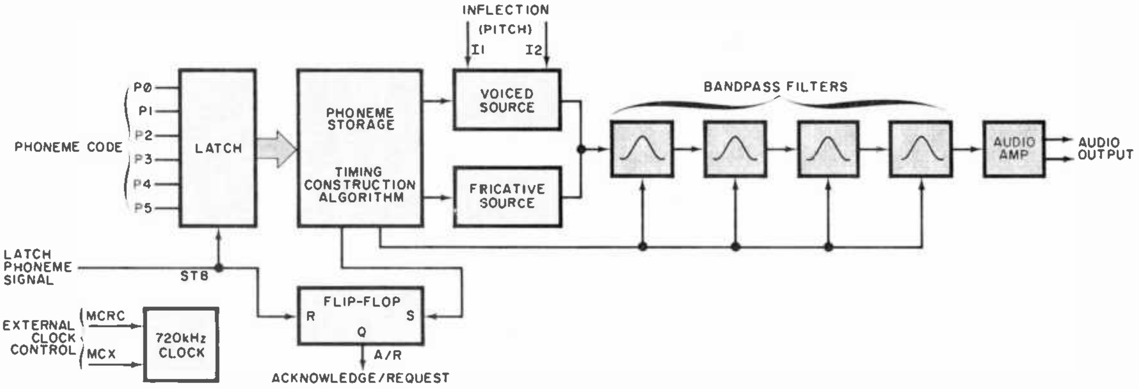


Fig. 4. Parallel data enters at P1 and is connected to IC9 through diodes.

vidual phonemes, groups of phonemes, or words to add inflections or variations to the speech. The pitch of an entire message can be changed even after the phrase has been entered provided it does not contain any pitch-control characters.

To change the pitch of individual phonenemes or words, enter a pitch-control character (#, $, %, &) immediately before the phoneme or word label. No space is needed between the pitch-control character and the phoneme. As an example, the word "Hello" will change pitch four times when typed in as: "#H $EH1 %L L &0 PA0." (Quotation

THE SPEECH CHIP



The Votrax SC-01 speech synthesizer chip used in this project is a phoneme type. It contains two voicing generators (voiced and fricative), four speech bandpass filters, a clock generator (710-kHz optimum), and a low-level audio amplifier. There are 64 stored phonemes in seven categories—the first six cover voiced, fricatives, and nasal sounds, while the seventh is silence.

The six-bit phoneme code is applied to inputs P0 through P5. After a 450-ns interval to allow for data settling, the inputs are latched on the rising edge of the strobe line (STB). The acknowledge/request (A/R) line switches from a high to a low one-clock cycle following the leading edge of STB to indicate that the chip has received the phoneme to be outputted.

Based on the chosen phoneme and the pitch (inflection) level selected, the words are synthesized by a construction algorithm controlling the fricative source ("airy" consonants such as F or S) and the voiced source (vowels like O or I). These signals are passed through a bandpass filter combination that simulates the opening and closing of the human throat. The speech is then amplified and outputted to the speaker or external audio amplifier.

As each phoneme is completed, the A/R line goes high to signal the external digital logic that the speech synthesizer is ready for the next phoneme. All SC-01 inputs, except for I1 and I2, the inflection inputs, are compatible with CMOS or TTL with pull-up resistors. The I1 and I2 inputs require level shifting for proper logic levels.

Besides speech (obviously in any language), the SC-01 can produce "sound effects" by a random choice of phonemes. In the phoneme listing shown here, phoneme length varies from 47 to 250 ms based on the recommended 720-kHz clock. This includes voice sounds as well as "stop," and end-of-word sounds that are important in creating natural sounds. ◇

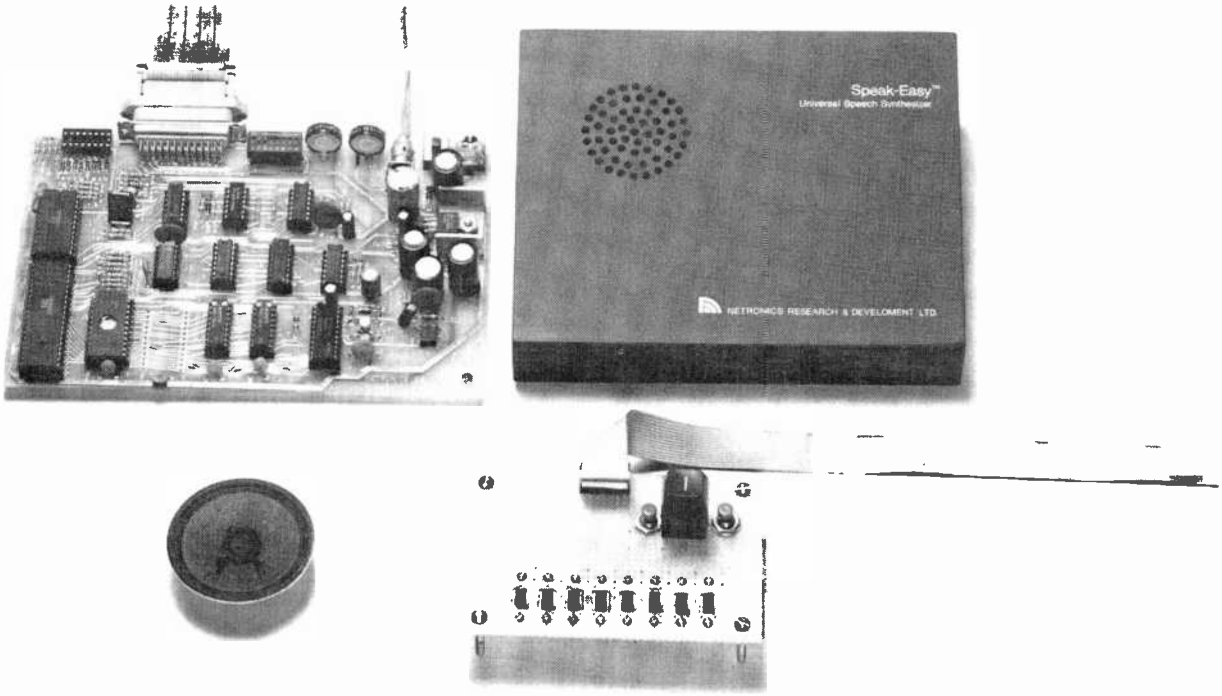


Photo of the prototype board with speaker and phoneme keyboard.

marks should not be entered, of course.) Similarly, for a pre-programmed word, entering "CONTROL A #48 $48 %48 & 48" says "Hello" four times at four different pitch levels.

To change the pitch of an entire message once it has been entered, enter CONTROL A, CONTROL P, and the desired pitch level (3, 4, 5, or 6). However, if an attempt is made to change the pitch of a message containing pitch-control characters, the pitch will change only up to the control character. The remaining portion of the message will not change.

To correct a typing error, use the delete (DEL) key. The last character entered is removed. Each previously entered character is removed in succession with each DEL key stroke. Once the message has been terminated with a "." though, the only way to correct an error is to re-enter the entire message.

Binary Mode. In the binary mode, phonemes must be entered by phoneme code rather than phoneme symbols. Any device, computer terminal, etc., capable of sending binary codes to the Speak-Easy can be

TABLE I—SWITCH POSITIONS

	BSY(1)	3(2)	2(3)	C(4)	B(5)	P(6)
ASCII/serial; computer as source.	Off	On	Off	Off	Off	Off
ASCII/serial; computer as source and program can interrogate busy signal at computer I/O.	On	On	Off	Off	Off	Off
ASCII/serial; terminal as source.	Off	Off	On	Off	Off	Off
Binary/serial; computer as source.	Off	On	Off	Off	On	Off
Binary/parallel; computer bus as source.	Off	Off	Off	Off	On	On
Binary/parallel; stand alone with switch debounce.	Off	Off	Off	On	On	On
ASCII/parallel; computer bus as source.	Off	Off	Off	Off	Off	On

(1) Busy to RS232, pin 20
(2) Serial communications via RS232, pin 3
(3) Serial communications via RS232, pin 2
(4) Negative clock for stand-alone input
(5) Binary/ASCII switch
(6) Parallel/Serial switch

used to operate it in the binary mode.

Again, before powering up the unit, set the mode switches to configure the Speak-Easy to the hardware being used, note that the ASCII/BINARY switch (*S1*, Fig. 2) must be in the BIN position. In the serial mode, the first entry must be 0D (hex). This character is used to measure the baud rate of the terminal or computer. Except for this entry, the parallel and serial modes are identical in operation.

As in the ASCII mode, the unit powers up in the off-line state. However, once turned on, it remains on-line until it receives an off-line com-

TABLE II—WORD TABLE

Memory Address	Line Number	Phoneme Codes	Word	ASCII	Binary
0324	0456				
0324	0457	WDTAB: ,#123C2B353703	ZERO	00	40
032A	0458	,#2D34320D03	ONE	01	41
032F	0459	,#2A36362803	TWO	02	42
0334	0460	,#382B2C03	THREE	03	43
0338	0461	,#1D262B03	FOUR, FOR	04	44
033C	0462	,#1D153C0F03	FIVE	05	45
0341	0463	,1F27191203	SIX	06	46
0346	0464	,#1F3B0F020D03	SEVEN	07	47
034C	0465	,#0521292A03	EIGHT	08	48
0351	0466	,#0D153C0D03	NINE	09	49
0356	0467	,#2A3B0D03	TEN	0A	4A
035A	0468	,#3C183B0F330D03	ELEVEN	0B	4B
0361	0469	,#2A2D0123180F03	TWELVE	0C	4C
0368	0470	,#38232B2A2A3C3C0D03	THIRTEEN	0D	4D
036F	0D03;	0470			
0371	0471	,#1D352B2A2A3C3C0D03	FOURTEEN	0E	4E
037A	0472	,#1D271D2A3C3C0D03	FIFTEEN	0F	4F
0382	0473	,#1F2719122A3C3C0D03	SIXTEEN	10	50
038B	0474	,#1F3B0F020D2A3C3C0D03	SEVENTEEN	11	51
0395	0475	,#21292A2A3C3C0D03	EIGHTEEN	12	52
039D	0476	,#0D153C0D2A3C3C0D03	NINETEEN	13	53
03A6	0477	,#2A2D0B0D2A2903	TWENTY	14	54
03AD	0478	,#38232B2A2903	THIRTY	15	55
03B3	0479	,#1D352B2A2903	FORTY	16	56
03B9	0480	,#1D0B1D2A2903	FIFTY	17	57
03BF	0481	,#1F27191F2A2903	SIXTY	18	58
0306	0482	,#1F3B0F020D2A2903	SEVENTY	19	59
03CE	0483	,#0621292A3C03	EIGHTY	1A	5A
03D4	0484	,#0D153C0D2A2903	NINETY	1B	5B
03DB	0485	,#1B32230D1E2B001E03	HUNDRED	1C	5C
03E4	0486	,#3915233712000D1E03	THOUSAND	1D	5D
03ED	0487	,#0C0B091829230D03	MILLION	1E	5E
03F5	0488	..			
03F5	0489	,#06212903	A	1F	5F
03F9	0490	,#320E3108372A03	ABOUT	20	5F
0400	0491	,#2F001E03	ADD	21	5F
0404	0492	,#2F001E2B02001F03	ADDRESS	22	5F
040C	0493	,#311C27000D03	AGAIN	23	5F
0412	0494	,#0818233A2A03	ALERT	24	5F
0418	0495	,#2E0C03	AM	25	5F
041B	0496	,#2F000D1E03	AND	26	5F
0420	0497	,#2E2A03	AT	27	5F
0423	0498	..			
0423	0499	,#0E3C2903	B,BE	28	5F
0427	0500	,#0E02000D03	BEEN	29	5F
042C	0501	,#0E291D34342B03	BEFORE	2A	5F
0433	0502	,#0F02002A34A3	BETTER	2B	5F
0439	0503	,#0E332A03	BUT	2C	5F
043D	0504	..			
043D	0505	,#1F3C2903	C, SEE, SEA	2D	
0441	0506	,#190621290C03	CAME	2E	
0447	0507	,#192F000D03	CAN	2F	
044C	0508	,#19022B02192A3A03	CHARACTER	30	
0454	0509	,#191835371203	CLOSE	31	
045A	0510	..			
045A	0511	,#1E20220D1E1A3A2B03	DANGER	32	
0463	0512	,#1E2C1C2B2C03	DEGREE	33	
0469	0513	,#1E02000F2308291F03	DEVICE	34	
0472	0514	,#1E283703	DO	35	
0476	0515	,#1E24183A03	DOLLAR	36	
047B	0516	,#1E2F08320D03	DOWN	37	
0481	0517	..			
0481	0518	,#0200181F03	ELSE	38	
0486	0519	,#01000D1E03	END	39	
048B	0520	,#2C192D131803	EQUAL	3A	
0491	0521	,#023A2B03	ERROR	3B	
0495	0522	..			
0495	0523	,#1D13182A03	FAULT	30	
049A	0524	,#1D3A2B1F2A03	FIRST	3D	
04A0	0525	,#1D153018353703	FOLLOW	3E	
04A7	0526	..			
04A7	0527	,#1E1A3C2903	G	3F	
04AC	0528	,#1C0521290C03	GAME	40	
04B2	0529	,#1C02002A03	GET	41	
04B7	0530	,#1C263703	GO	42	
04BB	0531	,#1C263C1403	GOING	43	
04C0	0532	,#1C16161E03	GOOD	44	
04C5	0533	,#1C2B06212A03	GREAT	45	
04CB	0534	..			
04CB	0535	,#1B2E001E03	HAD	46	
04D0	0536	,#1B2F000F03	HAVE	47	
04D5	0537	,#1B00231835340З	HELLO	48	
04DC	0538	,#1B21092B03	HERE	49	
04E1	0539	,#15000903	HIGH	4A	
04E5	0540	,#15352B03	HOUR, OUR	4B	
04E9	0541	,#3D3703	HOW	4C	
04EC	0542	..			
04EC	0543	,#1500092903	I, EYE	4D	
04F1	0544	,#0B091D03	IF	4E	
04F5	0545	,#0B090C2534342B2A000D	IMPORTANT	4F	
04FF	0546	,#2A03			
0501	0547	,#0B010D03	IN, N	50	
0505	0548	,#09000D2A2B371E3A03	INTRUDER	51	
050E	0549	,#271203	IS	52	
0511	0550	,#0B002A03	IT	53	
0515	0551	..			
0515	0552	,#0B010D03	K	54	
0519	0553	..			
0519	0554	,#183B1D2A03	LEFT	55	
051E	0555	,#1835343703	LOW	56	
0523	0556	..			
0523	0557	,#0C020D022A03	MINUTE	57	
0529	0558	,#0C320D2C03	MONEY	58	
052E	0559	..			
052E	0560	,#0D20290C03	NAME	59	
0533	0561	,#0D3B191F2A03	NEXT	5A	
0539	0562	,#0D35343703	NO	5B	
053E	0563	,#0D15082A03	NOT	5C	
0543	0564	,#0D320C0CDE3A03	NUMBER	5D	
054A	0565	..			
054A	0566	,#240F03	OF	5E	
054D	0567	,#08301D03	OFF	5F	
0551	0568	,#13230D03	ON	60	
0555	0569	,#3525270D03	OPEN	61	
055A	0570	,#35342B03	OR	62	
055E	0571	,#2308372A03	OUT	63	
0563	0572	,#260F3A03	OVER	64	
0567	0573	..			
0567	0574	,#25182C1203	PLEASE	65	
056C	0575	..			
056C	0576	,#153A03	R, ARE	66	
056F	0577	,#2B15292A03	RIGHT	67	
0574	0578	,#2B3C25212A03	REPEAT	68	
057A	0579	,#2E02001E2903	READY	69	
0580	0580	..			
0580	0581	,#1F0219230D2A03	SECOND	6A	
0587	0582	,#1F2A152B2A03	START	6B	
058D	0583	,#1F2A15232503	STOP	6C	
0593	0584	..			
0593	0585	,#392F010D03	THAN	6D	
0598	0586	,#392F012A03	THAT	6E	
059D	0587	,#39092C03	THE	6F	
05A1	0588	,#380B000D03	THEN	70	
05A6	0589	,#390B0A1F03	THIS	71	
05AB	0590	,#2A1500210C03	TIME	72	
05B1	0591	,#2A2B150A03	TRY	73	
05B6	0592	..			
05B6	0593	,#2236373703	U, YOU	74	
05BB	0594	,#332503	UP	75	
05BE	0595	..			
05BE	0596	,#2D352B0D0B1403	WARNING	76	
05C5	0597	,#2D23322A03	WHAT	77	
05CA	0598	,#2D02000D03	WHEN	78	
05CF	0599	,#2D0005002B03	WHERE	79	
05D5	0600	,#1B36373703	WHO	7A	
05DA	0601	,#2D150B03	WHY	7B	
05DE	0602	,#2D36361E03	WOULD, WOOD	7C	
05E3	0603	..			
05E3	0604	,#2934342B03	YOUR	7D	
05E8	0605	,#2200021F03	YES	7E	

mand. A list of the commands used in the binary mode is shown in Table IV.

Since the unit powers up in the off-line mode, it must first be turned on by sending it F0. When the unit is on-line, words or phonemes may be entered. For example, to say "How are you," the appropriate word labels may be selected from the word list. Note that the binary word labels are different than the ASCII labels. The sequence to be entered from the binary column is: F0 8C A6 B4 F5 (all hex).

When F5 is received the Speak-Easy will begin talking. When it is finished, it will remain in the on-line state. To go off-line, add the code FF to the string. Phonemes may also be used to form words. For example, the following phonemes will produce the sound "George":

F0 1E 1A 26 2B 1E 1A 03 F5

Recall that the F0 would only be necessary if the unit had not been previously turned on. No spaces are required between codes—they are included above in the interest of clarity.

Individual phonemes or words may be preceded by a pitch-control command (F1 to F4) to change the pitch of the phoneme or word. As many pitch-control commands may be used as desired within a message. Another way the pitch-control commands can be used is to change the pitch of the entire message. This use has the constraint that there can be no pitch-control commands within the message itself. Once the message has been entered (without pitch-control commands), enter F5 (hex) and the message will be repeated. Then enter F1, F5 to repeat the message at pitch level 1. Likewise, F2, F5, F3, F5, F4, and F5 will repeat the message at the respective pitch levels. Words and phonemes may be mixed within a message.

Vocabulary Expansion. As previously mentioned, there are 532 unprogrammed locations in the system's EPROM that can be used for custom vocabulary expansion. Therefore, as new words, phrases, or sentences are developed they can

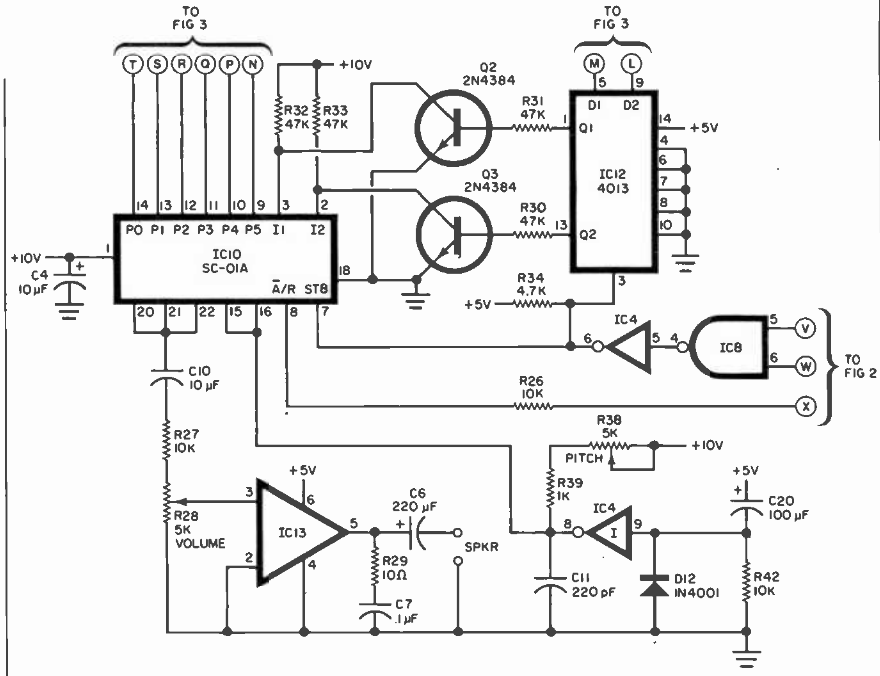


Fig. 5. The speech synthesizer (IC10) takes the required input data and delivers an output signal to a simple audio signal amplifier.

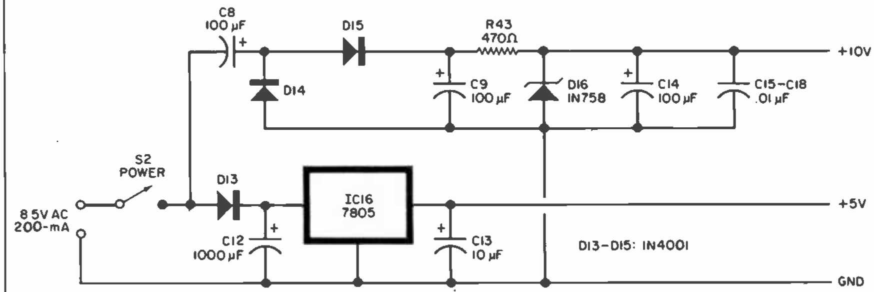


Fig. 6. Use this circuit for a power supply to drive the Speak-Easy speech board.

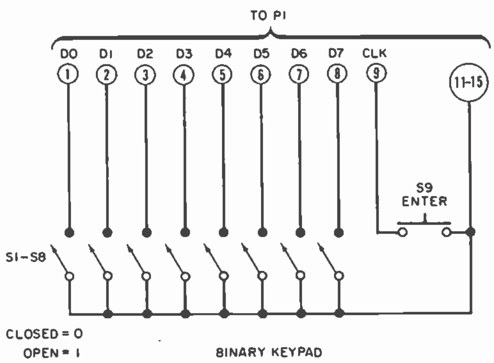


Fig. 7. For the stand-alone mode, this keyboard to enter phonemes must be built.

be added to the pre-programmed word list and called by a particular word label. (A separate EPROM programmer is required to do this.)

Valid word labels are from 00 to 7E (hex), with the remainder of the ROM for user-defined words. This means that 33 labels, 7F to 9F (hex), are available for expansion; that is, up to 33 words or messages may be added.

New entries to the pre-programmed word list are not limited to a single word per label, but can be a word, phrase, sentence, or even a whole paragraph for that label. For example, the sentence, "Good morning how are you" could be entered under a single word label.

TABLE III—BASIC PROGRAM

```
10 PRINT CHR$ (13)
20 REM OUTPUTS CARRIAGE RE-
   TURN FOR BAUD RATE
   INITIALIZATION
30 PRINT "ENTER REQUIRED WORD
   ADDRESSES, END WITH
   PERIOD"
40 REM FOR EXAMPLE 4C 66 74 WILL
   OUTPUT 'HOW ARE YOU'
50 INPUT A$
60 REM NEXT LINE OUTPUTS
   CONTROL-A CHARACTER
70 PRINT CHR$ (01)
80 PRINT A$
90 REM LINE 80 OUTPUTS WORDS
   OR PHRASES
100 GOTO 50
```

TABLE IV—BINARY MODE COMMANDS

Command (Hex)	Result
0D	Auto baud rate test character (serial only)
F0	Turns unit on line
F1-F4	Pitch control
F5	String Terminator (similar to "," in ASCII mode
FF	Turns unit off line

There are a few limitations to the messages. The total length of all added messages cannot exceed 532 bytes, and messages must contain only hexadecimal phoneme codes (no ASCII codes or word labels). Also, if a pause is needed within a message, the phoneme pause PA1 (3E hex) must be used since the short pause PA0 (03 hex) is used to terminate all labeled phrases. Word labels must be consecutive, with no skipping. Similarly, memory locations cannot be skipped between messages or within a message.

Here's an example to illustrate vocabulary expansion. Suppose the phrase "Danger intruder alert" is to be stored in the EPROM vocabulary. Note that all three of these words are in the pre-programmed word list. Consequently, the phoneme codes can be copied directly from the word list as:

Danger . . . 1E20220D1E1A3A2B03
intruder . . 09000DA2B371E3A03
alert 0818233A2A03

If a word is chosen that is not contained in the word list, the phoneme codes for the word must be developed before proceeding. The pause 03 (PA0) at the end of the "Danger" and the "intruder" phoneme code strings should be replaced with 3E (PA1). Remember, this is to be a three-word message under one label. Therefore, 03 cannot be used within the message. The pause 3E (PA1) will produce a slightly longer pause between words. The 03 (PA0) at the end of the "alert" phoneme listing will terminate the message. The phoneme string for the message then becomes:

1E20 220D 1E1A 3A2B 3E09 000D 2A2B 371E 3A3E 0818 233A 2A03.

The space between each four characters is for visual clarity only. The phoneme string must go in the EPROM at the first available EPROM address, as previously discussed. The last entry is "yes" at address location 05E8. The phonemes that comprise "yes" require five bytes of memory, 05E8 to 05EC (hex), so the next available EPROM address is 05ED. The phoneme string for "Danger intruder alert" should be programmed into the EPROM from addresses 05ED through 0604 (hex). Since the last label used for a "canned" phrase is 7E (hex), the label for this message will automatically be 7F (hex). Once the codes are stored in the EPROM, CONTROL A 7F (period) will produce the spoken message.

Stand-Alone Mode. The Speak-Easy can be used as a stand-alone talker with all the features of the binary mode, including phoneme, word, combined word and phoneme messages, message repeat, and pitch control. The only difference between the binary parallel mode and the stand-alone mode is that the phoneme/word data is entered with a small keyboard such as shown in Fig. 7.

The eight spst switches, *S1-S8*, are used to apply phoneme codes to the Speak-Easy's input port. An open switch applies a logic 1 and a closed switch applies a logic 0. Thus, the eight switches are set for the desired phoneme code, and ENTER switch (*S9*) is used to strobe the phoneme data into the input port. The ENTER switch must be debounced to prevent multiple entries of the data. Therefore, a switch debounce circuit is jumped between the ENTER switch and the strobe input of the I/O port.

Once the unit is powered, set switches *S1-S8* for 1111 0000 (F0 hex) and press ENTER to bring the unit on-line. Next, set the switches for 0000 0000 (00 hex) to select "zero" from the pre-programmed word list, and press the ENTER switch. Last, set the switches for 1111 0101 (F5 hex), press ENTER, and the unit will say "zero." It will respond this way every time ENTER is pressed as long as the switches are set for F5. It is important to recognize that the ENTER switch can be any electric switch, mechanical or electronic, that can close momentarily for about 200 ms.

One example of how this repeat feature can be used is for a speaking doorbell. The ENTER switch could be paralleled with a doorbell switch to initiate a message when the doorbell button is pressed. (The door switch should not be connected to anything else!) The sequence shown in Table V would produce the message "Hello, who is it" when the ENTER switch or alarm contacts are activated.

Set the switches for each code shown in the Table and ENTER it using the ENTER key. When the last entry (7) is set and the ENTER key is pressed, the message will be spoken. As long as the switches remain set to F5 (hex)—the start command—the message will be spoken every time the door switch (or ENTER) is pressed. Although this example uses only pre-programmed words, phoneme codes could also be used to construct the words. In fact, 3E (PA1) in Table V is actually the phoneme word for a pause.

The pitch can be changed by setting the switches to the desired pitch level, F1-F4 (hex), and pressing the ENTER key. Then set the switches back to F5 (hex) and press the ENTER key. Observe that the message says the same thing but at a different pitch level. Other messages may be entered in a similar manner. The message can also contain individual pitch-control codes, F1-F4 (hex) for effects. For example, the second sequence shown in Table V would produce a different pitch level for each word. However, the pitch of the entire message cannot be changed as before because the message itself contains pitch-control characters. A message can be up to 1023 characters in length including phoneme codes, word labels, and pitch-control characters.

As you can see, speech synthesis has become a practical system at moderate cost, whether or not you own a computer. You can build the programmable electronic talker described here on perforated board using point-to-point wiring or on a double-sided printed circuit board. Patterns for the latter are not included here because of their complexity. However, they can be obtained free of charge on request, with a self-addressed stamped envelope, from the source given in the Parts List. ◊

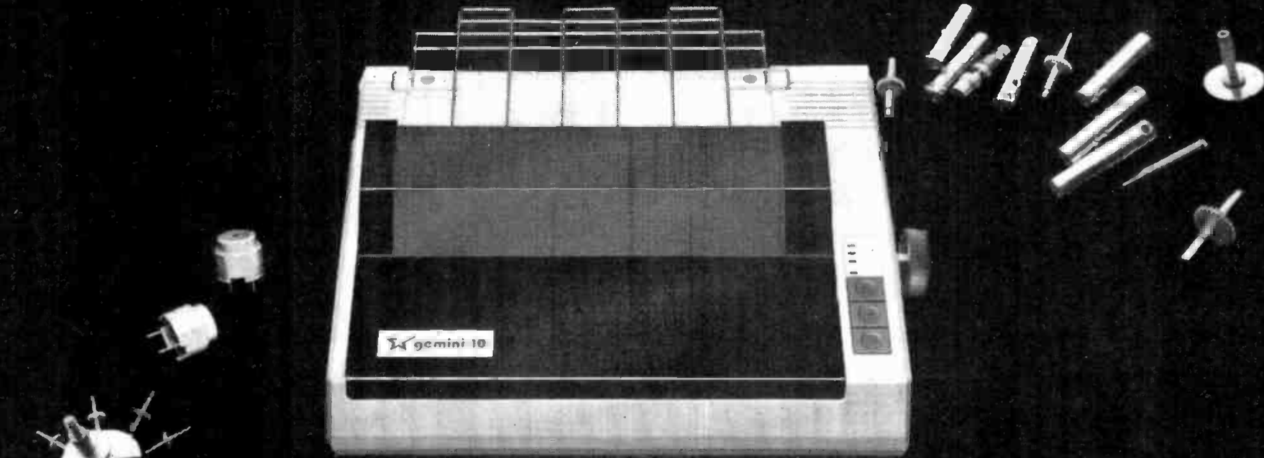
TABLE V—"HELLO, WHO IS IT"

Basic Switch Sequence

Entry	S8	S7	S6	S5	S4	S3	S2	S1	Action
1	1	1	1	1	0	0	0	0	Bring unit on line (if off-line)
2	1	0	0	0	1	0	0	0	Binary label for "Hello"
3	0	0	1	1	1	1	1	0	Phoneme code for PA1
4	1	0	1	1	1	0	1	0	Binary label for "who"
5	1	0	0	1	0	0	1	0	Binary label for "is"
6	1	0	0	1	0	0	1	1	Binary label for "it"
7	1	1	1	1	0	0	0	0	Binary command to start speech (switches must be left in this position).

Changing Pitch Levels

S8	S7	S6	S5	S4	S3	S2	S1	Action
1	1	1	1	0	0	0	0	on line command
1	1	1	1	0	0	0	1	select pitch level 1
1	0	0	0	1	0	0	0	"hello"
1	1	1	1	0	0	1	0	select pitch level 2
0	0	1	1	1	1	1	0	PA1 (pause)
1	0	1	1	1	0	1	0	"who"
1	1	1	1	0	0	1	1	select pitch level 3
1	0	0	1	0	0	1	0	"is"
1	1	1	1	0	1	0	0	select pitch level 4
1	0	0	1	0	0	1	1	"it"
1	1	1	1	0	1	0	1	start command



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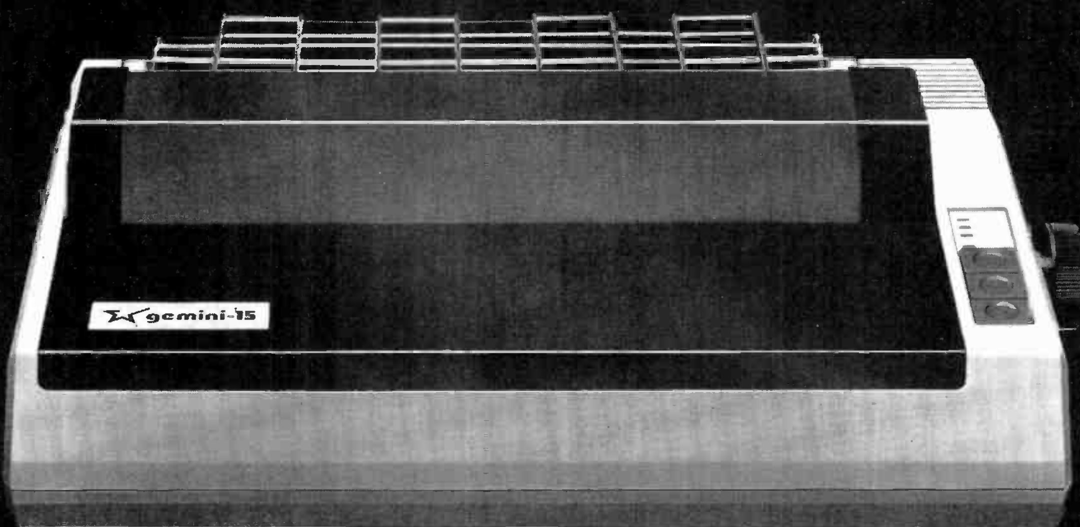

Over thirty years of down-to-earth experience as a precision parts manufacturer has enabled Star to produce the Gemini series of dot matrix printers—a stellar combination of printer quality, flexibility, and reliability. And for a list price of nearly 25% less than the best selling competitor.

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Gemini's flexibility is embodied in its diverse specialized printing capabilities such as super/sub script, underlining, backspacing, double strike mode and emphasized print mode. Another extraordinary standard feature is a 4k buffer (with an additional 4k on the serial board). That's twice the memory of leading, comparable printers. And Gemini is compatible with most software packages that support the leading printers.

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CIRCLE NO. 53 ON FREE INFORMATION CARD

The FLICKER BOX

Produce candle-like effects with ordinary incandescent bulbs

By William Russo

HOW would you like an electric light that simulates the warm, old-fashioned glow of an oil lamp? The Flicker Box can create this effect and more. Its adjustable flicker intensity can produce both the wild gyrations of a ghostly Halloween light and the friendly dancing flame of a single candle. What's more, for those times when you prefer a steady light, the flick of a switch makes it a full-range light dimmer. You can build the Flicker Box for about $25.

How It Works. In the schematic shown in Figs. 1 and 2, a flicker generator circuit controls a thyristor-type light dimmer. Transformer *T1* and components *C1, D1, D2, D3, F1,* and *R1* provide unregulated 9 V dc and regulated 6.2 V dc. The four op amps of the LM324 *IC1* are configured as nearly identical square-wave generators, the only difference being in the values of feedback resistors *R2, R7, R12,* and *R17.* These different values result in four different square-wave frequencies, chosen to best simulate an open flame.

Resistors *R6, R11, R16,* and *R21* add the square waves to produce a pseudorandom flicker voltage. This flicker voltage is applied to incandescent bulb *I1* through driver transistor *Q1* and calibration potentiometer *R23.* The light from the lamp is optically coupled to photocell *PC1.* Bias resistor *R22* keeps the lamp voltage above the minimum to which the lamp filament will respond, thus increasing the useful dynamic range of the circuit.

The photocell, with its resistance modulated by the flicker voltage, is connected in parallel with the potentiometer of a conventional full-wave 117-V ac dimmer. The dimmer pot provides control of the steady background light level, while the photocell adds the flicker effect. Switch *S1* turns off the flicker generator and opens the photocell circuit when the flicker is not desired. The dimmer switch serves as the master switch that can be used to turn off both dimmer and flicker generator.

Construction. Figure 3 shows the pc foil pattern for the Flicker Box and Fig. 4 shows the parts placement on the pc board. Other construction methods can be used since circuit layout is not critical. The optocoupler consisting of *I1* and *PC1* can be constructed by mating an incandescent bulb to the face of a photocell using clear glue. (It can also be purchased as a single unit.) After the glue dries, wrap the assembly with black electrical tape to seal out ambient light.

The dimmer is the usual type that replaces a wall switch. To modify it for use here, first remove the plastic case that is held to the metal front panel by two fasteners in diagonally opposite corners. Remove these

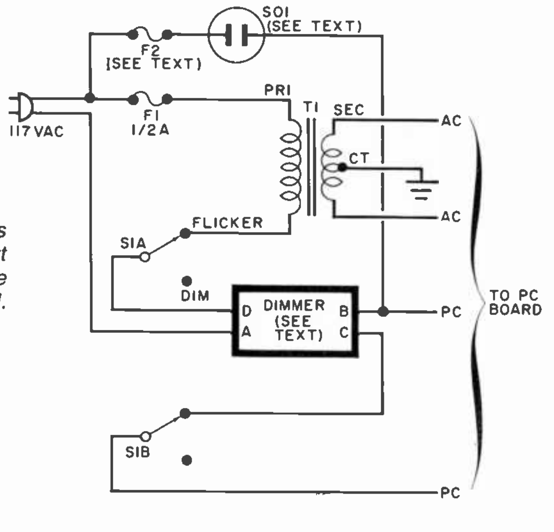


Fig. 1. Components shown in this part of schematic are mounted off the board.

CIRCLE NO. 8 ON FREE INFORMATION CARD

fasteners (drill out rivets, pry out pins, or unscrew, as necessary) and the plastic case should come off. You'll see a pot with a switch on it, a thyristor using the front panel as a heatsink, and a few other small components. One of the two black wires emanating from the dimmer is connected to a terminal on the switch. This one is labeled A in the schematic; the other is labeled B.

The pot is usually wired, rheostat fashion, with the center lug shorted to one of the end lugs, or with one of the end lugs left disconnected. Don't use the shorted or open-end lug, and do not disturb the lug to which wire B is attached. A length of insulated hookup wire should be soldered to the remaining lug, being careful not to damage or disconnect any dimmer components already soldered to it. The new wire goes to *S1* as wire C in the schematic. Wire D is connected to the dimmer-switch terminal not occupied by wire A.

The line cord and outlet for the controlled lamp come from a 9′ extension cord cut 3′ from the receptacle end. The 6′ piece is used as the line cord and the 3′ section is wired for the load as shown in the schematic. Fuse *F2* is optional (it protects the dimmer) and should be rated at the maximum dimmer current as listed on the dimmer. A typical 600-W dimmer requires a 5-A fuse.

The prototype unit was built into a 7.5″ × 4.3″ × 2.2″ plastic case. A plastic case is used rather than a metal one to minimize the chance of shock. It should be big enough to provide adequate clearances. Drill a 3/8″ access hole in the box for *R23* adjustment, and mount the assembled board so that the *R23* control is accessible through this hole. You can fasten the dimmer switch to the top of the case, using the two holes provided for securing the dimmer to a wall switch box. All of the components of the prototype unit, except *S1*, were glued to the top of the box with epoxy cement. This allows easy access to the circuitry while avoiding unsightly holes in the cover.

The line and load cords exit the box through notches filed in one end at the top. Doublecheck all wiring and close up the box before applying power. Remember that 117-V ac is present on the circuit board pc terminals as well as in the wiring inside the box.

Calibration and Use. Plug a 40-to-100-W lamp into the load receptacle. Now plug the Flicker Box line cord into an outlet and turn on the dimmer. With *S1* set to dim only, check the dimmer control for proper dimming operation. (Make sure the load lamp is turned on!) If

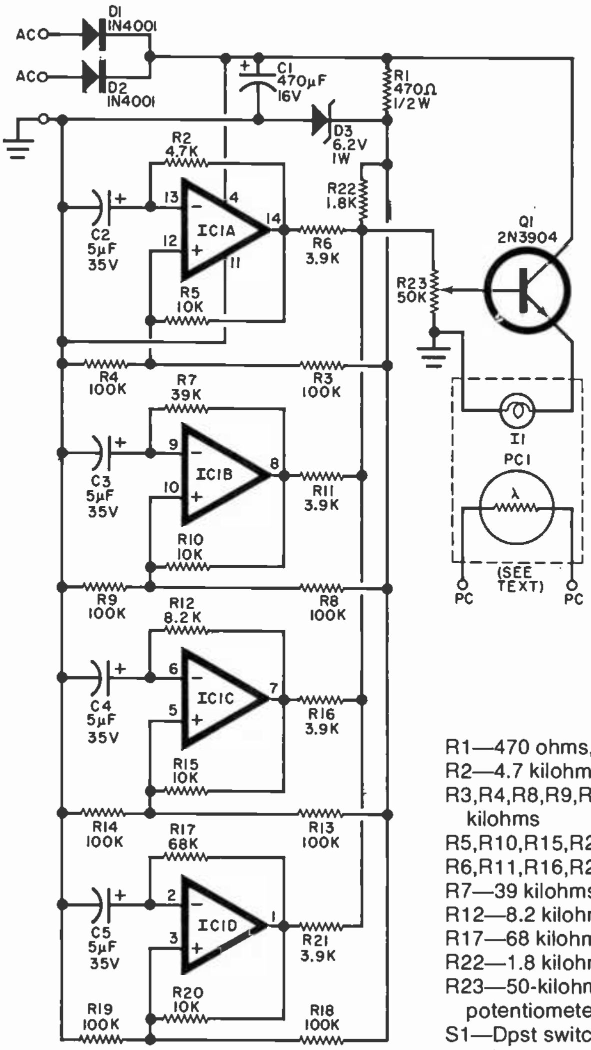


Fig. 2. Four square waves of different frequencies are generated in the four op amps and combined to produce the pseudo-random flicker voltage.

PARTS LIST

C1—470-µF, 16-V electrolytic (axial leads)
C2,C3,C4,C5—5-µF, 35-V radial-lead electrolytic
D1,D2—1N4001 rectifier
D3—6.2-V, 1-W zener diode
F1—0.5-A regular-blow fuse
F2—See text
I1—12-V, 25-mA incandescent lamp (Radio Shack 272-1141 or equivalent. See Note 1)
IC1—LM324 quad operational amplifier
PC1—Photocell (Radio Shack 276-116 or equivalent. See Note 1)
Q1—2N3904 npn transistor
The following are 1/4-W, 5% carbon resistors unless otherwise noted:
R1—470 ohms, 1/2 W
R2—4.7 kilohms
R3,R4,R8,R9,R13,R14,R18,R19—100 kilohms
R5,R10,R15,R20—10 kilohms
R6,R11,R16,R21—3.9 kilohms
R7—39 kilohms
R12—8.2 kilohms
R17—68 kilohms
R22—1.8 kilohms
R23—50-kilohm, linear-taper, trimmer potentiometer
S1—Dpst switch rated for dimmer current rating or higher
T1—Stepdown transformer, 115 V ac to 12.6 V ac center-tapped, 300 mA min.
Misc.—Dimmer (see text), case, line cord, load receptacle (see text), pc board, mounting hardware, fuse holders, hookup wire, IC socket (optional), pc board standoffs, solder, etc.

***Note 1:** Suitable optocouplers to replace I1 and PC1 are Sigma 301T1-12B1 and VacTec VTL3A26.*
***Note 2:** The following are available from JRJ Engineering, 2271 Mecklenburg Rd., Ithaca, NY 14850: etched and drilled printed circuit board at $6.50; optocoupler at $4.50; both pc board and optocoupler at $10.00. All prices postpaid in USA. New York state residents add local sales tax.*

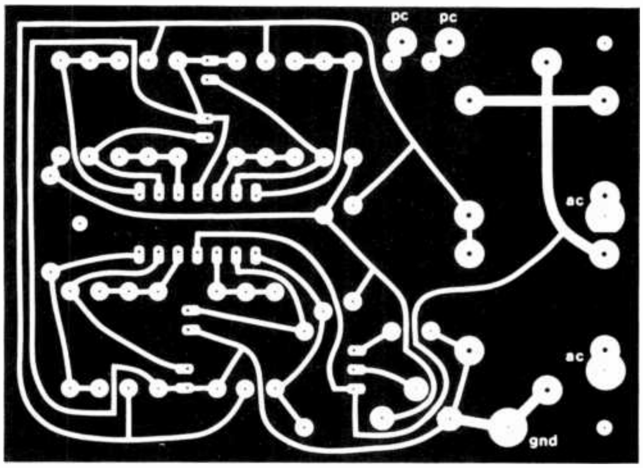


Fig. 3. Use this foil pattern for the printed circuit board.

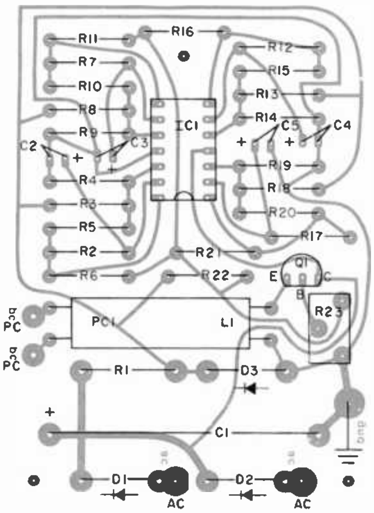


Fig. 4. Layout of components on the printed circuit board.

operation is satisfactory, turn the dimmer knob all the way counterclockwise so that the lamp is dark but the switch remains on. Now switch *S1* to FLICKER. If the lamp does not flicker, adjust *R23*, using a screwdriver through the hole in the case. Turn *R23* until the lamp intensity varies from full brightness to darkness. Then increase the flicker level a little until the minimum lamp brightness reaches a very low intensity, but the lamp never entirely goes out. The Flicker Box is now adjusted for best operation.

To operate the Flicker Box, first plug in your lamp (do not exceed the dimmer rating). Then, with the dimmer on and *S1* in FLICKER, adjust the dimmer pot for the desired appearance. The higher background level produced when the dimmer knob is turned up (clockwise) will give you less flicker. In general, larger lamps should use more flicker and smaller lamps less. For a grotesque spooky effect, the dimmer level can be set very low.

Here are a few suggestions for using the Flicker Box. For low-wattage candelabra lamps, use minimum flicker. Start with the dimmer fully on and back off until the flicker is just noticeable. For electric fireplace logs, more flicker is needed. To further increase realism, use two or three Flicker Boxes connected to separate colored lamps hidden in the synthetic logs. This produces a "dancing flame" effect. To add flicker to Christmas-tree lights use a Flicker Box for each string of lights and intermingle lights from different sets to create a random display.

For a jack-o'lantern or other Halloween prop, a high flicker level will give the spookiest results. For an even scarier effect, try adjusting *R23* for darkness between flickers. Play with the dark/light ratio until you're satisfied with the results. In any application you can control the overall light intensity by your choice of lamp wattage.

Finally, to change from a flicker back to a steady glow, just flip *S1* to DIM and dial the desired brightness. Your lamp may look the way it used to but it will never be the same again. ◇

SOFTWARE FOR GRAPHIC PLOTTING

A look at the many programs available for driving computer printers to produce a variety of statistical presentations

By Stan Veit, Technical Editor

THE graphic presentation of statistics is among the most effective ways to show such information, especially if the statistics represent complicated business or scientific material. Since so much of statistical analysis nowadays results from computer programs, it's natural to use a computer to generate them in the form of graphs and charts. Equipment requirements to accomplish this are simple enough: a computer, an output device, and a plotting software package such as those to be described here.

Some type of program is obviously necessary to drive an output device to desired X-Y plotting points and to cause it to print points at those locations. This may be done with a BASIC, Pascal, or other high-level language, or even with an assembly language program. Most personal computers with memory-mapped video displays—Apple, Atari, Commodore, T.I. 99/4, TRS-80, and IBM-PC—have provisions in their operating systems to control placement of graphic symbols on the screen. Other computers, such as the North Star Advantage, use an extended form of CP/M that incorporates special graphic provisions.

Once the graphic image is completed on the screen, it can be sent to a printer through use of a screen graphics printing program. In the past, such plotting has been done with ordinary character printers. Here, the printer placed plot points on the paper, but the user had to fill in the connecting lines. With the development of point-graphic printers, it's possible to print complete graphs, bar charts, and pie charts.

Pen plotters are commonly used as graphics output devices. This type of machine has a pen or other marker that is moved to an X-Y point under control of the computer. The marking device is moved by a solenoid so that it either marks a point or draws a line. When the complete table of X-Y points is plotted, the graph, bar chart, or pie chart is complete. The plotter can also print labels for the X or Y axis and for the titles. The more sophisticated plotters have an ability to change colored pens during the plotting operation, resulting in a multi-colored image.

Plotting Software. To accomplish these complicated operations demands complex programming that is likely beyond the ability of the user who needs the charts. The software publishing industry has responded to this by providing "user friendly" software to allow one to plot graphics from electronic spreadsheets, financial modeling programs, or other statistical programs. These plotting programs supply the X-Y coordinates and the labels from a file obtained from an electronic spreadsheet or data base. They also can plot information supplied directly from the keyboard. In this case, the user answers groups of questions resulting in the formation of a table of plot points and identification labels.

For someone who is considering the purchase of a computer and has an especially strong requirement for business or scientific plotting, it is suggested that the machine and software be selected from among the memory-mapped types on the market. Computers using memory-mapped video are ideally suited for composing and displaying statistical graphics because their screen image represents a part of the computer's memory. Thus, what you see is what you get. Changing the contents of any location on the screen is therefore tantamount to changing the contents of the memory cell it represents. Combining this attribute with the color capability offered by many memory-mapped video computers makes for a very effective graphics tool.

The plotting-software packages to be discussed here are, with one exception, designed to run on computers with memory-mapped video, which includes the Apple II and III, the IBM-PC, the Atari 800, and TRS-80, among others. We'll lead off with the exception, which is designed to perform on terminal-operated CP/M systems.

Graftalk. This is an interactive "language" by Redding Group, Inc.

(distributed by Lifeboat Associates, 1651 Third Ave., New York, NY 10028) for statistical plotting that operates under CP/M. It therefore extends the capability of graphic plotting to a wide population of computers. To use Graftalk the microcomputer must be using either CP/M level 2, MP/M, or a compatible operating system such as SB80. The system must include a video terminal and a graphics printer or plotter. The plotting data is kept in data files that can be entered from the keyboard or derived from other programs such as Supercalc. Graftalk includes a powerful editor which the user can enter to compose plotting command files that can be saved on a disk and then run to plot graphs or charts. This is particularly important when the same set of graphs or charts is used with reports prepared each month or quarter.

With Graftalk, the user enters the editor and composes a file of tabular data from the keyboard or specifies a data file of tabular data previously set up. The user then specifies the output device which will produce the graph or chart. The CRT screen, the printer, or the plotter are the permitted output devices for this program.

Once the output device has been specified, the user can create a command file that describes parameters for the graph or chart. Normal X-Y axis line graphs can be plotted with one or more sets of data presented on the same graph. If the output device is equipped to operate in color, a full set of color selection commands are available for drawing the plot on a color screen, or selecting color pens for multi-color hard copy. The user can also select to plot a bar chart or a pie chart from similar input data. Graftalk permits the user to compose headings, axis labels, and floating labels anywhere in the drawing area. Where no color is available to differentiate between pie sections or bars, the user can select shadings or cross-hatch lines. Other commands permit the user to change the scale of the plot so it can fit into various documents.

The Redding Group has provided every capability that a statistical plotter requires to produce graphs and charts from CP/M-based data. The same company provides a non-interactive graph package, called Graflib, which consists of subroutines that are called from your own programs. With Graflib, functions of the routines are carried out only when you run your own programs into which they are incorporated.

Though Graftalk provides people who have terminal-operated systems with the same graphic capability that memory-mapped systems have long enjoyed, computers using memory-mapped video are still superior for any type of video graphics.

The following plotting software packages are for memory-mapped video computers. Though not inclusive, they represent the major ones for machines that readers are likely to use.

Superplot (Visigraph). This package has been in development for almost two years by the author, Ed Bryman. Written for the Apple III and IBM-PC computers, it has been considered to be the ultimate plotting package by those who have had the chance to test it. The reason that there are two names for this software is that Visicorp has acquired the rights to the package. It will sell it in an IBM-PC version as well as the Apple III version. We'll refer to it as Visigraph from here on.

Visigraph can take its input from either Visicalc or from the keyboard. The program shows a preview of the graph as the data is entered. The graph is then scaled according to the format selected by the operator. If the scale of the graph is not what is wanted, it can be changed under program command and the graph will be rescaled automatically to one of six selected formats. The user can then add labels to the axis or to any "floating" point in the graph area. In addition, different colors can be selected to represent various plots or labels. The entire file with all characteristics can then be saved for later printing or reproduction by a pen-plotter. Another feature of Visigraph is its ability to change from the common graph to a bar chart or pie chart using the same set of data. This is done at the command of the user in a completely interactive mode. The scale of the plot can also be changed at the same time that the graph is changed to another representational form.

There is another feature that exists in the development version of Superplot that may be deleted in the initial release of Visigraph. This is the formula mode of operation. In this mode, the user selects one of the plottable formulas and inserts the constants. The program can then plot the formula with the graph changing as the values are changed.

In all modes Visigraph is one of the new generation of "user friendly" software that will bring the advantages of programming to those who simply master operation of the machine.

Plotting with the IBM-PC. The advanced BASIC language used in the IBM-PC (BASICA) has many features that make defining plotting software much simpler than with other versions of BASIC. The CIRCLE command can be used for plotting points and to make pie charts. The color graphics capability enhances the graphs and statistical charts made possible with this computer. Several plotting programs for the IBM-PC are in the public domain and others have been published in various publications.

The IBM-PC Business and Technical Graphics Generator from Brady Software (Bowie, MD 20715) at $200 is a typical interactive software system for producing statistical graphics on the IBM-PC. It allows the user to create line graphs, bar charts, and pie charts as color or monochrome displays. Moreover, it utilizes the computer's programmable function keys to provide single-stroke commands for running the programs.

The Plotrax from Omicron Software Div. of Engineering-Science (57 Executive Park, South N.E., Atlanta, GA 30329) is a $97 machine-language program that provides screen plotting of line graphs and bar charts, and includes statistical analysis of mean, standard deviation, linear, and polynomial regression. It also includes matrix functions and solution of simultaneous equations in N unknowns. In addition to all this, it has a program to dump the screen to the Epson printer supplied with an IBM-PC system. For those who have other plotting software, Omnicron has its Transplot program for only $27. This program dumps the graphic image on the screen to an Epson printer equipped with Graftrax. The Omicron software even includes user-modifiable source code. These packages are a boon for the IBM-PC.

The foregoing are only a small portion of the programs that are either on the market or are soon to appear for the IBM-PC. In addition, graphic programs are included in several complete systems. For example, the Context MBA system includes a complete Business Graphic module that creates line, scatter, bar, or pie graphs from the spreadsheet data. Because of the unusual design of the Context MBA system, the graphs change automatically as the spreadsheet is updated.

Plotting for TRS-80 Computers. All of the TRS-80 computers have memory-mapped video and they are well equipped for plotting graphics. Radio Shack has provided Statistical Analysis and plotting software for the Models II, III, and 16 computers. In addition, it has both printers and pen plotters for use with its computers. Of particular interest are its new $250 four-color printer, a $240 smaller model that attaches to the TRS-80 Hand-Held Computer PC-2, and a $995 plotter/printer.

The new Graphics Option for $499 turns the Model II or 16 into a high-resolution graphics computer, which includes a special graphics BASIC with the option package. This version of BASIC incorporates commands to draw circles, arcs, or ellipses with one command. It can also draw the lines between plotting points with the LINE command, paint an area with a specified pattern or shading, and change the viewpoint of the image on the screen by using the VIEW and VIEWPORT commands. The graphics option provides a resolution of 640 by 240, giving 153,600 picture elements.

At the other end of the spectrum is the Radio Shack TRS-80 PC-2 handheld with the printer-plotter/cassette interface. This combination comes with a powerful Extended BASIC that includes plotting commands that provide a simple method of producing complex graphs and charts in four colors (256 by 4096 X,Y,Z-axis graphics). Though memory limitations preclude the development of interactive plotting programs for the hand-held computers, provisions in the Extended BASIC make them unnecessary.

In the middle, for Model IIIs, is a new Business Graphics Analysis package for pie, bar line, or scatter charts, with data manipulation and text editing, all for $175.

In addition to the software provided by Radio Shack there is a huge library of TRS-80 software available from third-party vendors. Space precludes a complete listing here, but the TRS-80 Applications Software Sourcebook sold by Radio Shack stores and Computer Centers lists most of it. It should be noted that, in addition to the software available under the TRSDOS operating system, CP/M software is also available for TRS-80 computers using that DOS.

Plotting Software for Apple II. The Apple II was the most popular early computer with color graphic capabilities. As a result, the quantity of plotting software for this machine exceeds all other systems. The powerful graphic functions in Apple DOS make graphic and plotting very easy to do with the Apple II, and the application software is very simple. Here are major plotting software packages for this machine.

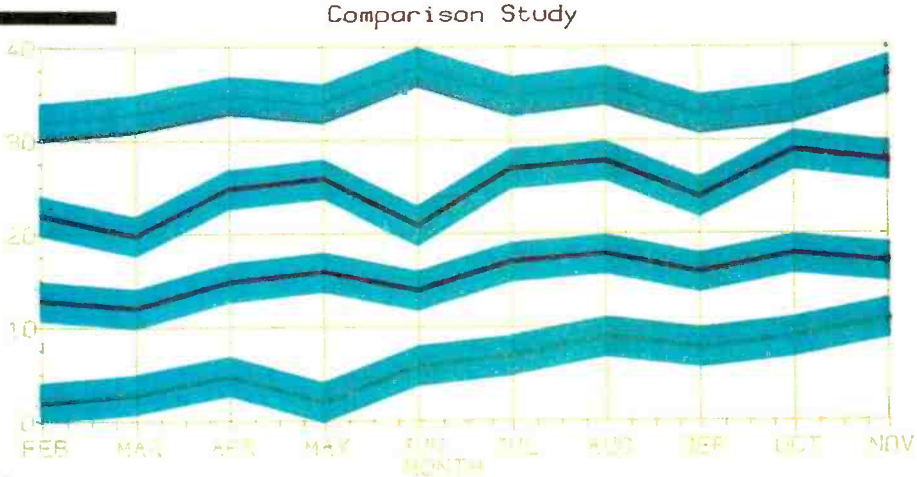
As can be seen from its name, VisiTrend/Plot is one of the family of programs that work in conjunction with the popular VisiCalc electronic spreadsheet. The plotting program requires an Apple II with 48K and at least one disk drive (two are recommended). As with VisiCalc, the more RAM memory available, the more effective the system becomes. It supports the Apple Silentype Printer and also the Epson MX-80/100 with Graftax printers, the Trendcomm 200, Centronics 739, NEC Spinwriter 5510, and the IDS 440,445,460/460G, 550/550G with Dotplot option. It will also support the new IDS Prism in the future. The plotting section of this program uses data derived from VisiCalc or directly for the keyboard. It automatically plots line graphs, area graphs, bar charts, pie charts, high/low charts, and X-Y plots. The system automatically scales its graphs from the data without complex instructions. Graphs can be overlayed for more than one data series. In fact up to 16 data series with a total of 645 data points can be held in memory. A single chart can contain 150 data points. Bar graphs can be split for side-by-side comparisons and a window command permits two graphs to be displayed at the same time.

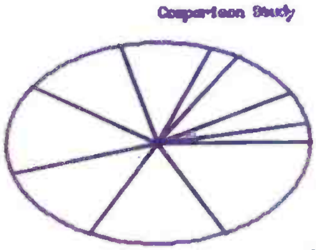
The statistical section of the package performs linear multiple regression with up to five independent variables. It projects the data into the future and forecasts trends, using cumulative totals, lead, lag, and percent change. It also does curve smoothing and moving averages.

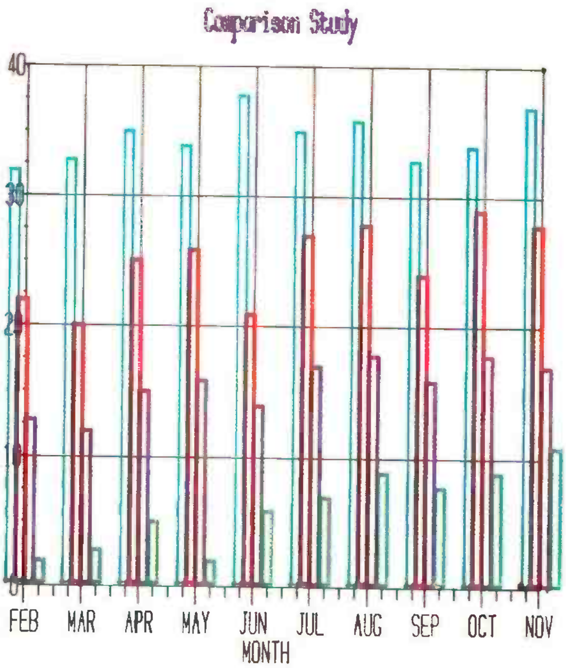
The VisiPlot plotting software package is also available without the VisiTrend capability. Both packages can also work with any data files prepared in the Data Interchange Format (DIF).

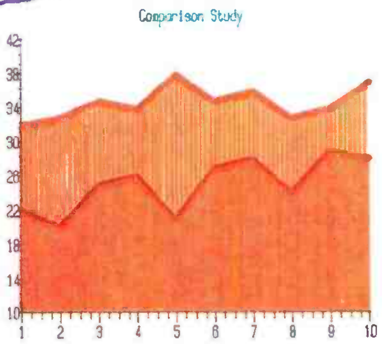
The Superplotter by Dickens Data Systems (478 Eagle Drive, Tucker, GA 30084) is a $70 package for the Apple II requiring at least 48K RAM and one disk drive. The Superplotter package is designed to serve the needs of the business and scientific community for an inexpensive all-inclusive plotting package. It generates all of the standard type of graphs: line, pie, bar, and point. It also plots mathematical functions and fits polynominal curves and graphic shapes input from the Apple keyboard. It includes a complete data file editor and comes with a tutorial for instruction in how to use the program. Menu driven, it's simple to learn and use.

Other packages for the Apple II computer are available to the user.









Four ways of presenting the same data using Superplot (Visigraph) on an Apple II or IBM-PC. Type of chart and colors can be selected after entering data.

The Hewlett-Packard pen plotter can be connected to a variety of computers to produce business and technical graphics on film or paper.

They all do more or less the same thing, with each having some unusual feature as a reason for existing. Apple Plot from Special Delivery Software, Apple Computer Co., is sold by Apple dealers for $70. Ultra Plot from AvantGarde Creations (PO Box 30160, Eugene, OR 97403) sells for $70. Graf-fit is $28 from Micro-Ware Dist. (PO Box 113, Pompton Plains, NJ) and Scientific Plotter costs $25 from Interactive Microware, State College, PA 18801. All of the above will do satisfactory statistical plotting.

Apple III Business Graphics. This package has been written by Business and Professional Software, Inc. (PO Box 11, Kendall Square Branch, Cambridge, MA 02142). It is distributed by Apple Computer as part of its Special Delivery Software program.

Apple III Business Graphics is a general graphics program that can take data entered by the user, store it, and create black-and-white or color statistical graphics from that data. In use, the operator enters simple commands and the coordinates of each plottable point for the horizontal axis and the vertical axis. On a color monitor, Apple III Business Graphics program displays plots in 16 colors. It provides eight distinct plot marks that can be used to differentiate multiple sets of points for plotting different graphs. The programs can draw line graphs with either solid lines or dotted lines. It can fill in the space beneath the lines to provide area plots. The program can also draw vertical or horizontal bar graphs in either single bar, side-by-side bars, or vertical stacked bars. The package can handle as many as four bars for each label and it can also overlay combinations of line, bar, and area plots to create complex graphic images. Detailed information can be displayed and points of importance can be highlighted. Apple III Business Graphics can also draw multicolored pie charts.

In any of the plot modes the user can specify the horizontal and vertical ranges to be used on any of the graphs or the software will automatically calculate the ranges from the data entered.

The data used by Apple III Business Graphics can be continuous or discrete as long as it is entered in the correct format, which is the value for the horizontal (X-axis) and then the value for the vertical (Y-axis), with a space between. These values can be either numbers or labels (alphanumeric). Data can also be supplied from VisiCalc or any other program that uses the Data Interchange Format (DIF). Once the data is entered it can be stored on the disk and modified or manipulated in many ways. For example, a set of data points can be divided by a constant or a new set of points can be generated in which each point is the sum of the preceding set of points (or the difference between them).

Apple Business Graphics can also perform statistical analysis on the data entered, such as calculating the mean, minimum, maximum, or standard deviation, variance, and sum. It can also fit any set of data points to any of five curve functions (a constant, a straight line, a logarithm, a parabola, or a sine function) and report automatically the error that the fitted curve represents. This is of great value in business forecasting because it enables the user to extend the plots past the most current data entered and to fit additional points representing the future plots. Apple III Business Graphics can also project trends into the future on the basis of exponential smoothing, or moving averages.

The software package can use either the Apple Silentype Printer as an output device, a Hewlett Packard 7225A/B plotter, or a Houston Instruments Hiplot plotter. It can also use a Qume Sprint 5/45, 5/55 daisy-wheel printer.

The North Star Advantage Graphics CP/M. The North Star Advantage computer has a memory-mapped video screen and it is specially designed to produce graphic images. To this end, the Advantage is supplied with an extended version of the CP/M operating system called Graphics CP/M. This version contains a Graphics Subsystem that inlcudes two sets of functions, geometric routines, and graphic support routines. The four geometric routines are called Polygon, Rectangle, Ellipse, and Special Line. They enable the user to draw points, lines, or special shapes. Additional commands provide for graphic support routines such as scrolling and screen clear. There are also provisions to produce patterns and shades of grey. North Star Advantage CP/M is not a specific plotting program, but it enables the programmer to incorporate plotting routines into a program. The Graftalk package can run on the North Star Advantage, but it works just as it would on any other CP/M-based system and does not interface with the special features of Graphic CP/M. The North Star Computer Co. is reported to be working on special graphics software that will use the special features in an interactive way.

Plotting with Hewlett-Packard Computers. The HP-80 series of computers is equipped to make use of the extensive line of pen-plotters manufactured by Hewlett-Packard. The HP BASIC used with these computers has built-in commands to make the generation of statistical plots very simple and to output them through the HP-IB (IEEE-488) bus to the plotter or printer. Plots can be derived from VisiCalc or generated from HP BASIC programs. In addition, HP-86 and HP-87 computers equipped to run CP/M can use Graftalk and other CP/M based plotting packages. The new HP-75 handheld computer also has graphing capabilities and can output to its own mini printer or be connected to a larger HP computer and from there to a plotter.

Plotting with Other Handhelds and Sinclair/Timex Computers. The Sharp-1500 handheld computer is identical to the Radio Shack Model PC-2 previously described, and it also has the Extended BASIC with plotting functions. The manual supplied with this computer contains extensive instructions in plotting with this machine. In addition, an Applications Manual is supplied

(Continued on page 92)

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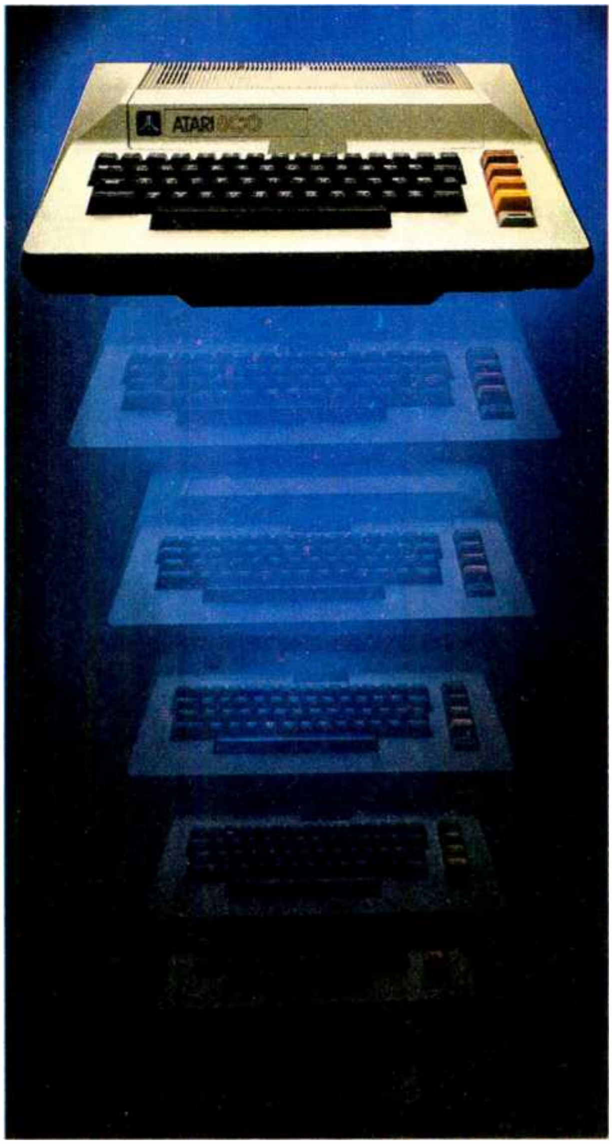

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CIRCLE NO. 24 ON FREE INFORMATION CARD

AUDIO VOLUME BOOSTER OVERCOMES OUTSIDE NOISE

Increases audio level when external noise is too high

By William Stamile

IF YOU live near a busy airport, highway, or railroad, you are very familiar with the problem of interrupted radio, TV, and audio system listening because external noise frequently overcomes the level of the program you want to hear.

The automatic audio augmenter described in this article constantly monitors external noise, and if that noise rises above a preset level, the augmenter raises the volume of the audio system to which it is connected. When the interfering noise subsides below a preset threshold, the augmenter returns the audio volume to normal.

Circuit Operation. As shown in Fig. 1, the external noise is picked up by a speaker mounted at a window or other location external to the listening area. The speaker is transformer-coupled to SENSITIVITY control *R1* for application to audio amplifier *IC1*. The amplified noise signal is coupled via *C2* and step-up transformer *T2* to a voltage doubler consisting of *C3, C4, D1,* and *D2* that converts the audio signal into a dc voltage. This voltage is stored in *C5*, which is constantly being discharged by *R2, R4,* and *R3.* DELAY control *R3* allows the discharge time to be adjusted. (The stored dc voltage can be measured at test point *TP1.)*

The dc voltage across *C5* is applied to the threshold and trigger (pins 6 and 2 respectively) of timer *IC2.* As a monostable, *IC2* is triggered by bringing the trigger input below a lower threshold (about 2 V). This makes pin 3 go high. When the trigger level rises above the upper TTL threshold, pin 3 goes low and remains low until the trigger level again drops below the 2-V threshold.

When pin 3 on *IC2* is high, transistor *Q1* conducts and closes the contacts of relay *K1*. This action applies a dc voltage, via *R7*, to the center connector of phone jack *J1*, whose outer shell is ground. When pin 3 goes low, *Q1* cuts off, *K1* is released, and the voltage is removed from *J1*.

A second part of the device—consisting of *LED2*, photo-sensitive

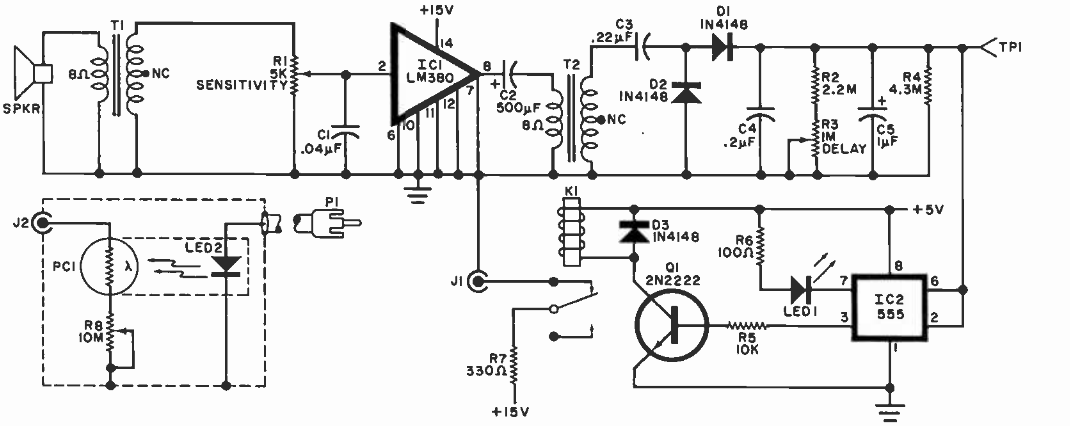


Fig. 1. Schematic of the circuit.

PARTS LIST

C1—0.04-μF capacitor
C2,C6—500-μF electrolytic
C3—0.22-μF capacitor
C4—0.2-μF capacitor
C5—1-μF tantalum capacitor
C7—220-μF electrolytic
D1,D2,D3—1N4148 diode
IC1—LM380 audio amplifier
IC2—555 timer
IC3—7815 15-V regulator
IC4—7805 5-V regulator
J1,J2—Phono jack
K1—5-V relay (Radio Shack 275-216 or similar)
LED1,LED2—Red light-emitting diode
P1,P2—Phono plug
PC1—Photoresistor, 5 megohms dark/100 ohms light (Radio Shack 276-116 or similar)
Q1—2N2222 transistor
R1—5000-ohm audio-taper potentiometer
R2—2.2-megohm resistor
R3—1-megohm trimmer potentiometer
R4—4.3-megohm resistor
R5—10,000-ohm resistor
R6—100-ohm resistor
R7—330-ohm resistor
R8—10-megohm potentiometer
RECT1—Bridge rectifier, 50 V, 1 A
SPKR—8-ohm speaker
T1,T2—Audio transformer, 1000 ohms CT/8 ohms (Radio Shack 273-1380 or similar)
T3—Transformer, 24 V, 10 VA
Misc.—Suitable enclosure (2), phono shielded cable, electrician's tape, mounting hardware, etc.

resistor *PC1*, and level-set potentiometer *R8*—is cable-connected via *P1* to *J1*. This part of the audio augmenter circuit is arranged so that when the LED is powered, its emitted light falls on the sensitive surface of *PC1*. When *PC1* is illuminated, its resistance decreases, and when it is in the dark, its resistance increases. This resistor, in series with *R8*, is connected across *J2*.

As shown in Fig. 2, a shielded cable is connected to *J2*, via *P2*, to the system volume control. The illustration shows how connections should be made to two of the most common types of volume-control circuits. Experiment with shielded/center-conductor wiring polarity to minimize hum pickup.

Thus, when no external noise is detected, *LED2* glows and a low-resistance shunt consisting of *PC1* and *R8* is connected across the system volume control. This causes the system volume level to assume a relatively low level that is set by the system control and the adjustment of *R8*.

But when an external noise is detected, *K1* opens to remove power from *LED2*. When this LED extinguishes, *PC1* reverts to its very high resistance state, thus removing the effect of the *PC1-R8* shunt from the system volume control. As a result, the system volume increases.

When the external noise ceases, the audio volume remains high until the dc voltage across *C5* is discharged. (This time period is determined by the setting of *R3*.) Once *C5* has discharged, *IC2*'s pin 3 goes high, causing *LED2* to glow and place the *PC1-R8* shunt back across the system volume control, reducing the audio to normal, preset levels. Note that when high volume (augmenting) is required, *LED1* glows.

The power supply required is conventional, and uses a bridge rectifier and 15- and 5-V regulators (Fig. 3).

Construction. Since layout is not critical, either perf-board or wire-wrap can be used, or a small pc board can be designed and fabricated. All components except the speaker, *LED2, PC1,* and *R8* can be installed on the selected circuit board.

LED2 and *PC1* are physically mounted so that the glowing face of the LED is adjacent to the sensitive surface of *PC1*. The two are then taped with dark electrician's tape to form an optoisolator in a light-tight package.

This optoisolator, together with *R8* and *J2*, is mounted within a small enclosure that can be cable-connected via *P1* to *J1* on the main electronics package. Everything else is mounted in an enclosure with the power supply. *LED1* should be mounted so that it is visible through the cover, and a dial plate should be used for SENSITIVITY control *R1*. The power cord can exit via a grommetted hole on the rear apron.

To test the system, connect an ohmmeter between the center and ring of *J2*. With the power off, there should be a very high resistance (many megohms) at this point. A few moments after the operating power has been turned on, this resistance should drop to a much lower value—which can be adjusted via *R8*. You may hear relay *K1* click as power is applied.

Now create a loud noise or tap the speaker and note that the resistance across *J2* goes up, and remains up for a brief interval after the noise ceases. The delay observed is determined by the setting of *R3*.

Use a schematic of your radio, TV, or audio system to determine where to attach the leads coming from *J2*, in accordance with Fig. 2. If you have a transformer-less "ac/dc" system, keep in mind that the system chassis may be "hot" with respect to the power line and ground. This can be a problem, since it could make the augment chassis potentially dangerous.

Measure for an ac voltage between the volume control and earth ground—it should be zero. If there is an ac voltage present, reverse the line cord plug at the wall socket and re-check for the ac voltage. It should be zero. If it is not, you cannot use the augmenter safely unless the audio system's power supply is modified to run off a transformer.

If reversing the wall plug results in a zero ac voltage between the system volume control and ground, make sure that this plug orientation cannot be tampered with, in the interests of user safety. This is very important.

Adjustment. The augmenter's speaker (SPKR) should be mounted at a window, or outside if possible, so that it will pick up external noise easily. Conventional speaker leads can be used to make the connection to *T1*. Locate the optoisolator close to the audio system being controlled, and connect it to the main augmenter circuits via a cable to *P1*.

With the augmenter connected and no noise present, turn on the audio system and set its volume to normal listening level. (This volume will now be determined by both the regular volume control and the setting of *R8*.) Now, when the augmenter detects noise, the system volume should automatically rise. Trial-and-error will determine the best location for the augmenter's speaker, the settings of the SENSITIVITY control and *R8* for increased volume, and the adjustment of *R3* for providing time delay. ◇

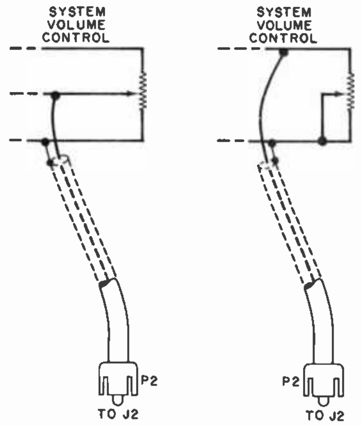


Fig. 2. Connect a shielded cable to the system volume control.

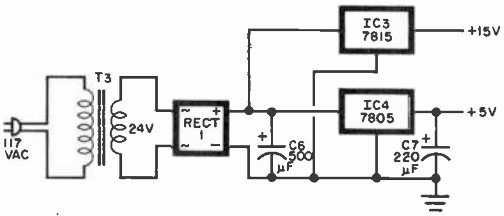
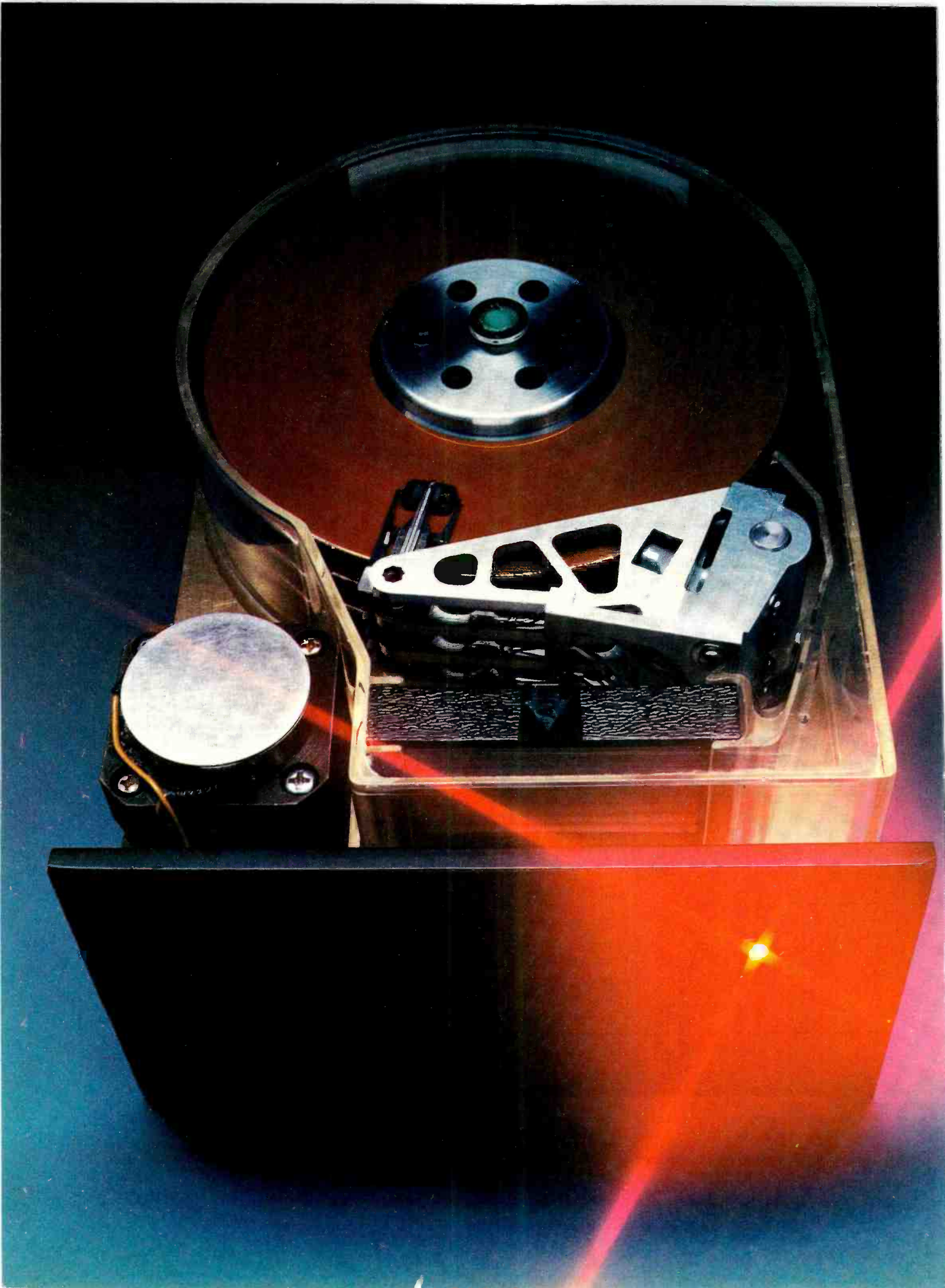


Fig. 3. Schematic of a suitable power supply.



MEMORY STORAGE THE MEGABYTE WAY

How hard disks operate and what's needed for backup and interfacing with small computers

By Stan Miastowski

THE Winchester hard disk drive is the most powerful data storage peripheral available for microcomputers. It may also be the most economical system if you're a serious computer user who handles large amounts of data and needs the kind of high-speed access to them that multiple floppy disk systems cannot provide.

What's a Winchester? At one time, hard disk systems were huge in size. In its evolution, IBM developed smaller rigid disk drives with one fixed and one removable disk pack. Each held about 30 megabytes of data, so the model was dubbed "3030's," which according to legend soon became "Winchester" (as in 30 cal. Winchester rifle). Although IBM abandoned the name, it's commonly used today to identify hard disk drives for small computer systems.

Most Winchester hard disks share the following characteristics: 1) the disk(s), read/write heads, and the mechanism for moving heads across the surface of the disk are enclosed in a sealed environment in which air is continuously filtered and circulated; 2) the disk(s) spin at high speed (normally 3600 rpm) and the read/write heads do not actually touch the surface of the disks; 3) since the heads must rest on the surface of the disk when the drive is turned off, the disk surface is lubricated; 4) there is a very thin magnetic coating on the disk(s); and 5) the media isn't removable (although this attribute is changing.)

Color photo courtesy Shugart Associates.

Winchesters owe their large storage capacity to a number of factors, including the thin magnetic coating mentioned above. The thinner the coating, the more data that can be stored on it. In addition, the magnetic heads that read the data actually "fly" over the surface of a disk on a cushion of air created by the enormous speed at which the platter rotates. It's the same as the "ground effect" created when the wings of an aircraft come close to ground level. Continuing the aircraft analogy, when the disk stops turning, the head ends up on a special area of the disk known as the "landing zone." The usual flying height for today's typical Winchester is about 1.5 microns—a height considerably smaller than the diameter of a speck of dust or particle of smoke. This flying height is related to the bit density of the disc—the lower the height, the higher the density.

Owing to the microscopic tolerances involved, Winchesters require a climate-controlled environment. Any particle that gets in the way of the head can cause a "head crash"—a condition where the head actually touches the surface of the platter while it is moving. When this happens, the entire disk often becomes useless. To eliminate this problem, the platters and heads of a Winchester drive are enclosed in a sealed environment, with microscopic air filters that continually recirculate air (Fig. 1). The drives are also assembled in "clean rooms."

Positioning the head so that it's exactly over a track every time is crucial. There are primarily two ways of doing this: stepper motors and voice-coil positioners. The former is the most common method. The stepper motors are used in one of two ways. In the first the motor is attached to a lead screw. As the stepper motor moves back and forth, the screw turns and moves the read/write head from track to track. The more common method is to attach the read/write heads to metal bands, which move back and forth with the stepper motor as shown in Fig. 2. Bands are subject to less wear than a lead screw.

Unlike a stepper motor, a voice-coil head positioner is a closed-loop system that actually tells the system where the heads are positioned. A voice-coil positioner uses a linear motor which moves smoothly throughout its range, but can stop at any track. Each track contains magnetically coded information that tells the controller where the head is positioned. The controller uses the information to move the head until the right track is found.

Although a voice-coil head positioner is more accurate than a stepper motor, it's considerably more expensive to manufacture and requires a sophisticated (and more expensive) controller. Also, because the magnetic position information is permanently encoded on the disk,

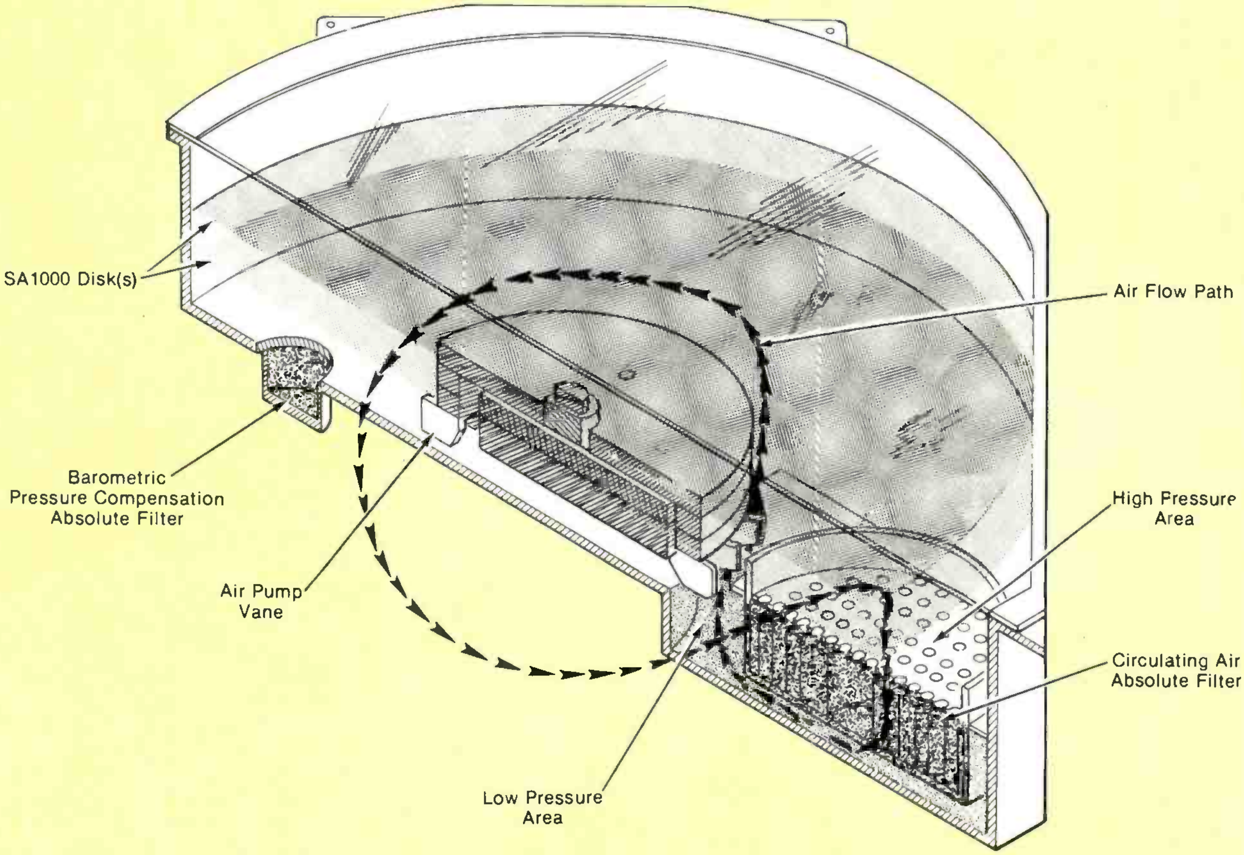


Fig. 1. Air flow diagram of the Shugart SA1000 8" fixed disk system.

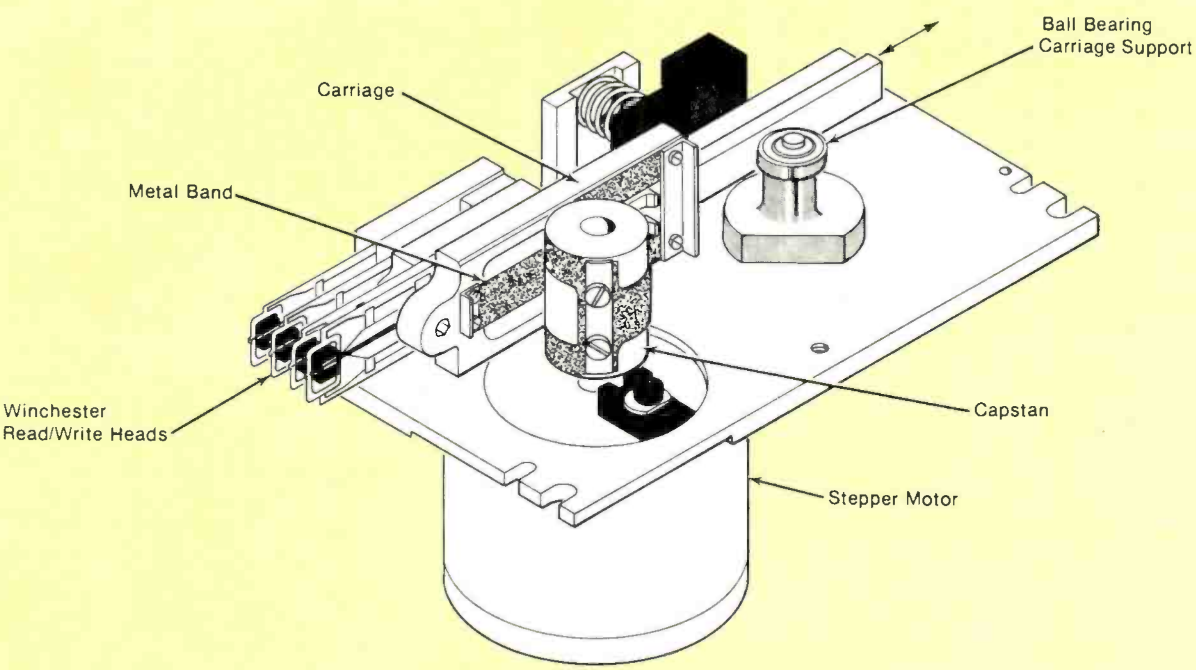
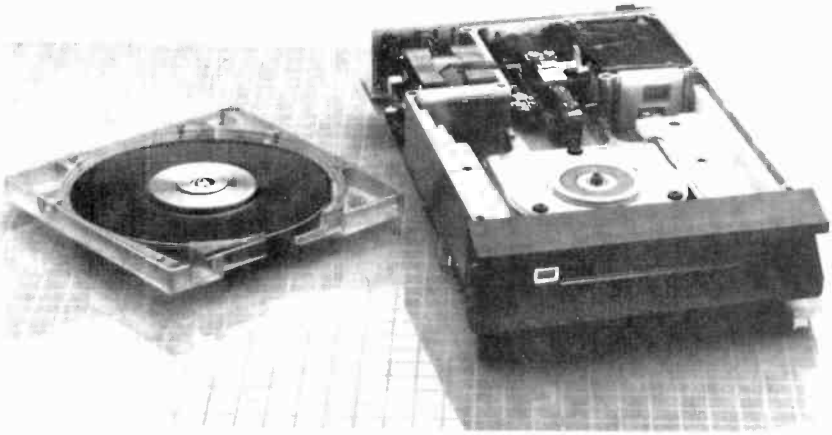
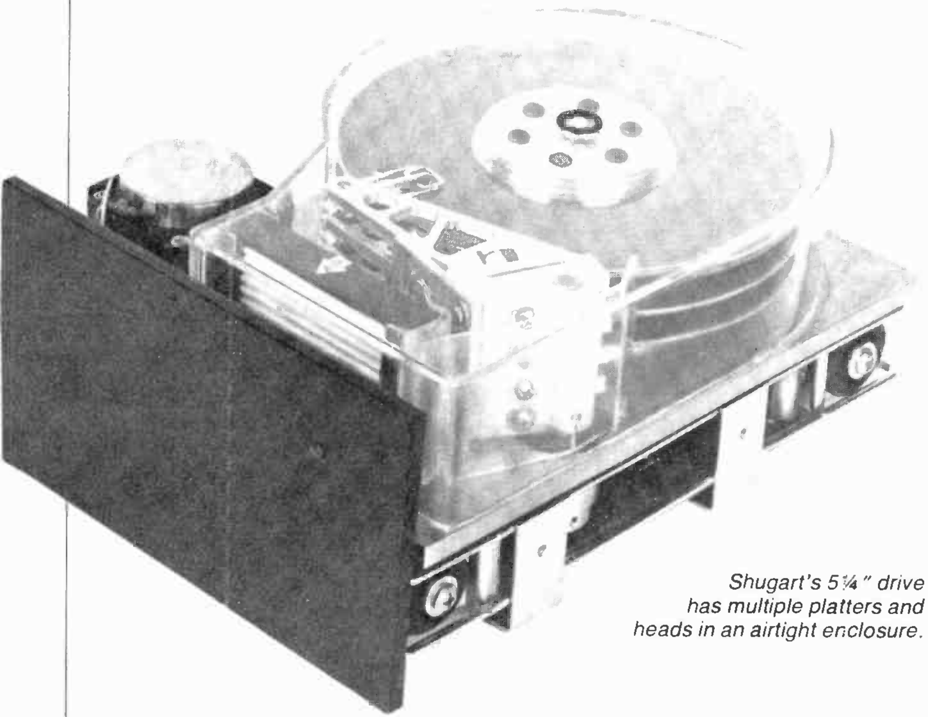


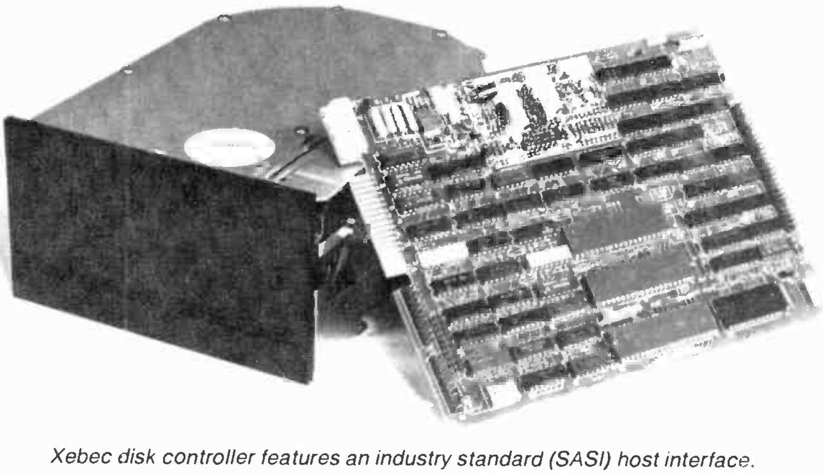
Fig. 2. Actuator assembly of the Shugart SA1000.



The Syquest SQ306 hard disk drive uses removable 3.9" cartridges.



Shugart's 5¼" drive has multiple platters and heads in an airtight enclosure.



Xebec disk controller features an industry standard (SASI) host interface.

it takes up storage space. You'll find voice-coil head positioners on some 8" hard disks, but few 5¼" disks—at least at present.

Why a Hard Disk? No matter what you use your personal computer for, it doesn't take long for the limitations of even floppy disk storage to become evident. Although floppy drives are relatively fast and storage capacity on a double-sided, double-density, 5¼" disk has increased to nearly a megabyte (one million characters), any serious personal computer user soon collects a shelf full of the disks and has to keep swapping back and forth among them. If you're a professional and must use your computer for handling very large amounts of data (such as a list of accounts), you may have to purchase additional drives to have all the information you need "on line" at the same time. Not only is it expensive, but most personal computers can't handle more than four floppy disk drives. On the other hand, a single 5¼" Winchester hard disk normally stores 5 megabytes, with 10-megabyte units (using multiple platters) common.

Hard disks have another selling point—speed. Because the read/write head of a floppy disk actually touches the disk surface and because of the friction of the "envelope" all floppies are enclosed in, there's a speed limitation of about 300 rpm. Winchesters, however, spin at 3600 rpm. The speed of the disk dramatically decreases the speed required to find a specific point on the disk—known as seek time. While a floppy disk's seek time is between 1/10 second and 1 second, most small Winchesters can find specific data between 25 and 75 ms. This speed, coupled with the increased bit packing density of the disk, means data is transferred ten to twenty times faster. Most Winchesters designed for personal computer applications can transfer data at 600,000 to 900,000 bytes per second resulting in greatly increased efficiency in disk-intensive operations.

Backing Up a Hard Disk. Nearly everyone who uses a personal computer keeps backup copies of their important programs and data in storage—usually on floppy disks. But backing up data on a Winchester is more of a problem because of the huge amounts involved.

Obviously, the most logical and least expensive way to back up Winchester data is to use floppy disks. The problem is that backing up all the data on a 5-megabyte Winchester can require changing disks as many as 20 times—a time-consuming and inconvenient process.

Floppy disks can be useful though, if you only back up part of the data, such as files you worked on that day. In that way, you can do a "rotating backup" where all the information on the Winchester is backed up every couple of weeks. One of the most popular backup devices, especially for Winchester users with large databases is the streaming tape drive. These drives use special tape cartridges and operate at relatively high speeds. They can copy a 10-megabyte disk in less than a minute. They copy data from the Winchester in a continuous stream, with no starting and stopping as each file is copied. Although streaming drives come in both ¼" and ½" varieties, the ½" variety is often as expensive as low-priced Winchesters. The ¼" variety is still expensive though, costing about $1200. Individual tape cartridges cost only a couple of dollars, and hold over 20 megabytes of data.

Another backup method is to use a second Winchester drive. However, tying up several thousand dollars just to keep a backup of data isn't economical for most personal computer users. A developing trend is hard disk drives with removable media. SyQuest Technology (Fremont, CA) is offering a hard disk drive that has 3.9" removable cartridges. Each cartridge holds about seven megabytes and costs about $85. At $2995 (plus another $100 to $250 for a system adapter for your computer), the SyQuest SQ 306 isn't the lowest cost hard disk around. But it's attractive for those who absolutely need a convenient way to keep backup data.

Another manufacturer, DMA Systems Corp. (Santa Monica, CA) is also going the removable media route. The company has just started to ship the Micro Magnum 5, a 5¼" hard disk drive with removable cartridges. Although no final price has been set (the company is presently shipping to OEMs only), the drive is expected to cost $3000 to $4000, with each five-megabyte cartridge selling for about $200. DMA is also offering the Micro-Magnum 5/5 disk drive. It contains two five-megabyte disks, one fixed, the other removable. It's an excellent approach to backup, although a throwback to the first hard disks for large systems. The 5/5 is expected to retail in the $3500 to $4500 range, and will use the same cartridges as the Micro Magnum 5.

There are some other rather novel approaches to backing up data on a Winchester. For instance, Corvus Systems Inc. (San Jose, CA), one of the largest marketers of hard disk systems for personal computers, has a system called the Mirror™. It consists of an interface card that hooks up to any video cassette recorder. It's a relatively inexpensive way to back up your Winchesters, but there's some concern about the long-term reliability of data recorded on video tape.

WINCHESTER SOURCES

If you're ready to buy a hard disk for your personal computer, the best place to start is with the company you purchased your computer from. Most companies including Apple, Commodore, Heath/Zenith, Radio Shack, and others offer some hard disk systems, although usually not for all models.

There are a number of companies that market ready-to-plug-in-and-run hard disk systems for most popular personal computers. Listed below are a few.

Corvus Systems, Inc.
2029 O'Toole Ave.
San Jose, CA 95131
408-946-7700
One of the largest integrators of hard disk systems for personal computers, Corvus offers 6-, 11-, and 20-megabyte systems for almost all popular computer systems. Prices start at about $3000.

Data Peripherals
965 Stewart Dr.
Sunnyvale, CA 94086
408-745-6500
The Lynx 8", 10.6 megabytes, with removable media is $5300 with Apple II interface.

Laredo Systems
2264 Calle deLuna
Santa Clara, CA 95050
800-538-5137 [orders]
408-980-1888 [technical help]
LS525 5¼", 5 megabyte is $1995. TRS-80 host adapter is $250.

Percom Data Company, Inc.
11220 Pagemill Rd.
Dallas, TX 75243
214-340-7081
PHD 5¼" 5 and 10-megabyte systems start at $2495. Direct interface to the TRS-80 Model III, Apple II, Heath/Zenith 89, and IBM Personal Computer.

SyQuest Technology
44160 Warm Springs Blvd.
Fremont, CA 94538
415-490-7511
The SQ306 with 3.9" removable media, 5 megabytes is $2995. Host adapters are available for most personal computers. Prices range from $99 to $300.

United Peripherals
432 Lakeside Dr.
Sunnyvale, CA 94086
The UP-9800 is 5-¼" 5 megabytes for HP and IEEE-488 interface and UP-9705 is 5¼" 5 megabytes, both $2995. Host adapter for Apple II $99; S-100 $149; IBM $149; Q-bus $299; Multibus $179.

Xebec
432 Lakeside Dr.
Sunnyvale, CA 94086
408-735-1340
Complete 5 megabyte semi-kit for most personal computers is $1299.

Finally, if you're interested in designing your own system, the following "big three" companies are the largest manufacturers of hard disk drives and interfaces. Contact them for technical information.

Seagate Technology
360 El Pueblo Rd.
Scotts Valley, CA 95066
408-438-6550

Shugart Associates
475 Oakmead Parkway
Sunnyvale, CA
408-733-0100

Tandon Corp.
20320 Prairie St.
Chatsworth, CA 91311
213-993-6644

Hooking Up a Hard Disk. In the past, hooking up a Winchester hard disk drive to your computer was a long and involved exercise that required intimate hardware and software knowledge and the patience of Job. Thankfully, most of today's Winchesters are specifically designed for a particular microcomputer system—plug in a board, turn on the power, and off you go. Interfacing has become simple because of standard controllers and host adapters.

As many of us tend to forget in the era of "plug-in-and-go" systems, moving data from your computer to the disk surface and back again is a sophisticated process. In today's most commonly used method, data flows from the computer through an interface, to the controller, and then to the disk.

The interface between the controller and the host computer is called a host adapter. It's specific to your computer system and plugs directly into the computer bus (for example, S-100, IBM-PC, TRS-80, etc.). Through the host adapter, the host computer "sees" the hard disk as just another logical device like a floppy disk. All that the host computer need do is send the interface a read or write address and the number of blocks to be read or written.

Host adapters are comparatively simple devices consisting of an 8-bit bi-directional data-bus and appropriate control signals adapted to your computer system's bus configuration. Because these adapters allow manufacturers to use identical controllers for different computer systems, they've become the most popular method of interfacing a computer and Winchester hard disk. A number of companies have entered the hard disk "sweepstakes" in the past couple of years and, consequently, there are several "standard" host/controller interfaces. Two of the most popular are the SASI (Shugart Associates System Interface) and Seagate Technology's ST506/406.

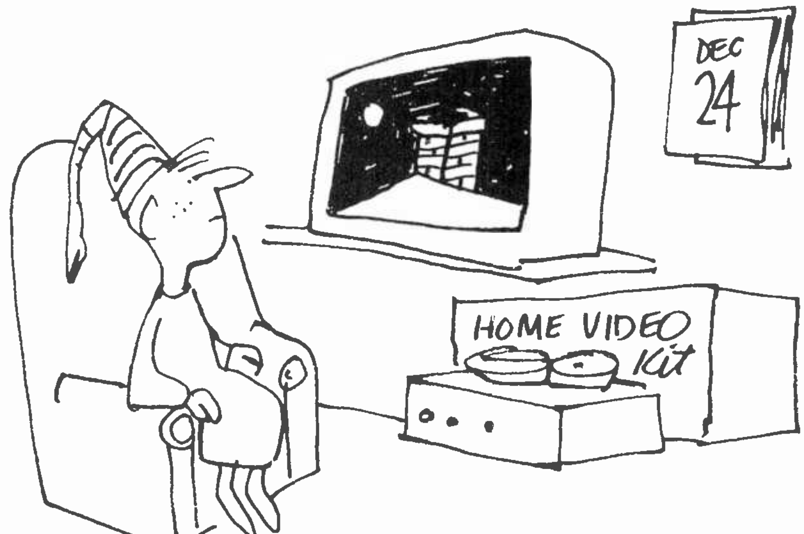
The heart of a hard disk system is the controller. It connects between the host adapter and the drive. Today's intelligent controllers, such as the Western Digital WD1000 and the Shugart SA1400, make the disk completely transparent to the host computer and perform formatting, head positioning, data I/O, error checking and correction, and other necessary "housekeeping" tasks. The controller coupled with DMA (direct memory access), which allows data to be swapped from RAM to disk and back without any intervention from the host processor, vastly increases system throughput.

A "Typical" intelligent controller includes a microprocessor, line drivers and receivers, input/output buffers, and control software in ROM. Today's sophisticated intelligent controllers are versatile, too. For example, Shugart's SA1400 is based on an advanced bit-slice microprocessor and can control up to five devices, including any combination of hard disk drives (5¼", 8", or 14"), floppy disk drives (5¼" or 8"), and streaming tape drives.

Such versatility doesn't come cheap. In fact, the cost of the actual drives has become a small part of the cost of the plug-in hard disk controller. Controllers are sophisticated, and the many components needed to build one keep their price from falling as fast as other peripherals. (For example, Shugart's SA1400 contains some 150 ICs.) A typical controller costs the manufacturer $500 to $1000. But this may change very soon. Earlier this year, National Semiconductor announced a 4-chip hard disk controller. This breakthrough should result in less expensive controllers and, thus, Winchester systems in the future.

What Should You Buy? The largest manufacturers of Winchester drives sell most of their output on an OEM (original equipment manufacturer) basis, with the OEM adapting the controller to a particular system. Numerous companies offer complete systems that are ready to plug in and run. Although it may cost a bit more than "rolling your own," buying a Winchester with a controller specifically set up for your particular personal computer system is generally the best way to go.

Summary. Even though they've just recently become economical for personal computer users, Winchester hard disks are fast becoming popular peripherals. Besides their storage capability, speed, and convenience, one of their greatest drawing cards is cost. When looked at on a cost-per-byte basis, a Winchester can be as much as five times less expensive than multiple floppy disk drives. And prices are falling rapidly, too. As this was written, Xebec (Sunnyvale, CA) was offering a complete ready-to-plug-in-and-run 5-megabyte system for just $1299. There is little doubt that we can expect to see more and more hard disk drives used with sophisticated microcomputer systems. ◇



Carpenter's De"Light"

An ultra-simple circuit replaces the handyman's level

By Arthur Plevy

YOU'VE probably used a carpenter's level and know that when the "bubble" is between the appropriate lines the surface is level. But how often have you strained to "read" it when lighting was poor?

The electronic level presented here eliminates this problem by using two LED indicators instead of an air bubble. (It also makes a delightful paperweight conversation piece.) If the surface is tilted to the right, one LED lights; if it's tilted to the left, the other LED lights. When the surface is level, both LEDs light.

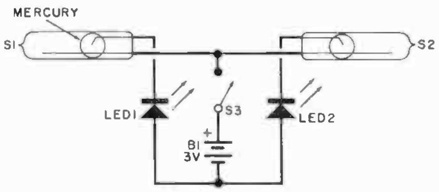
Circuit Operation. The heart of the unit consists of two unidirectional mercury switches *S1* and *S2*. The unidirectional mercury switch has one long electrode and one short, angled electrode. The pool of mercury "rides" on the long electrode and makes contact between the two electrodes if the unit is held in a horizontal position.

Mercury switch *S1* turns *LED1* on and off, while *S2* does the same for *LED2*. The long terminals of switches *S1* and *S2* are connected together, while the short terminals of each switch are connected to their respective LEDs. The anodes of each LED are connected together and to the negative terminal of the battery. An on/off switch is connected between the battery and the long electrodes.

To operate the unit, turn switch *S3* on. If the unit is tilted to the right (left side higher than the right side) the left LED will light and the right LED will be off. If the unit is tilted to the left (right side higher than the left), the right LED will light and the left will be off. If the surface is horizontal, both LEDs will light.

LEDs do not have to be used. They may be replaced by any other indicator devices.

Construction. Any type of housing can be used for the level. The prototype was assembled in a plastic housing. To align the unit, use a regular carpenter's level to determine that a surface is horizontal. Position the mercury switches in the housing by using a double-backed tape so that they can be easily adjusted.



The heart of the circuit is the two mercury switches controlling two LEDs.

PARTS LIST

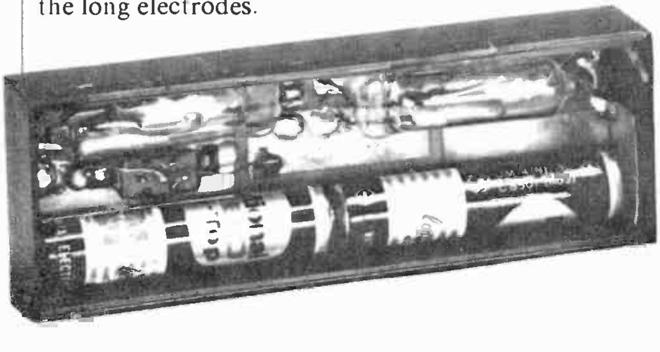
B1—Two 1.5-V, AAA batteries
LED1, LED2—Red light emitting diode (Motorola 4303F1 or similar)
S1,S2—Mercury switch (Comus CH03-0 or similar)
S3—Spst miniature switch

Note: Mercury switches are available from New Ventures, P.O. Box 38 East Brunswick, NJ 08816 for $3.00 each. New Jersey residents, add 5% sales tax.

Connect the electrodes of the switches as shown in the schematic. The LEDs are the high-intensity type that will illuminate using a 3-V battery (two 1.5-V cells in series). With the housing on the horizontal surface, adjust the switches so that the mercury is just in contact with both electrodes. In this position both LEDs will light.

The mercury switches can now be permanently secured in place by means of a super glue or any other adhesive desired. In the prototype, the switches were embedded in silastic to protect them. The on/off switch can be any type of inexpensive switch.

The concept of the electronic level is extremely simple. If an accurate adjustment is made in positioning the mercury switches, one can measure deviations from the horizontal of less than 1 degree. If the housing is lengthened and the mercury switches placed further apart, greater accuracy can be achieved. In the unit shown, the housing is approximately 3.5 in. long. A printed circuit board was used to allow easy construction, but this is not necessary as the wiring is not critical. ◇



GENERATING SQUARE WAVES WITH ANY FREQUENCY AND DUTY CYCLE

By Mark McWilliams

EXPERIMENTERS often need to generate square waves for test circuits and other applications. A simple way to do this is with a 555-timer IC operating in the astable mode. Most manufacturers' spec sheets include graphs to help you choose the resistor values needed to obtain a desired frequency with a given capacitance. The only drawback of this method is that you can't maintain control over the duty cycle of the square wave. This article presents simple formulas and plots for selecting resistor values to control both frequency and duty cycle.

Figure 1 shows the circuit commonly used to produce a 555 astable waveform such as that shown in Fig. 2. In Fig. 1, the output voltage at pin 3 will be high or *on* during the charging of capacitor *C* through R_A and R_B. The output will be low or *off* or near ground potential during the discharging cycle. The *on* time is designated as T_1

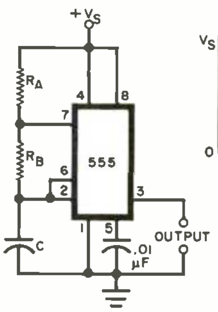


Fig. 1. Standard 555 square-wave generator.

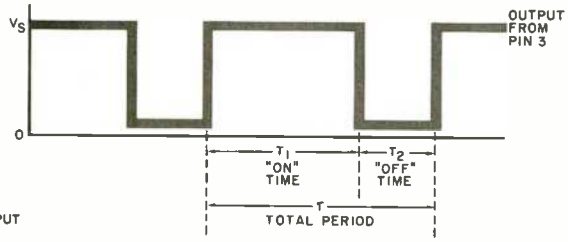


Fig. 2. Output of the circuit in Fig. 1, with characteristics defined.

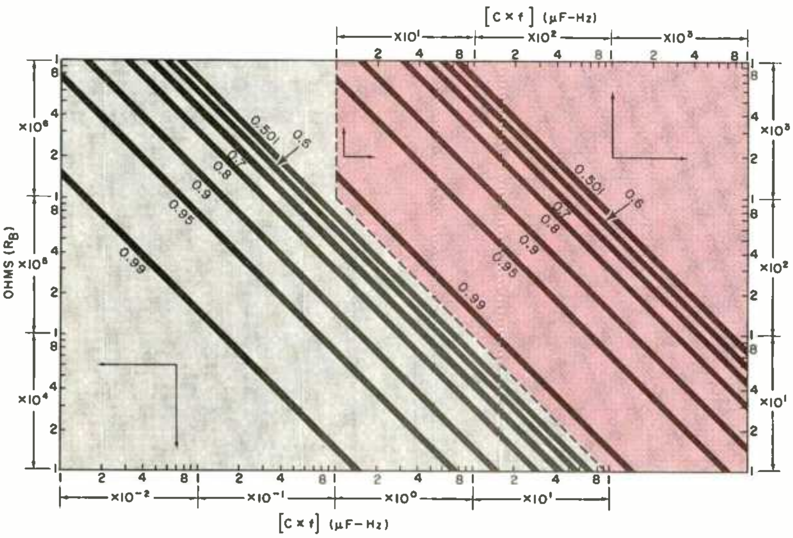


Fig. 3. Plot of $C \times f$ vs. R_B, which can be used with Fig. 4 to determine circuit values.

Examples:

(1) *Given:* f = 1000 Hz, C = 0.1 μF, D = 0.7
Solution: $C \times f = 10^2$ μF-Hz;
from equation (B) or Fig. 3,
R_B = 4.3 kΩ;
from equation (A) or Fig. 4,
R_A/R_B = 1.333;
therefore: R_A = (1.333)(4.3 kΩ) = 5.73 kΩ

(2) *Given:* f = 50,000 Hz, *C* = 100 pF, D = 0.51
Solution: $C \times f$ = 5 μF-Hz;
from equation (B) or Fig. 3,
R_B = 141 kΩ;
from equation (A) or Fig. 4,
R_A/R_B = 0.041;
therefore; R_A = (0.041)(141 kΩ) = 5.78 kΩ

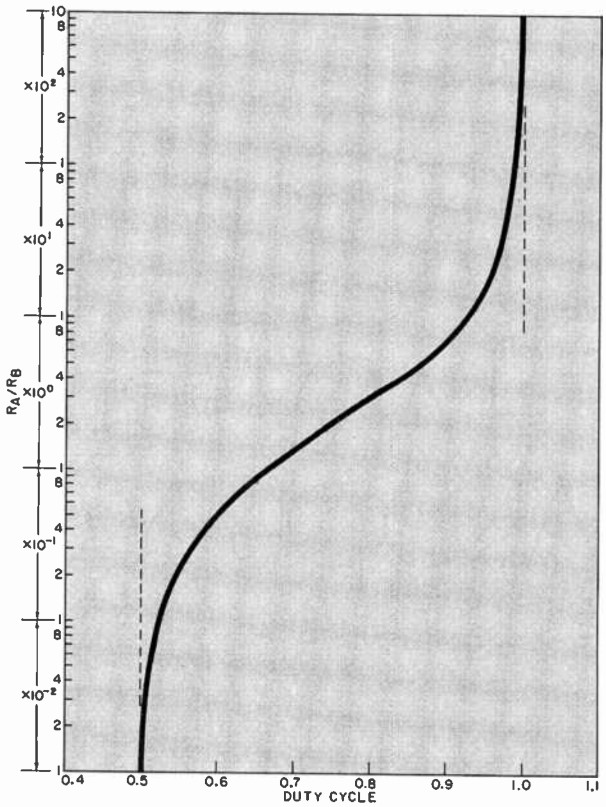


Fig. 4. Duty cycle vs. resistance ratio R_A/R_B based on Eq. (A).

in Fig. 2, and the *off* time as T_2. The total period is thus $T = T_1 + T_2$. The frequency of oscillation is $f = 1/T$.

The *on* time is given by

$$T_1 = 0.693\,(R_A + R_B)C$$

The *off* time is

$$T_2 = 0.693\,R_BC$$

Thus

$$f = 1/(T_1 + T_2) = 1.443/(R_A + 2R_B)C$$

If we define duty cycle as the ratio of the *on* time to the total period, then $D = T_1/T = T_1/(T_1 + T_2)$. Some algebraic manipulation results in two very simple formulas:

$$R_A/R_B = (2D - 1)/(1 - D) \quad \text{(A)}$$

$$R_B = 1.443\,(1 - D)/Cf \quad \text{(B)}$$

where f is in Hz, R_B and R_A are in ohms, C is in farads, and $0.5 < D < 1$.

Note that, given a particular capacitor, one can quickly calculate the R_A and R_B values necessary to achieve a desired frequency *and* a desired duty cycle.

These two equations are presented graphically in Fig. 3 and Fig. 4. For convenience in plotting, C and f were combined to form one variable, $C \times f$. In the plots, the units of $C \times f$ are (μF - Hz) and R_B is in ohms.

Of course, equations A and B give more accurate answers than the plots but the extra decimal places are meaningless if wide-tolerance capacitors are used.

If a duty cycle of *exactly* 0.5000 must be produced, it can be done by connecting the timer output at pin 3 to the clock input of a J-K flip-flop. The output of the flip-flop will be a perfectly symmetrical square wave at half the frequency of the timer output. This configuration is shown in Fig. 5 and is independent of the value of R_A and R_B. ◇

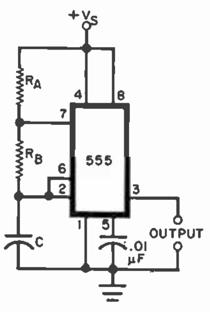


Fig. 5. Use this circuit for a duty cycle of 0.5000.

The Optimized GRAPHIC EQUALIZER

Part 1—New design approach provides sharper frequency control in the all-important audio midband

By Joe Gorin

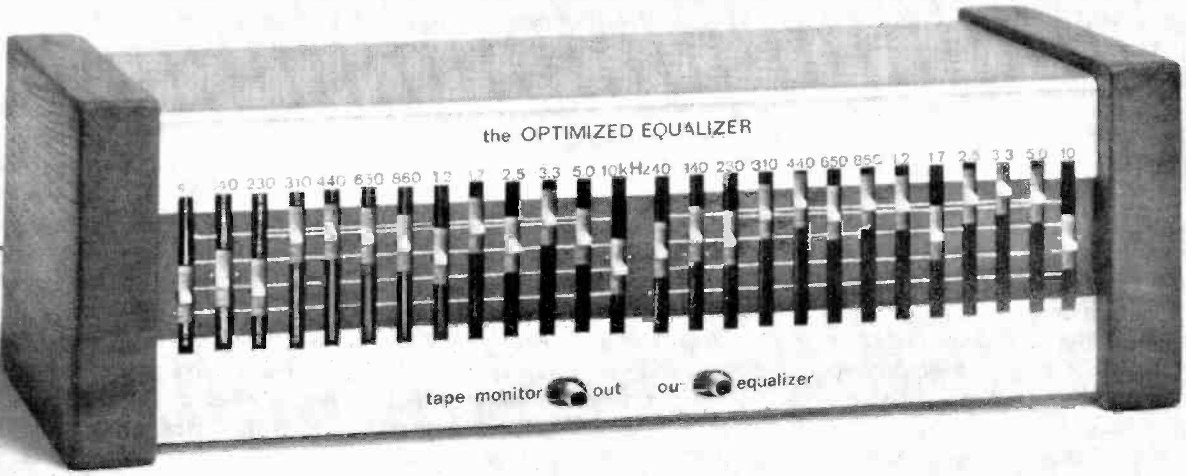
GRAPHIC equalizers are popular audio accessories nowadays. They enable hi-fi buffs to adjust the frequency response of a stereo system to compensate for loudspeaker errors, room acoustic problems, and unsuitably balanced recordings and broadcasts. In essence, they are super tone controls that allow one to change small portions of the audio spectrum.

The 10-band graphic equalizer is the most popular type for home use. But a new design gives improved performance at low cost. It's called the Optimized Graphic Equalizer. Now, instead of equalizing one-octave bands, half-octave control is available for the ten important midrange bands. Although bass and treble suffer somewhat (there are just three controls for these), the overall design allows for better control of frequency response. Additionally, an optional real-time analyzer can be incorporated into the circuit for equalization setup.

Design of the Equalizer. Human hearing is relatively insensitive to frequency response errors of less than ⅓ of an octave (called the "critical bandwidth"). This is why professional equalizers have 24 to 31 bands at approximately ⅓-octave spacings. But the critical bandwidth is actually narrower in the midrange than in the bass or high treble. Also, because the vast amount of musical information occurs in the midrange, this is the most important area for high-resolution (close band spacing) equalization. Normally, equalizers designed for home use have 1-octave spacings. In order to create an economical, but very effective equalizer, the Optimized Equalizer uses ½-octave spacing of bands in the midrange (for five octaves), a relatively wide band in the treble range, and two in the bass.

The most important function of an equalizer is the taming of two kinds of resonances—those with gain and those with loss. But a giant "hole" in the frequency response of a system (for example, a −20-dB "suckout" in a typical second-order speaker crossover) is practically inaudible. This is because the information in a narrow notch is small and masked by nearby signals. Furthermore, it isn't feasible to equalize a narrow notch. Practically speaking, you can't set the frequency and bandwidth close enough, and the phase relationships of the notch are so poorly controlled that, even if the frequency response were right, the actual signal waveforms wouldn't sound right.

On the other hand, resonances that boost the frequency response are painfully obvious to the listener. A +3-dB resonance adds more signal to a system than a −20-dB notch removes, and since it is an error of commission rather than omission, it "pops out" at you. Also, the sound from such a reso-



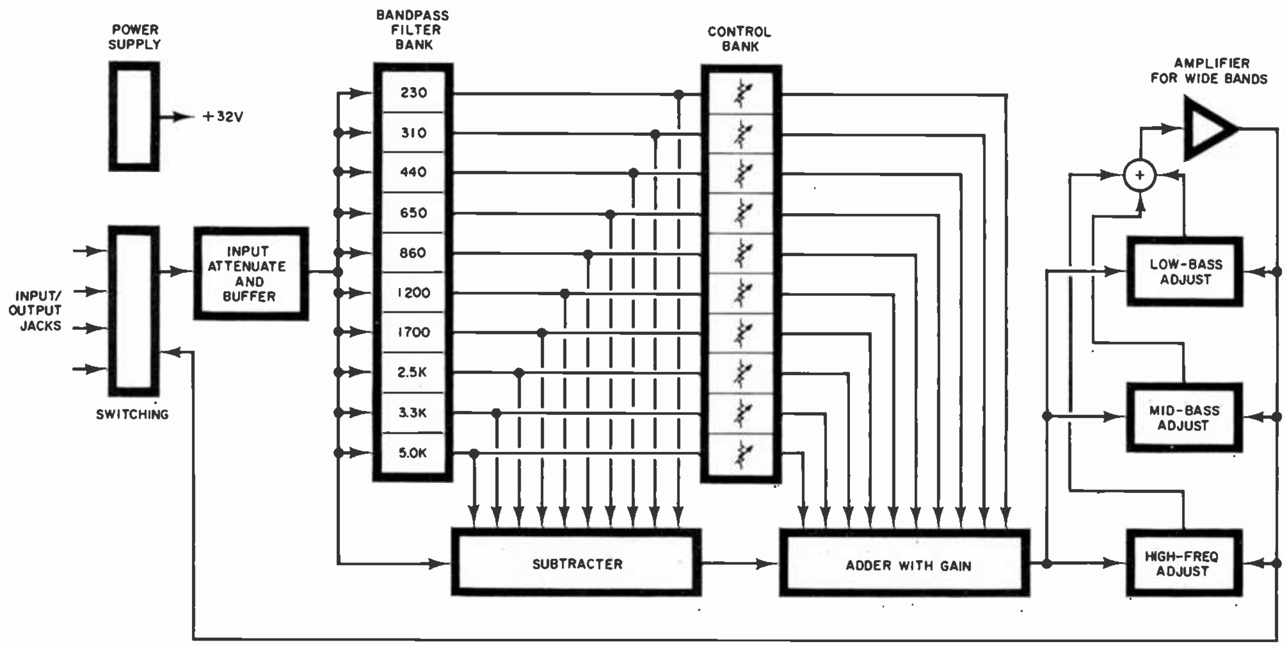


Fig. 1. Block diagram of the Equalizer. Midband frequency selection is made by filter bank.

nance continues in the room long after the signal to the loudspeaker has stopped. An equalizer eliminates this problem, even if it isn't "right on" the frequency of the resonance, by reducing the energy that drives it.

Thus, it's more important for an equalizer to cut signals than to boost them. We chose to allow only +3 dB of boost in the midrange bands, but a full 12 dB of cut. This is enough range to tame the worst resonances.

The bottom bass band of the Optimized Equalizer is just the opposite in range. It goes from −3 dB to +12 dB, with the hinge frequency of the band moving higher with more boost. This band is thus optimized to improve the bottom useful octave of home loudspeaker response, usually stretching it from 45 to 65 Hz downward.

The mid-range band is placed at about 140 Hz in the Optimized Equalizer. This covers the space between the other bands and coincides with the typical midbass hump (the one that helps speakers sell so well in the hi-fi stores). Most persons will need to reduce the gain slightly at this frequency for improved accuracy, but a full ±8 dB is allowed because boosting this band can be fun, even if it is unrealistic.

The treble band covers the range above the last midrange band. Because of the large variations in loudspeakers and recorded material, ±10 dB is allowed on this band.

Circuit Operation. Figure 1 is a block diagram of the Optimized Equalizer. The midband frequency selection is done by the filter bank. Since the filters have gain, the signal is attenuated at the input. This prevents even the largest signals at the tape monitor terminals of your amplifier from causing clipping of the filters. By subtracting three-quarters of the signal using the filter outputs, the result is a gain of −12 dB at the filter center frequency. Next, a variable amount of the filter output is added back to the signal. When the control is set to 0 dB, the added signal cancels the subtracted signal exactly for flat frequency response.

An important point about this block diagram is that the arrangement of the input attenuator and filter bank is exactly that required for a real-time analyzer (which will be discussed next month).

The signal from the adder (which has gain to make up for the input attenuator) goes to a three-band circuit that is similar to those found in preamplifiers. The controls adjust the amount of feedback, and thus gain, in a particular frequency region.

Figure 2 is the complete schematic for the Optimized Equalizer. The power supply is a full-wave bridge rectifier (*D201-D204)* with a wall-plug transformer. The use of a remote transformer obviates the need for coaxial cables (without the penalty of hum pickup). Power to *IC2-IC6* is unregulated because the power-supply noise rejection of these ICs is so good that hum pickup is trivial. However, power to *IC1* and *IC7* is passed through an RC filter to reduce hum by 18 dB because the circuits that use these two ICs are more sensitive to supply noise.

Resistors *R202-R204* and capacitors *C203* and *C204* bias the ICs at 15 V. This double filter reduces the hum from the power supply to about 1 μV. The circuit could not be any quieter even with dual, fully regulated, power supplies (which would be much more expensive than the single supply used here).

Resistors *R1* and *R2* form the input attenuator. Capacitor *C1* reduces the attenuation at high frequencies where the filter bank

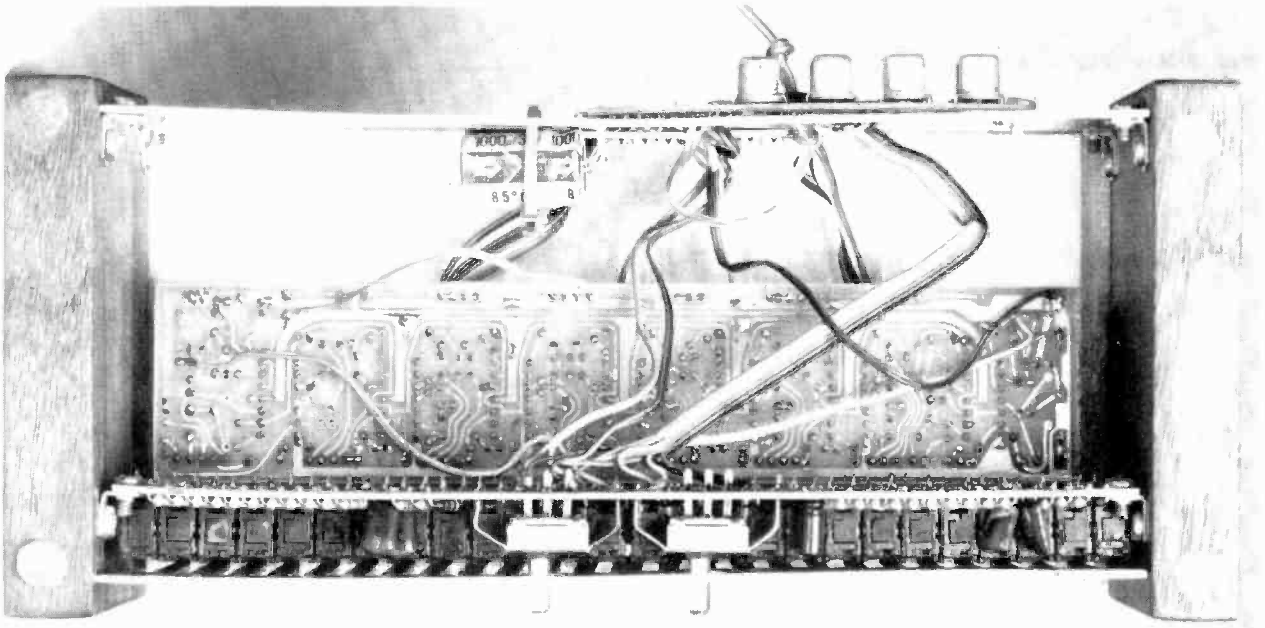


Photo of the author's prototype showing internal arrangement of the boards.

cannot clip because the filters have low gain. Reducing the attenuation here allows the reduction of the gain, and thus noise, later on. Capacitor *C2* couples the attenuated signal to *IC1A*, a gain-of-one stage that presents a high input impedance, but can drive the low impedance of the filter bank.

Op amps *IC2A* through *IC4B* are ten parallel filters. All have a bridged-T configuration. Let's examine *IC2A* as an example. At low frequencies, the input signal from *R22* is blocked from *IC2A* by the high impedance of *C22*. At frequencies much higher than the filter's center frequency, the low impedance of *C21* bypasses the signal from *R22* into the low output impedance of *IC2A*, preventing its amplification. At the center frequency, though, the stage has a high gain. The signal from *R22* is coupled through *C22* to be amplified and inverted by *IC2A*. The output of *IC2A* is coupled back through *C21*. Due to the phase shift of the capacitor circuits and the op amp's inversion, this feedback signal is in phase with the direct signal. Resistor *R23* controls the gain and positive feedback.

The signals from *R55* and the even-numbered resistors, *R34* through *R52*, are added at the input to *IC1D*. The filter outputs are all inverted at their center frequencies, which forms the subtractor in the block diagram. Controls *R24* through *R33* adjust the amount of signal added back in *IC1C*, which implements the adder. The feedback around *IC1C* rolls off the gain at high frequencies to make up for rolling off the attenuation with *C1*. It thus allows better signal-to-noise ratio with flat response.

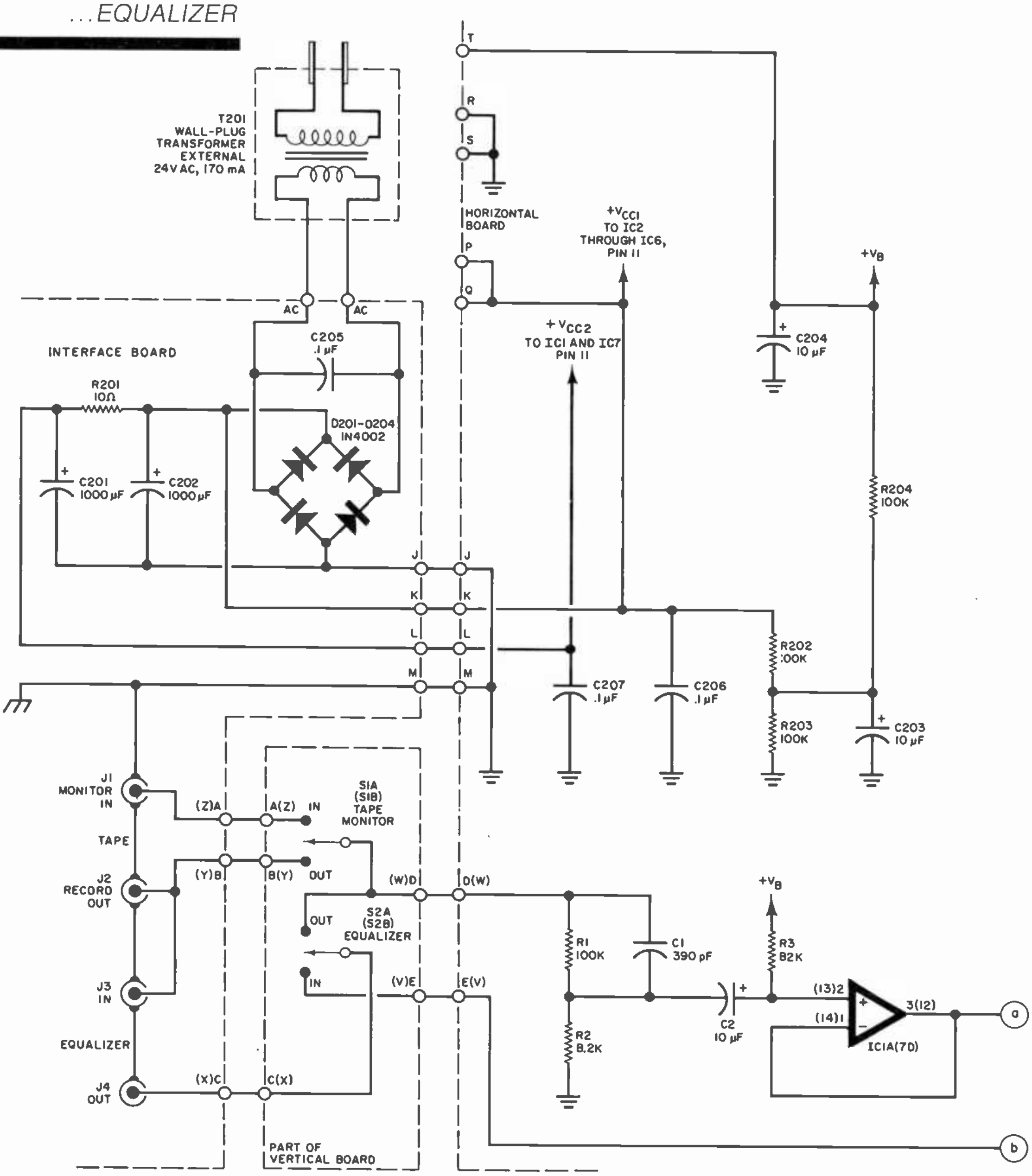
Op amp *IC1B* adds the last three bands to the equalizer. Consider first the bass band, controlled by *R60*. If it is set to full boost, then at low frequencies the input signal is applied to *IC1B* through relatively low-valued resistor *R59*, for little attenuation. Feedback comes from *R62, R61*, and *R60*; very large values imply little feedback and thus a large gain. If *R60* is set to the other end, there is more attenuation and more feedback, for a net attenuation. At high frequencies, the bass control is bypassed by *C26* and *C27* and the midbass control is coupled in through *C28*. Above the midbass frequencies, *C29* and *C30* bypass the midbass control, and *C31* couples the high-frequency control to *IC1B*.

The output of *IC1B* is coupled through *C32* to eliminate the 15-V dc bias from the output. Resistor *R72* increases the output impedance to about 600 ohms and prevents possible oscillation of *IC1B* due to highly capacitive connecting cables.

TECHNICAL SPECIFICATIONS— OPTIMIZED EQUALIZER

Frequency Response: 10 to 80,000 Hz +1/−3 dB
Gain: 0 dB nominal
Distortion: Less than 0.02%, from 20 to 20,000 Hz at rated output
Rated Output: 0.5 V
S/N per IHF-A202: 82 dBA ref: 0.5 V
Maximum Input/Output: 9 V rms
Input Impedance: Approx. 100 kilohms in parallel with 390 pF
Output Impedance: Less than 600 ohms
Total controls: 13 bands per channel
Range:
Midrange: +3 to −12 dB nominal
Bass: −2 to +10 dB nominal
Midbass: ±8 dB nominal
Treble: ±10 dB nominal

Construction. The Optimized Equalizer, except for the power supply input connectors and options, is built on two pc boards. The foil patterns for these boards are shown in Fig.3, and the parts placement diagrams are given in Fig. 4. By placing all the controls on one board (the vertical board) and most of the remainder of the unit on the horizontal board, front panel space requirements are minimized. This makes for an efficient, compact assembly. The boards are connected
(Continued on page 90)



(A)

PARTS LIST

Horizontal Board

C1,C101—390-pF, 5% capacitor
C2,C32,C102,C123,C24,C124,C132, C203, C204,—10-µF, 25-V aluminum electrolytic
C3 through C22,C103 through C122—0.0022-µF, 5% polyester film capacitor
C25,C125—0.001-µF, 5% polyester film capacitor
C28,C128—0.22-µF, 10% polyester film capacitor
C31,C131—0.01-µF, 10% polyester film capacitor
C206,C207—0.1-µF, +80/−20% ceramic disc capacitor
IC1 through IC7—RC4136 quad op amp
The following are 1/4-W, 5% carbon-film resistors unless otherwise noted:
R1,R101,R202 through R204—100 kilohms
R2,R102—8.2 kilohms
R3,R5,R103,R105—82 kilohms
R4,R104—2.7 kilohms
R6,R106—3.9 kilohms
R7,R107—120 kilohms
R8,R108—5.1 kilohms
R9,R109—160 kilohms
R10,R110—7.5 kilohms
R11,R111—240 kilohms
R12,R112—11 kilohms
R13,R113—330 kilohms
R14,R114—15 kilohms
R15,R115—470 kilohms
R16,R116—20 kilohms
R17,R117—620 kilohms
R18,R118—30 kilohms
R19,R119—910 kilohms
R20,R120—43 kilohms
R21,R121—1.3 megohms
R22,R122—56 kilohms
R23,R123—1.8 megohms
R54,R154—16.2 kilohms, 1% metal film
R55,R155—1.62 kilohms, 1% metal film
R56,R156—24.9 kilohms, 1% metal film
R57,R157—36 kilohms
R58,R158—3 kilohms
R64,R71,R164,R171—5.6 kilohms
R72,R172—560 ohms

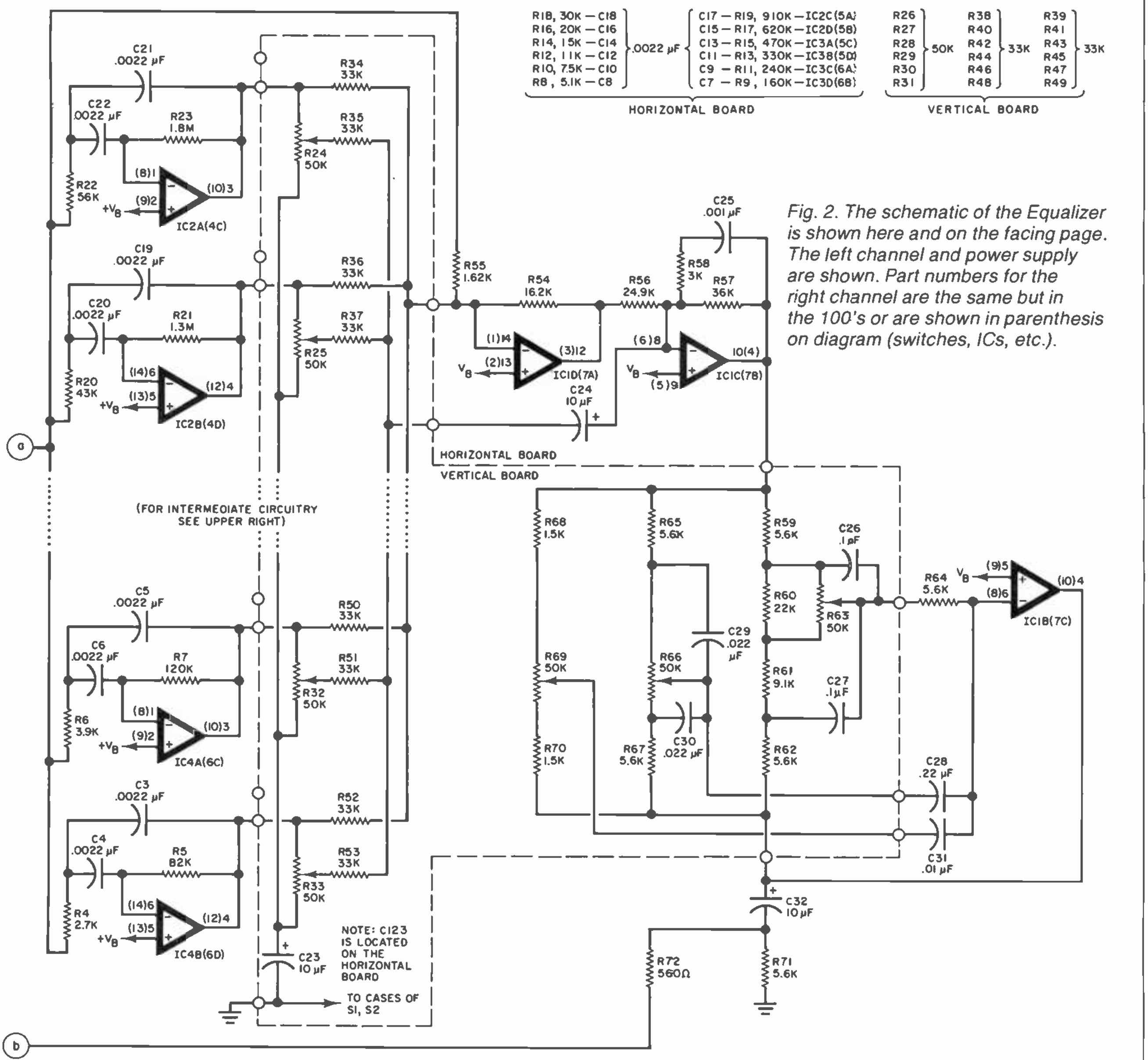


Fig. 2. The schematic of the Equalizer is shown here and on the facing page. The left channel and power supply are shown. Part numbers for the right channel are the same but in the 100's or are shown in parenthesis on diagram (switches, ICs, etc.).

(B)

Vertical Board

C23—10-µF, 25-V aluminum electrolytic
C26,C27,C126,C127—0.1-µF, 5% polyester film capacitor
C29,C30,C129,C130—0.022-µF, 5% polyester film capacitor
The following are ¼-W, 5% carbon-film resistors unless otherwise noted:
R24 through R33,R63,R66,R69,R124 through R133,R163,R166,R169—50-kilohm slide potentiometer
R34 through R53,R134 through R153—33 kilohms
R59,R62,R65,R67,R159,R162,R165, R167—5.6 kilohms
R60,R160—22 kilohms
R61,R161—9.1 kilohms
R68,R70,R168,R170—1.5 kilohms
S1,S2—Dpdt nonshorting switch

Power Supply

C201,C202—1000-µF, 35-V aluminum electrolytic
C205—0.1-µF, +80/−20% ceramic disc capacitor
D201 through D204—IN4002 (or equivalent)
R201—10-ohm, ¼-W, 5% resistor
J1 through J4, J101 through J104—Phono jack
T201—24-V, 170-mA wall-plug transformer (Dormeyer PS14201 or equivalent)

Misc.—No. 20 AWG bus wire (6′), ribbon cable (14 conductor, 7½″), angle bracket (#6-32 threaded, one side, 8), #6 × ⅜″ sheet metal screw (11), #6-32 × ¼″ machine screw (8), chassis, 16-pin DIP socket, 14-pin DIP socket.

Note: The following are available from Symmetric Sound Systems, 856 Lynn Rose Ct., Santa Rosa, CA 95404 (707-546-3895): complete Optimized Equalizer kit (EQ-4) with unfinished walnut end panels at $100; complete Optimized Analyzer kit (AN-1) at $60. Also available separately: horizontal and vertical pc boards for Equalizer (EQ-4PC) at $17.; Analyzer and interconnect pc boards (AN-1PC) at $13.; slide potentiometers #EQ-4SP, $.95 each. Quad op-amp IC #4136, $1.75 each. Set of IC's for the analyzer #AN-1IC, $6.00. Wall plug transformer #EQ-4PT, $7.50. Minimum order $10.00. All prices include shipping on prepaid orders in the U.S. Canadians add $4.00 shipping and handling. California residents add sales tax.

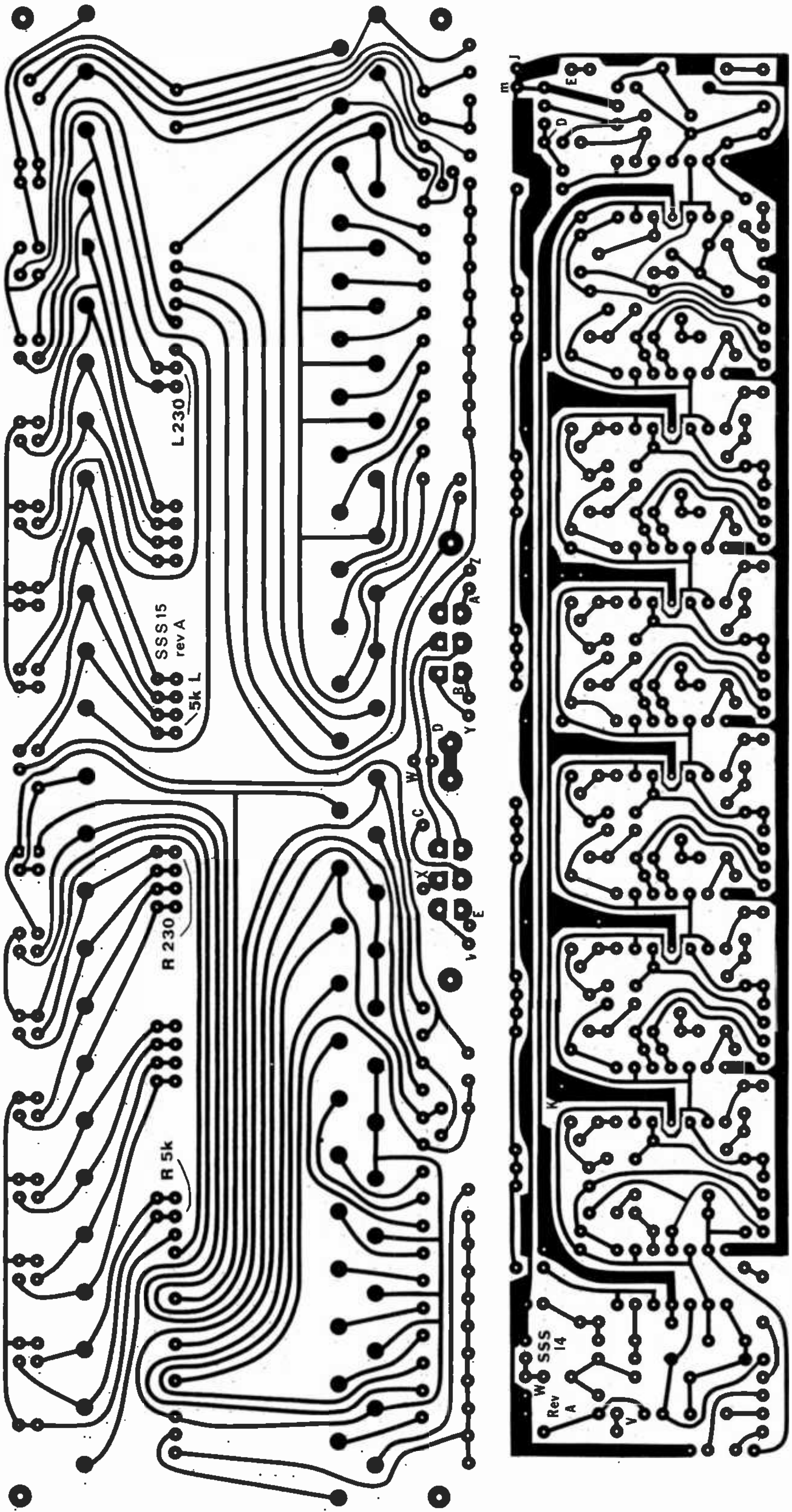


Fig. 3. Foil patterns for the Equalizer pc boards

together with #20-AWG bus wire between adjacent pads. The bus wire is stiff enough to make a rigid assembly of the boards, with easy access to both sides of boards for testing and experimenting.

Components should be soldered to the horizontal board first, in order of resistors, capacitors, jumpers, and ICs. Be careful to observe the index marking on the ICs and the polarity of the electrolytic capacitors. Next solder components to the vertical board—slide potentiometers first, then resistors, capacitors, and switches (observe the polarity on *C123*).

To connect the boards, push #20-AWG bus wire or solid uninsulated wire through the pads in the long line on the vertical board from the back side, and solder to the pads. Taper the length of these pieces of wire from 3/4″ on one end to 3″ on the other end. Starting on the long end, and with the copper-clad sides of both boards facing each other, push the leads through the matching pads on the horizontal board, working your way to the short end. Bend the horizontal board, and thus all the wires, until it is perpendicular to the vertical board and flush against it. Solder all the wires.

Wire the switches, jacks, and boards together according to the schematic (wires A through E, M, and V through Z). Wire the power supply on a terminal strip, and connect it to the horizontal board (wires J through L). A foil pattern for an interconnect board is given in Fig. 5. One 16- and one 14-pin DIP socket are wired to this board. The sockets are used to connect to the real-time analyzer, which will be covered in Part 2.

Because of the compactness of the pc-board assembly, many mechanical configurations are possible. In the prototype, the vertical pc board was attached to two pieces of walnut. The rear of an inverted "U" chassis was also attached to the walnut. The chassis provides marking for all the controls, switches, and jacks. Grounding the chassis to circuit ground shields the circuit from radio-frequency interference and electrostatic pick-up of 60 Hz and its harmonics.

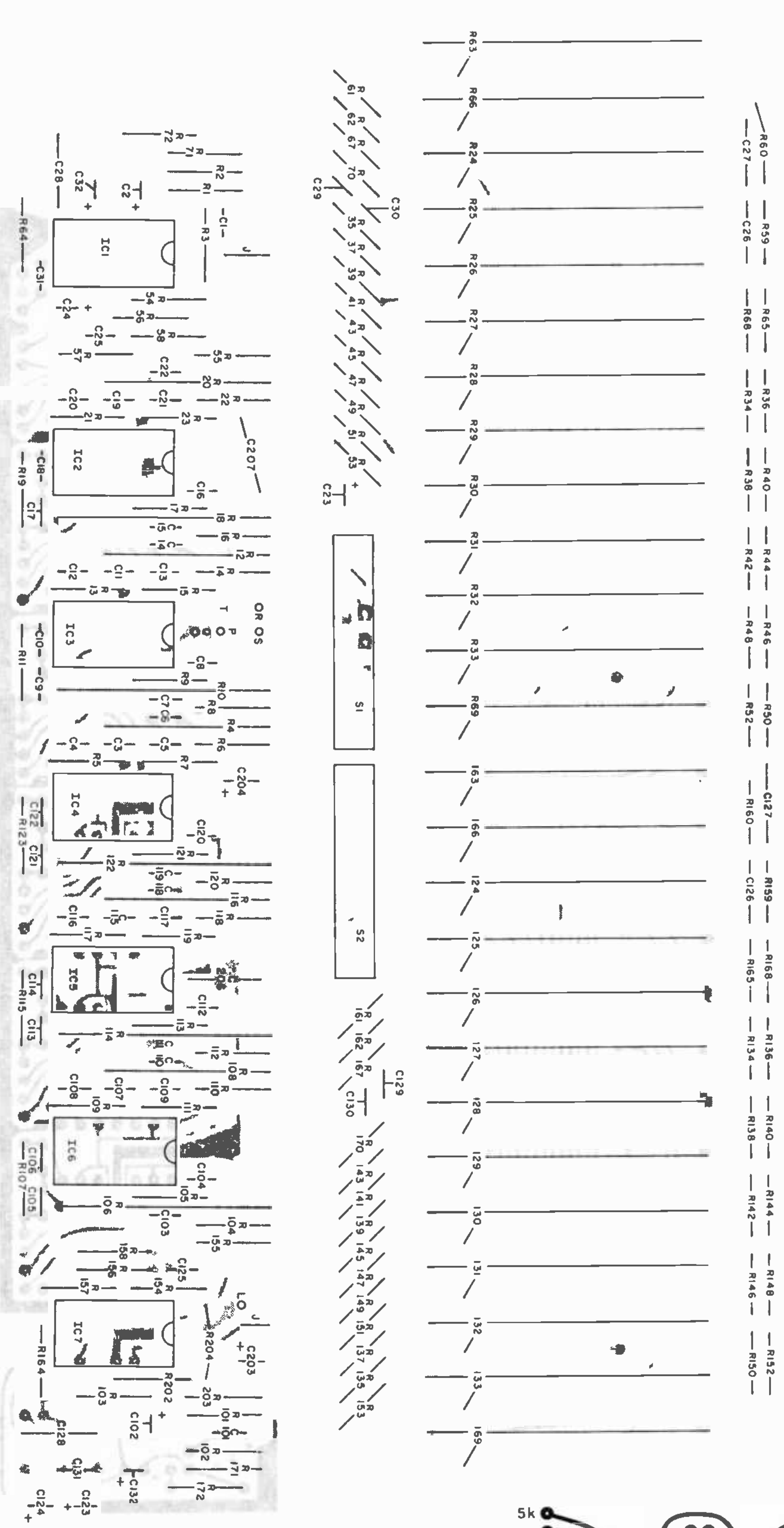


Fig. 4. Component layouts for the pc boards.

Installation. Most component high-fidelity systems can accommodate signal processors, such as the Optimized Equalizer, through the tape-monitor loop. Connect the "tape out" or "tape record" output of your amplifier to the equalizer's input. Then connect the equalizer's output to the "tape in," "tape monitor," or "tape play" jacks of your amplifier. Switch the amplifier's tape monitor switch to "on" to enable the equalizer. The tape monitor function is replaced on the equalizer. Connect your tape deck to the equalizer as it had been connected to the amplifier.

Some amplifiers have separate tape source switches to enable you to play one source while recording another. In this case, you will have to use your tape source switch as your selector. Switch the selector switch to tape, so that the signal always passes through the equalizer.

Equalizer Adjustment. There are a number of different techniques available to adjust your equalizer; these vary in convenience, cost, and accuracy. Audiophiles with very good familiarity with live music can adjust the bands by ear to match their idea of the way the music should sound. A different technique is to use a test record, perhaps with the aid of a sound-level meter, to adjust the bands for flat response.

An easy way to adjust an equalizer is with a real-time analyzer. Although this can be a costly audio accessory, it's not in this case. The equalizer was designed to inherently contain much of the circuitry of the analyzer. In Part 2, we will describe the design, construction, and use of the analyzer.

With the high performance and build-it-yourself economies of the Optimized Equalizer/Analyzer, you can anticipate an impressive improvement in the sound of your system. ◇

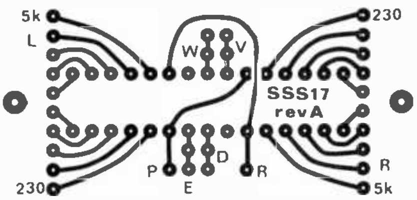


Fig. 5. Foil pattern for the connector board to the analyzer.

that includes graphic and plotting software.

The Panasonic (Quasar) HHC is also equipped to do graphical and plotting functions when equipped with the mini-plotter/printer. Software for these machines is supplied by the manufacturer through manuals and distributed through some of the information networks.

The Sinclair ZX-81 (Timex TS-1000) computers have memory-mapped video and special graphic characters that can be used to produce graphic plotting images. The Graphic Kit and Programmers Toolkit from Softsync Inc. (PO Box 480, Murray Hill Station, New York, NY 10156) at $14.95 for each cassette provide the capability for using this computer for statistical plotting. Use of the mini-printers available for this computer and the additional memory capacity provided by the Memopak plug-ins from Memotech Corp. (7550 W. Yale Ave., Denver, CO) complete the peripherals needed to do plotting with the Sinclair/Timex computers.

Plotting Graphics for Epson QX-10. One of the features of the Valdocs Operating Systems for the QX-10 computer is the DRAW facility. It is entered by merely pressing the DRAW button. The system will ask if you want shapes, or lines, or business graphs. If business graphs is selected, the system next asks if you wish to make a (L)ine graph, (P)ie chart, or (B)ar graph. Upon selection, the system asks additional questions and the user is prompted to specify the parameters of the plot. Once the data is input into the computer, the system generates the graph and stores it on the disk. The plot can also be sent to the printer for reproduction. The user also has the ability to label the graph with the same selection of type available in the word-processing mode. This includes normal, italic, bold, or a combination of bold and italic types. It should be noted that this capability is built into the Epson Valdocs Operating System. No additional software package is needed. ◇

CALCULATING PARALLEL RESISTANCE PAIRS

Using a programmable calculator to find two resistance values to substitute for an unobtainable one

By Kevin Quinn

EVEN in this age of the IC, experimenters are often faced with the simple problem of paralleling two resistors because a component with the exact value isn't available. For example, you may need a 15-ohm resistor, but there's none in your box. Formulas are of little help, since you're looking for *two* unknowns. So what do you do? Here are a few ways to solve the problem.

If you need a 15-ohm resistor, multiply 15 ohms by a number such as 4. You get 60 ohms—that's one resistor, *R1*. Then divide 60 by 3—that's 20 ohms for *R2*. Resistors *R1* (60 ohms) and *R2* (20 ohms) in parallel give you 15 ohms.

Another way is to multiply 15 ohms by 3, so that *R1* equals 45 ohms. Then 45 divided by 2 gives 22.5 ohms for *R2*. Another pair! You can do the calculations in your head. It's much easier than "the reciprocal of the sum of the reciprocals."

One other way to solve the problem is with a programmable calculator. You can set up a simple program that will give you 5 or 6 pairs in no time. The program for a TI machine is shown below.

Begin by entering the number of the desired resistance. Press R/S. Then enter the multiplier. The number that will be displayed is *R1*. Press R/S. The next number displayed will be *R2*. Press R/S again to repeat the cycle.

Sometimes this method gives values that do not correspond to standard values such as 47 kilohms or 82 kilohms. But in the trials we made, using the closest standard values (47 kilohms for 49 kilohms, etc.) worked out to an accuracy of better than 5%.

To find 3 or more resistors equivalent to the desired value, first find the first two values. Then use one of them as the new desired value and find two more. For example, if the desired value is 47 kilohms,

$47 \times 5 = 235$	*(R1)*
$235/4 = 58$	
$58 \times 3 = 174$	*(R2)*
$174/2 = 87$	*(R3)*

Using standard values of 240 kilohms, 180 kilohms, and 91 kilohms in parallel will give an equivalent resistance of 48 kilohms. Usually, this is close enough. ◇

```
00 x        09 =
01 R/S      10 ÷
02 STO 1    11 RCL 2
03 =        12 =
04 STO 2    13 1/x
05 R/S      14 R/S
06 RCL 1    15 RST
07 -        16 R/S
08 1
```

Testing & Comparing

HEWLETT-PACKARD'S LATEST DESKTOP COMPUTERS

Most costly and least costly HP desktop models—HP-86 and HP-87 are put through their paces here

Hewlett-Packard has been producing personal computers for several years—ever since it introduced the HP-83. The company's series 80 computers have evolved from the original small-screen and tape-storage design used in the HP-83 to modern desktop computers with both 5¼" and 8" disk systems and a full range of peripherals.

The recently introduced HP-87 is the most powerful computer in the HP-80 Series, while the new HP-86 represents the first lower-cost machine built by Hewlett-Packard. Both are examined here in detail.

HP-87. This is a powerful desktop personal computer designed for the professional user. It is an extension of the HP-80 series of microcomputers and bears a similarity to the HP-85, examined here last year. The HP-87 offers a number of enhancement features, including: 1) An improved CRT display. It is 4" high by 9" wide, giving the overall effect of providing more horizontal viewing room. 2) Improved memory capability. The HP-87 supports up to 540K bytes of RAM/ROM. 3) Graphics functions can be incorporated into alphanumeric displays. 4) Built-in HP Interface Bus (HP-IB) for facilitating adding of peripherals. 5) Four expansion slots are included for additional memory or peripherals.

The configuration we tested was the System 10, which includes an HP-87 with 28K bytes of RAM and built-in BASIC operating system, Model 82901M dual 5¼" flexible disk drive, and the necessary cables. Basic suggested retail price for this package is $4695.

To the foregoing, we added the Model 8290 80-cps dot-matrix printer (Epson MX-80), a Model 7470A Graphics Plotter, a Model 82936A ROM Drawer, with the HP-87 plotter ROM and HP-87 Input/Output ROM, a Model 82909A 128K-byte memory module, and a Model 82950A series 80 modem. Total cost of the system tested is $8430.

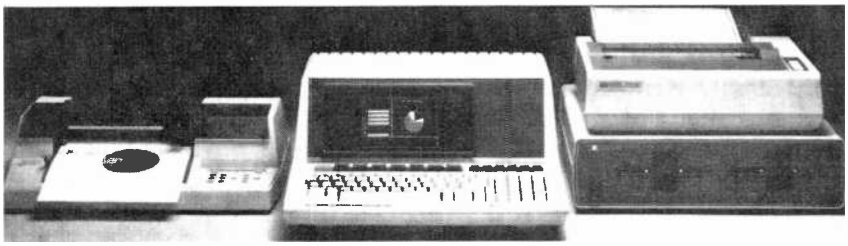
The software tested consisted of HP-87 Visicalc Plus, the Data Communications package, and the Graphics Presentations package, totaling $700.

Even though the HP-87 is designed to support a Z-80 microprocessor add-in and CP/M for an additional $495, it was unavailable for testing. We were able, however, to observe its operation, which is similar to any CP/M system. The implementation, though, doesn't utilize the full memory capability of the system, and is restricted to the standard 64K boundary. On checking with Hewlett-Packard engineers, we were advised that this was done because of the method of communication between the Z80 and the rest of the system and the limitation imposed by the Basic Input Output System (BIOS) of CP/M. Expect in future enhancements, however, to see blocked memory and bank switching solve this problem.

The set-up of the HP-87 is very simple, and you are guided by a 60-page booklet that describes in detail how to get the system up and running in either a basic configuration or with a number of peripherals.

Basically, all you do is connect everything together. One problem we encountered was that we didn't have all the cables required for use on the HP-IB for the various peripherials. At first we thought this might be an oversight since the system we were testing was a demo unit and, consequently, might not be packed as an off-the-shelf model. On checking with Hewlett-Packard however, we found this was not the case. Since the printer and plotter are designed to be used with a variety of interfaces, no cables are shipped with them unless specifically ordered for a given interface (RS232, parallel, or HP-IB).

The HP-IB cables have double AMP edgetype connectors with



Complete HP-87 system with plotter, disk drive and printer.

thumb-screw hold downs. One side is male and the other female, thus permitting stacking the connectors together.

The way we hooked up the system was with the HP-87 connected to the disk drive, which was cabled to the plotter, followed by the printer. Essentially, the peripherals are daisy-chained and, thus, require a special address on the "bus," a unique attribute of the HP-IB.

In order to appreciate how the HP-87 operates, you have to have a basic understanding of the HP-IB. This bus, also known as General-Purpose Interface Bus (GPIB) and IEEE-488, is a bit-parallel, byte-serial I/O scheme that is defined both electrically and mechanically, as well as by certain communication protocols.

Unlike other interfaces such as RS232C, the HP-IB isn't equipment specific; it can work with virtually any digital system as an extension of the main backplane bus. In addition, because of the byte-handshake-byte protocol, data reception is ensured. The above characteristics make it an ideal interface for use with instruments or other digital equipment.

The HP-IB bus uses a talker/listener type arrangement. This allows you to put equipment anywhere on the bus and to assign it a specific address by setting select codes on the printer or plotter with dip switches. For example, in operation each device "listens" to the bus and responds when specifically "talked" to. In addition, it responds by "talking" either with handshake messages or data, depending on the device.

Although the HP-IB interface arrangement is ideal in many respects, a problem exists as far as the HP-87 is concerned. Even though the optimum transfer rate for the HP-IB is 22,000 cps the average on the HP-87 implementation is about 12,000 cps. Moreover, when dealing with the disk system this is reduced to approximately 1000 cps due to processor and disk system overhead. The overall result, therefore, is very slow disk access. A 1000-line BASIC program, for example, took almost 18 seconds to load.

The slowness of the disk system was the only disappointing part of the HP-87. We found that when printing or plotting, the devices operated at maximum levels and only slowed if disk access was required.

Further slowing the disk access is the format (the way data is laid out on the diskette) chosen by HP. Rather than interleave the sectors (staggering their arrangement), the sectors are numbered concurrently. This increases the time it takes for the data to come under the read/write head. Generally speaking, then, the disk system isn't overly efficient.

As with other Series-80 computers, the HP-87 contains an internal timer that allows you to set and recall the current time and date both from the keyboard and within programs. The timer is specified to be accurate within 1 second/hr, which we found to be precisely met.

Although the timer is accurate, the methodology used for setting it is cumbersome. Using the SETTIME function, you enter the time in seconds and the date in a five-digit integer in the form YYDDD—July 10, 1982 is 82191; 4:05 pm is 16 hours = 16 × 60 = 960 + 05 minutes = 965 min × 60 = 57600 sec. This is entered: SETTIME 57600, 82191.

A similar difficulty arises with the HP-IB interface system. As previously stated, each device is given a unique address. In addition, the CPU must be advised of the existence of each device by using what we term "IS" commands. To tell the 87 that the printer is on-line, for example, you enter PRINTER IS 701,80. This tells what channel and the printer width. This same approach is used even with a serial or parallel interface because of the internal HP-IB system bus.

Even though the slowness of the bus and the necessity of learning new names for well-known functions was troublesome, we felt they could be easily overlooked in light of the powerful HP BASIC and other programs supplied or available.

The HP BASIC is one of the better implementations of this language and uses an unusual method of interpreting the source code that the user enters. Most BASIC interpreters store the source code as ASCII characters; when the RUN command is given, they parse it and convert it into object code on a line-by-line basis. In HP BASIC, when a line of source code is completed and the END LINE key is pressed, BASIC parses each line and converts it into object code tokens. The tokenized object code is then stored in memory on a line-by-line basis. When the RUN command is given, BASIC executes the lines of code stored in memory. This system has the speed of a compiler and the ability of editing single lines like an interpreter. Because of this you get the best of both worlds in terms of code efficiency and editing capability.

In addition, with HP BASIC you have built-in intrinsics for screen, printer and plotter graphics, the ability to set up X and Y axes with hack marks, plus handling a variety of draw, fill and rotate functions for manipulating figures and corresponding data.

In our test we employed BASIC along with the HP plotter to create a variety of figures and nonsense outputs. The Model 7470 plotter gives you two pens to work with when plotting and allows you to change the pens under program control. The Graphics Presentation Pack takes advantage of this fact. This software allows you to create line, bar and pie charts by simply entering the data and defining how you want them presented in terms of color, size, font, and horizontal or vertical format. In addition, you have the capability to draw freehand to create unique CRT and plotter displays.

The graphics software is designed to work with the 7470A plotter and dot-matrix printer. With the software you have full control over the plotter functions, even including the ability to change pens (the 7470 supports two pens at a time). The printer is used to list tabular data so that you can create special reports that combine the tabular data along with the graphics representation.

The Graphics Presentation Pack does allow a great deal of functionality, but it has some short comings. First, it requires too many overlay

files to be loaded in. This indicates inefficient use of the system memory. In addition, return to a given figure is not convenient and the drawing speed should be enhanced. For example, typical dual pie chart drawn on the CRT took approximately 4½ minutes. This indicated that each plot point was recalculated each time and the vectors drawn. A more efficient method is to calculate the vectors, then show the results in display memory.

The VisiCalc-Plus we tested was much more efficient. And except for the slowness of the disk system, we found that it calculated quickly and updated the display to compete with the fastest systems. We were also pleased to learn that, because of the superior HP keyboard, we could quickly perform Visicalc functions with the touch of a button.

The communications package and modem were excellent. This Bell 103A (300 baud) modem plugs into one of the expansion slots in the back of the machine and provides auto dialing and answer functions. The software package is written in BASIC with machine language I/O drivers like the Graphics Package. It allows for a ten-number phone directory that it dials by pressing a single key.

We dialed on to various network systems, including Compuserve, the Source, and a number of local bulletin boards. The only problem we encountered was that the software was incompatible with the protocol for file transfer that Compuserve expects. But we bypassed this by using the Filge command on Compuserve (Filge is the Compuserve Line Editor) to create a file and merely listed it.

With respect to the 7470A plotter. We could have devoted a single review to this device alone since it is so versatile and accurate. Basically we found that it had almost 100% repeatablity on plots that were removed and replotted on the same paper. We could instruct the plotter to work any way we liked and dynamically size paper and plots. In addition, it can use any type of paper because of the microgrips.

User Comment. Generally, we give the HP-87 high marks. But we do fault it on the implementation of the disk subsystem and memory techniques used for creating CRT plots.

Though we give it a top grade on the quality of the documentation, we would have liked in-depth technical detail on the hardware and software, as well as a full discussion of the internal operation of the machine, including timing considerations, and greater details on the HP-IB.

If you want a high-speed multiprocessing/multiuser system, skip the HP-87. But should you be doing design work in any discipline or solving business problems, then take a careful look at this machine. And for applications requiring sampling of data from a variety of test equipment, including DVMs, gas chronographs, and even spectrometers, you'll find that the series 80 machines with the HP-IB are well-suited. In addition, over 1000 programs are available from a variety of sources, including the HP software library, to support the machine.

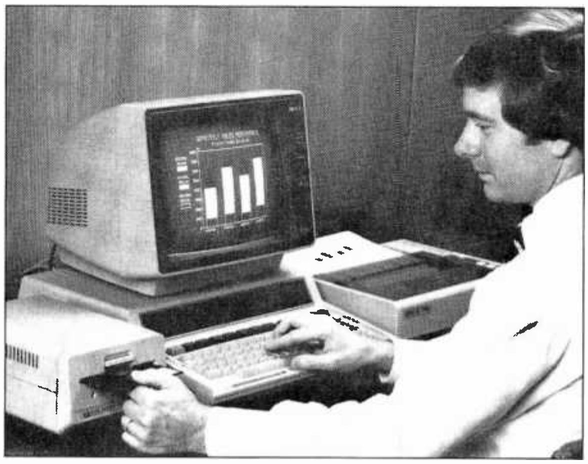
HP-86. This is the lowest cost desktop computer in the Hewlett-Packard line, with a suggested price of $1795. It represents HP's entry into a price range where they have never sold computer equipment before. Nevertheless, it is an attractive, well-built unit with the appearance of high quality that we have come to associate with Hewlett-Packard.

The HP-86 features an integrated video interface for connecting either an HP-82912A Monitor (9", $295), an HP-82913A Monitor (12", $325), or any compatible video monitor. It is supplied with 60K of user memory, expandable in increments of 32K (at $295), 64K ($450), and 128K ($795) bytes to a maximum of 572K bytes. The HP-86 uses the HP-91030A Flexible Disk Drive, which can only be used with HP-86 because the drives derive their power from the computer. Though the drives are not interchangeable with those used on other HP computers, the diskettes used are the same as those in the HP-82900 Series Disk Drives and they are interchangeable with other Hewlett-Packard units. The HP-86 uses the same HP BASIC and application programs that are supplied for the HP-87; so our previous comments concerning the excellent quality of the BASIC and the graphics capability are also applicable to the HP-86.

Hewlett-Packard BASIC contains such features as four variable types, simple numeric, simple string, numeric array, and string array. The arrays can be either one-or two-dimensional. There are three types of numeric precision: integer, short, and real (full). Multi-character labels enable the programmer to reference program lines by name in branching statements.

The HP-82913A Monitor supplied with the test unit was a 12" video monitor, with a green hue and clear character display.

When the HP-87 was tested, CP/M was not available. However, it became available for the HP-86 and it was tested with this unit. CP/M is the same for both HP-86



The HP-86 with a monitor, disk drive and printer.

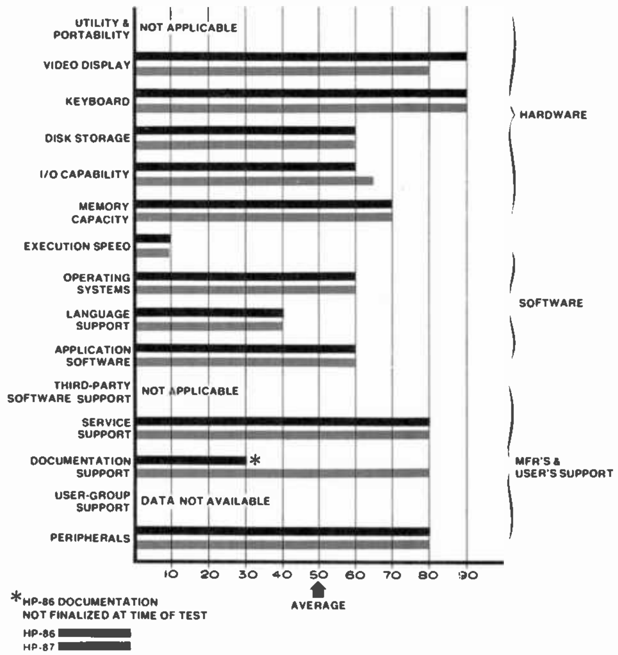
and HP-87, so the results are applicable to both computers. Since CP/M has been available for the HP-87/86 computers, a large body of application software from other sources has been converted to run with these machines. We tested both the HP version of CP/M and Wordstar and dBase II. We also tested VisiCalc Plus for the HP-86/87.

As in the HP-87, the HP-86 has slots in the rear panel for various plug-in modules to extend the capability of the computer. These include the HP-87 memory modules, the Modem Module, the ROM Drawer which holds the I/O ROMS, mass storage ROMS, and other peripheral driver ROMS. The HP-86 is also capable of running the CP/M operating system when the CP/M plug-in module is installed.

The keyboard has an excellent "feel" and is equipped with 14 user-defined keys to provide program controls and typing aids. Eight large keys at the top of the keyboard contain the HP-86/87 default typing aids. These are identified by a removable label that can be replaced if the keys are redefined by the user. The system control keys, such as PRINTER IS and CRT IS are described in the preceeding HP-87 review. There is also a full numeric key pad and six cursor-control keys located at the upper right of the keyboard.

VisiCalc Plus is a version of the familiar electronic spreadsheet program designed to run on the HP-86/87 Series of desktop computers. While this is not a review of the software system, we found that the large memory capacity of the HP-86 (we were supplied with the 128K memory extension) made an extra large VisiCalc matrix size possible. Having become accustomed to using this program on computers with limited user memory, we found that the large memory freed VisiCalc to handle much larger jobs. Although the software runs a little slower on the HP-86, it may be the answer to users who feel memory-bound while using VisiCalc.

The "Plus" portion of the software system consists of four separate programs that allow you to use information from VisiCalc to generate training aids, overhead projector slides, charts, and any other form of graphs and plots. The graphs can be clear, cross-hatched, or shaded. A choice of eight plotter pen colors makes the graphs colorful. Graphs can be created on either



Comparative analysis of the HP-86 and HP-87.

a peripheral plotter such as the HP-7470A or the video display screen.

The HP-82900A CP/M System is an implementation of the Digital Research operating system that has been configured for the HP-87/86 Computers. It consists of the CP/M Module, which contains a Z80 microprocessor, 64K of RAM memory, a 2K "Boot" ROM, and I/O circuits to interface the module with the HP-86 bus. When the CP/M is installed and booted, it takes control of the computer and turns it into a 64K CP/M based Z80 Computer. CP/M occupies approximately 8K, leaving 56K bytes of memory available to the user. If one of the HP-86 Memory Modules is installed (such as the 128K module) it doesn't add anything to the systems; the maximum memory that is effective is the 64K in the CP/M module.

The software is contained on a 5¼" disk and although the system is compatible with 8" drives, none is supplied. The diskette is formatted in Logical Interchange Format (LIF), where the directory is only one sector long and includes three entries. The first entry is a large data file named "CP/MSYS", which includes the CP/M operating system, the CP/M directory, and the CP/M user file space. The second directory entry is a BASIC autostart program used to bootstrap the CP/M system. The third directory entry is the binary program that runs the computer while the CP/M system is running in the Module.

The CP/M system and the HP BASIC must be kept separate; no attempt must be made to save BASIC programs on a CP/M diskette or they will overwrite the CP/M system and it will be lost. This places the burden of keeping the CP/M diskettes and the BASIC diskettes separate on the user.

We have seen many versions of the CP/M system running on many different computers, but this version is certainly the slowest we have ever come across. It takes four times longer to copy a system disk using the standard CP/M PIP program than it does for , say, the Osborne 1 Computer. It took five times as long to place the CP/M format on a diskette using the FORMAT program.

We also ran some of the application software that runs under CP/M and observed the results. The dBase II data base program ran as well as it does on any other CP/M Computer, and it performed with the accuracy that this system is known for. However, the disk access is noticeably slow during the search and sort functions. Even if you had never used dBase II, you would notice how lethargic the selection and sort processes were.

We had a lot of trouble with the version of WordStar supplied with the HP-86 since it was set up for the HP-87 and a daisy-wheel printer. We used the Install program so we could run the system on our HP-86 sample with an Epson MX-100 Printer. We discovered that, while the word processor would run in video mode, it would not talk to our Epson printer. We asked the people at HP for help, but nothing they could suggest worked any better than our own efforts! Finally, we fooled the system by configuring the new WordStar set up with Install to think it was outputting to a teletype connected to the CP/M List Device.

User Comment. Since the HP-86 and H-87 are members of the same family, the evaluation of one machine should be like the other. In essence, the assessments are similar, though there are some basic differences. The HP-86 is also a fine machine, with a lot of desirable characteristics. But it runs painfully slow. We ran our standard benchmark in BASIC, for example. This is a version of the Sieve of Eratosthenes, which generates the prime numbers from 0 to 1000. I/O is not a consideration in this version of the program. The Osborne 1, running Microsoft BASIC, took 24 seconds to run the program. The TRS-80 Model I, also running Microsoft (Level II) BASIC, took 26 seconds. The HP-86, running HP BASIC which should run faster because of its method of interpreting BASIC, took 58 seconds . Shame! While the HP-86 is a good value considering the low basic price for a Hewlett-Packard Marque, HP should be able to improve the machine's performance. The method of disk access as well as the general speed of the CP/M operation indicate that not enough thought was put into this offering by one of the world's leading computer manufacturers.

Conclusion. Both of the new Hewlett-Packard computers reviewed here make valid contributions to extending the breadth of the company's desktop computer product line—the Model HP-87 at the high end and the Model HP-86 at the lowest end.

We cannot escape the feeling in comparing the two that they are more than simply members of the same family, however. That's because the HP-86 can be brought up so close to what the HP-87 is by plugging in a variety of modules. There's not that much difference in overall performance when similarly equipped. In essence, then, the HP-86 might be considered to be close to a stripped-down HP-87, though the lower-cost one uses a different video monitor.

So if you want a Hewlett-Packard desktop computer that resembles other desktoppers at a rock-bottom price, and don't really need all that extra computing power and functions right now but know you can get it later, you may well consider the HP-86. For the most that HP has in desktop computing power and built-in versatility, the laboratory/design-engineer oriented HP-87 might do well for you.

As with most products there are tradeoffs, some of which show up in the rating chart that accompanies this report, and others that crop up in our discussions. You'll have to weigh the pluses and the minuses cited against your needs, of course. In general, though, we feel that we cannot sing the praises for these two models quite as loudly as we had hoped we could. One doesn't expect to hear a clock tick in a Rolls Royce, you know. But you are getting highest quality in terms of construction and dependability.

—*Carl Warren and Stan Veit*

CIRCLE NO. 103 ON FREE INFORMATION CARD

Recommended Shortwave Programs, Part 2 Continued from November

By Glenn Hauser

GMT	Station	Program & Frequencies
		TUESDAY
0010-0028	Kol Yisrael	Spectrum; 15585, 11640, 9815 (also 0210)
0010-0035	R. Japan	DX Corner; Crossroads; 17825, 21610 (also 0155)
0030-0059	BBC	Comedy Series; 15260, 9410, 7325, 6175, 6120, 5975
0100-0109	BBC	Waveguide; (as above)
0130-0150	R. Australia	Arts News; 21740
0230-0300	HCJB	DX Party Line; 15155, 9745 (also 0630)
0430-0450	R. Australia	Arts News; 17795, 15320
0630-0659	BBC	Jazz for the Asking; 15070, 11955, 9510, 9410, 6175
0730-0750	R. Australia	Arts News; 11775, 9570
1115-1124	BBC	Letter from London; 21710, 21660, 15070, 11775, 9510, 6195
1210-1230	R. Finland	Air Mail; 15400, 21475 (also 1310, 1410)
1211-1226	R. Moscow	Roundabout the Soviet Union; 9600
1215-1244	BBC	Promenade Concerts; 21710, 21660, 15070, 11775, 9510
1235-1245	R. Australia	Industrial Design; 9580; 5995
1413-1427	R. Sweden	Sweden Calling DXers; 21615
1430-1459	BBC	Thirty Minute Theatre; 21710, 21660, 15070, 11750
2045-2114	BBC	Thirty Minute Theatre; 15260, 15070, 12095, 11750
2115-2200	BBC	Calling the Falklands; 15400, 11820
2130-2145	SPLAJOBS, Libya	The Eternal Jerusalem; 11815
2313-2327	R. Sweden	Sweden Calling DXers; 11705; 9695
2330-2359	BBC	Meridian; 15260, 9590, 9410, 7325, 6175, 6120, 5975
		WEDNESDAY
0005-0035	R. Japan	One in a Hundred Million; Our Heritage; 17825, 21610 (also 0150)
0130-0158	R. Budapest	Hungarian History; 11910, 9835, 9585
0145-0159	BBC	Report on Religion; 15260, 7325, 6175, 6120, 5975
0230-0259	BBC	Thirty Minute Theatre; 15070, 9410, 7325, 6175, 6120, 5975
0243-0258	R. Sweden	Sweden Calling DXers; 11705, 9695
0330-0359	BBC	Discovery; 9410, 6175, 5975, 6120
0400-0412	R. Budapest	Calling DXers & Radio Amateurs; 11910, 9835, 9585
0430-0439	BBC	Waveguide; 9510, 9410, 6175, 5975
0530-0559	AFRTS	Science Editor; Meet the Author/Newsmaker; 6030 (also 1030)
0540-0554	R. New Zealand	Letter from America; 17705, 15485
0605-0650	R. Cook Islands	Superstars; 11760
0630-0659	BBC	Prom Concerts; 11955, 9640, 9510, 6175
0730-0739	BBC	Letter from London; 11955, 9640, 9510
0745-0759	BBC	Report on Religion; (as above)
0830-0859	BBC	Quiz programs; (as above)
1115-1129	BBC	Listening Post; 21710, 21660, 11775, 11750, 9510, 6195
1130-1159	BBC	Meridian; (as above)
1215-1244	BBC	Nature Notebook; Farming World; (as above)
1245-1255	R. Australia	Tale of the Open Road; 9580, 5995
1315-1340	R. Japan	Science & Industry Journal; Japan Today; 9505, 11815
1330-1414	BBC	Radio Theatre; 21710, 21660, 15070, 11750
1415-1429	BBC	Report on Religion; (as above)
1430-1459	BBC	Man, Myth and Music; 25650, 21710, 21660
1629-1644	BBC	Arts & Africa; 21470 (also 1729)
1734-1743	BBC	Waveguide; 21710
2030-2059	BBC	Assignment; 15260, 15070, 12095
2130-2159	BBC	Jazz for the Asking; 15260, 15070, 12095, 9410
		THURSDAY
0020-0035	R. Japan	Japan Today; 17825, 21610 (also 0205)
0030-0044	BBC	Listening Post; 15260, 9410, 7325, 6175, 6120, 5975
0045-0114	BBC	Pageant of the Past; (as above)
0130-0150	R. Australia	Jazz Australia; 21740
0230-0259	HCJB	Program Notes; Música del Ecuador; 15155, 9745
0230-0259	BBC	Assignment; 9410, 7325, 6175, 6120, 5975
0430-0450	R. Australia	Jazz Australia; 17795, 15320
0630-0659	BBC	Nature Notebook; Farming World; 15070, 9510, 9410, 6175
0730-0750	R. Australia	Jazz Australia; 11775, 9570
1130-1159	BBC	Assignment; 25650, 21710, 21660, 11775, 11750, 9510 (also 1615)
1225-1255	R. Peking	Culture in China; 9820
1238-1244	R. Australia	CSIRO Newsfile; 9580, 5995
1303-1313	R. RSA	DX Corner; 25790, 21535
1315-1325	R. Japan	Japan Cyclopedia; 9505; 11815
1430-1459	BBC	Discovery; 21710, 21660, 11750, 15070
1831-1859	R. Moscow	Folk Box; 11840
2049-2119	R. Nederland	Media Network; 21685, 17695, 17605, 15220, 9715
2115-2159	BBC	Calling the Falklands; 15400,11820
2119-2129	BBC	Program Previews; 15260, 15070, 12095, 11750
2330-2359	BBC	Meridian; 15260, 9590, 9410, 7325, 6175, 6120, 5975
		FRIDAY
0000-0030	HCJB	Sellecciones Interamericanas; 11960
0010-0020	R. Japan	Japan Cyclopedia; 17825, 21610 (also 0155)
0010-0030	Kol Yisrael	Studio Three; Frequency Schedule; 15585, 11640, 9815 (also 0210)
0015-0030	R. Moscow	Science & Engineering; 9600 (also 0215)
0025-0055	R. Peking	Culture in China; 17855, 17680, 15120 (also 0125, 0225, 0325, 0425)
0030-0114	BBC	Radio Theatre; 15260, 15070, 11835, 9410, 7325, 6175, 6120, 5975
0115-0130	RAE, Argentina	DX program 11710 (also 0245, 0445)
0130-0150	R. Australia	Bill Belcher's Band Bazaar; 21740
0149-0159	BBC	Program Previews; 15260, 7325, 6175, 6120, 5975
0230-0259	BBC	Features; 9410, 7325, 6175, 6120, 5975
0249-0322	R. Nederland	Media Network; 9590, 6165 (also 0549)
0300-0330	R. Australia	Calling Antarctica; 17750
0330-0359	BBC	Business Matters; 9410, 7325, 6175, 6120, 5975
0430-0439	BBC	Letter from London; 9510, 9410, 6175, 5975
0430-0450	R. Australia	Bill Belcher's Band Bazaar; 17795, 15320
0534-0559	AFRTS	Capitol Cloakroom; Letters to CBS; 6030 (also 1034)
0630-0640	R. Australia	Letters to the Editor; 11775
0630-0659	BBC	Fiesta; 15070, 11955, 9510, 6175
0730-0750	R. Australia	Bill Belcher's Band Bazaar; 11775, 9570
0800-	KTWR	Dateline Guam and the World; 11840
0830-0859	BBC	Comedy series; 9510, 9640, 11955, 15070
1115-1124	BBC	Program Previews; 21710, 21660, 11775, 11750, 9510, 6195

1130-1159	BBC	Meridian; (as above)
1215-1245	R. Peking	Profile; the Land and the People; 9820
1215-1244	BBC	Jazz for the Asking; 21710, 21660, 11775, 11750, 9510
1240-1255	R. Australia	Letters to the Editor; 9580, 5995
1330-1414	BBC	Features; 25650, 21710, 21660 11750
1415-1429	BBC	Letterbox; 21710, 21660, 15070, 11750
1615-1644	BBC	Science in Action; 21710, 21660, 17830, 15260
2145-2154	BBC	Letter from London; 15260, 15070, 12095, 11750
2030-2059	BBC	Pageant of the Past; 15260, 15070, 12095
2145-2159	HCJB	Música del Ecuador; 21477.5
2240-2257	Kol Yisrael	Shabbat Shalom; 15585, 11640, 9815
2315-2329	BBC	From the Weeklies; 15260, 15070, 9590, 9410, 7325, 6175, 6120, 5975
2330-2359	BBC	Thirty Minute Theatre; (as above)

MULTI-DAY

0012-0027	R. Australia	Four Corners; 21740 Mon-Fri
0015-0029	BBC	Radio Newsreel; 15260, 9590, 9410, 7325, 6175, 6120, 5975
0030-0100	VOA	Magazine Show; 17640, 9650, 6130, 5995 Tue-Sat
0100-0200	R. Zinica	Revolution Now; 6120 Tue-Sat
0115-0144	BBC	Outlook; 15260, 9410, 7325, 6175, 5975 Tue-Sat
0125-0130	HCJB	Latin American News; 15155, 9745 Tue-Sat
0125-0135	R. Moscow	Vladimir Pozner's Daily Talk; 9600 (also 0325)
0130-0135	AFRTS	The Rest of the Story; 21570, 6030 Tue-Sat
0145-0159	BBC	The World Today; 9410 Tue-Fri
0145-0200	Deutsche Welle	Musik; 15410, 11795, 9735, 6075 Tue-Sun
0150-0213	Swiss R. Int'l	Dateline; 15305, 11715, 9725, 6135 Tue-Sat (also 0435)
0204-0259	CBC No. Service	As It Happens; 9625, 6195 Tue-Sat
0209-0215	BBC	British Press Review; 15260, 9410, 7325, 6175, 6120, 5975
0212-0225	R. Australia	Four Corners; 21740, 17795 Mon-Fri
0215-0229	BBC	Radio Newsreel; 9410 Tue-Sat
0230-0245	AFRTS	The World Tonight; 21570, 6030 Tue-Sat
0300-0359	CBC No.Service	Jazz; 9625, 6195 Tue-Sat
0309-0329	BBC	News About Britain; World Today; 9410, 7325, 6175, 6120, 5975 Tue-Sat
0330-0345	AFRTS	Commentaries; 6030 Tue-Sat
0340-0400	Deutsche Welle	Musik; 9735, 6145, 6085, 6075 Tue-Sat
0345-0359	V. of Yerevan	Music & News; 17870
0358-0359	R. Australia	Jacko; 17795
0400-0429	BBC	Newsdesk; 9410, 6175, 6120, 5975
0403-0500	R. New Zealand	Music for Pleasure; 17705, 15485 Mon-Fri
0435-0445	AFRTS	Rather; Reasoner; 6030 Tue-Sat
0445-0454	BBC	Financial News; 9510, 9410, 6175, 5975 Tue-Sun
0454-0459	BBC	Reflections; (as above)
0509-0529	BBC	Twenty-four Hours; 9510, 9410, 6175, 6975 Mon-Fri
0545-0559	BBC	The World Today; 15070, 9510, 9410, 6175, 5975 Tue-Sat
0555-0600	HCJB	Latin American News; 11910, 6095, 9745 Tue-Sat
0600-0630	BBC	Newsdesk; 15070, 9510, 9410, 6175, 5975
0610-0630	R. New Zealand	Checkpoint; 17705, 15485 Mon-Fri
0635-	AFRTS	Program Notes; 6030 Tue-Sat
0658-0659	R. Australia	Jacko; 11775, 9570
0709-0729	BBC	Twenty-four Hours; 15070, 11955, 9640, 9510, 6175 Mon-Fri
0809-0814	BBC	Reflections; 15070, 11955, 9640, 9510, 6175
0830-0840	R. Australia	Australian News; 11775, 9570
0909-0915	BBC	British Press Review; 15070, 11955, 9510, 6195
0915-0929	BBC	The World Today; 15070, 11750, 9740
1035-1059	Far East Network	Oldtime Radio; 15260, 11750, 6155, 3910 Mon-Fri
1058-1059	R. Australia	Jacko; 9580
1100-1159	AFRTS	Morning Edition; 15430, 15330, 11805, 9700, 6030 Mon-Fri
1109-1115	BBC	News About Britain; 21710, 21660 11775, 11750, 9510, 6195
1110-1125	R. Australia	Australian Insight; 9580 Mon-Fri
1200-1214	BBC	Radio Newsreel; 21710, 21660, 11775, 11750, 9510 Mon-Sat
1200-1259	AFRTS	Morning Edition; 15430, 15330, 11805, 9700 Mon-Fri
1212-1227	R. Australia	Four Corners; 9580, 5995 Mon-Fri
1230-1240	R. Australia	Australian News; 9580, 5995
1258-1259	R. Australia	Jacko; 17795
1300-1320	R. Canada Int'l	World at Eight; 17820, 15440, 11955 Mon-Fri
1309-1329	BBC	Twenty-four Hours; 21710, 21660, 11775, 11750, 9510 Mon-Fri
1320-1343	Swiss R. Int'l	Dateline; 25780, 21570 Mon-Fri (also 1535)
1330-1345	AFRTS	World News This Morning; 15430, 15330, 11805, 9700 Mon-Fri
1345-1400	Deutsche Welle	Musik; 21560, 17845, 17715 Mon-Sat
1413-1459	CBC No. Service	Morningside; 11720, 9625 Mon-Fri
1449-1459	AFRTS	First Line Report; Newsbreak; 15430, 15330, 11805, 9700 (also 1749) Mon-Fri
1500-1514	BBC	Radio Newsreel; 21710, 21660, 15070 (Sat & Sun also 17830, 15260)
1515-1559	BBC	Outlook; (as above) Mon-Fri
1530-1545	AFRTS	World News Roundup; 15430, 11805, 9700, 15330 Mon-Fri
1540-1600	Deutsche Welle	Musik; 21560 Mon-Fri
1615-1630	BBC	Focus on Africa; 21470 Mon-Fri
1630-1645	AFRTS	Spectrum; Jack Anderson; 15430, 15330, 11805 Mon-Sat
1645-1659	BBC	The World Today; 21710, 21660, 17830, 15260 Mon-Fri
1709-1723	BBC	Focus on Africa; 21470 Mon-Fri
1745-1800	Deutsche Welle	Musik; 21560 Mon-Sat
1800-1900	HCJB	En la Sala de Conciertos; 15160
1835-	AFRTS	Program Notes; 15430, 15345, 15330 Mon-Fri
1915-1930	HCJB	Música Latinoamericana; 15160 Mon-Fri
1917-1929	AFRTS	Paul Harvey; 21570, 15430, 15345, 15330 Mon-Sat (also 2117)
1940-2000	Deutsche Welle	Musik; 21600, 21500 Mon-Fri
2009-2029	BBC	Twenty-four Hours; 15260, 15070, 12095, 11750 Mon-Fri
2030-2035	AFRTS	Rest of the Story; 21570, 15430, 15345, 15330 Mon-Fri
2130-2145	AFRTS	Commentaries; (as above)
2145-2200	Deutsche Welle	Musik; 17810, 17795, 15275 Mon-Sat
2200-2229	R. Canada Int'l	The World at Six; 15325, 17875 Mon-Fri
2200-2329	AFRTS	All Things Considered; 21570, 15430, 15330 Mon-Fri (Sat & Sun 2200-2259)
2205-2230	Austrian R.	Musik; 11665, 15200
2209-2223	BBC	The World Today; 15260, 15070, 12095, 11750, 9410 Mon-Fri
2230-2257	R. Canada Int'l	As It Happens; 15325, 17875 Mon-Fri
2239-2244	BBC	Reflections; 15260, 15070, 12095, 11750, 9410
2255-	RAI, Italy	Musica; 11800, 9575 (length varies)
2300-2329	R. Canada Int'l	The World at Six; 11850, 5960 Mon-Fri
2309-2315	BBC	Commentary; 15260, 15070, 9590, 9410, 7325, 6175, 6120, 5975
2325-2335	R. Moscow	Vladimir Pozner's Daily Talk; 9610
2330-2350	AFRTS	The World Today; 21570, 15430, 15330 Mon-Fri
2330-2459	R. Canada Int'l	As It Happens; 11850, 5960 Mon-Fri
2340-2400	Deutsche Welle	Musik; 17860, 15410, 9735, 6075 Mon-Fri

Note: This listing deliberately omits regular newscasts, which almost always are on the hour or at opening of transmissions, as listed in our January and July columns. During the period of standard time, you may convert these times to local times by subtracting as follows: Newfoundland, 3½ hours; Atlantic, 4h; Eastern, 5h; Central, 6h; Mountain, 7h; Pacific, 8h; Yukon, 9h; Alaska & Hawaii, 10h; Bering, 11h.

HOBBY SCENE

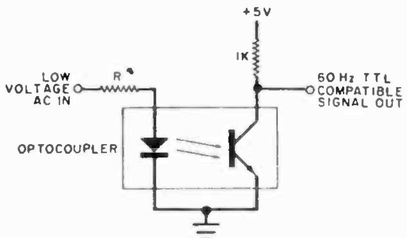
By Joe Desposito

ANOTHER TTL TRIGGER

In the March issue, we gave a circuit for obtaining a 60-Hz, TTL compatible signal. Reader John Wettroth sends the following comments:

Your circuit was fine, but there is an easier way to do it as shown below.

R* must be chosen to give the required current through the LED for reliable operation. For example, using a typical power-supply transformer delivering 7.5 V ac and a 15-mA diode current (sufficient for most optocouplers), R* is approximately equal to 0.5 kilohms.



Some other nice features of the circuit are: 1) by connecting two of the above circuits to the same ac input with their diodes reversed, two signals 180° out of phase can be obtained; 2) if you use a neon-input optocoupler (Clairex makes many or a hobbyist could build one), the idea would work directly from the line and is isolated! It might be necessary to also insert a diode in series with the neon lamp or you'll get a 120-Hz output (desirable for some designs).

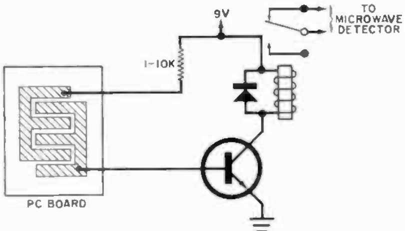
One thing to watch is the maximum reverse voltage on the LED in the isolator (many are about 5 V). This is easily remedied with a series conventional diode or a parallel reverse-biased diode.

Thanks for the contribution.

MICROWAVE SHUTOFF

Q. *I have several microwave detectors outside to let me know when someone approaches the front or back doors of the house. However, they will give a "false" alarm when it rains. I need a circuit that can turn off power to the detectors when it is raining hard enough to make them false. When the rain stops, the power would be restored.—R.J., Clayton, MO.*

A. A simple way to detect rainfall is with the transistor circuit shown below.



Connect the two wires to a pc board that has an interleaved pattern. Mount the board on an angle. When it rains, the wires will conduct, turn the transistor on, and energize the relay.

CAPACITOR RATINGS

Q. *I am building a project and need a capacitor that can carry 3 A at 125 V. I can find capacitors rated for 125 V but how can I find one that will carry 3 A?—Jerry R. Lane, New York, N.Y.*

A. Don't knock yourself out looking for current ratings on capacitors—they don't exist. If you can find a capacitor with the correct voltage rating, use it.

Have a problem or question in circuitry, components, parts availability, etc.? Send it to the Hobby Scene Editor, COMPUTERS & ELECTRONICS, One Park Ave., New York, NY 10016. Though all letters can't be answered individually, those with wide interest will be published.

About that Card File...

By Carl Warren

"STUFFED in shoe boxes and stacked on shelves, or sometimes just lying around," was the way my friend Jack described his index-card file of model railroad vendors and hobbyists. Jack has, I guess, been fooling around with model trains for at least the 15 years that I've known him. And he always complained that he could never find the right company or address when he wanted it. Well, I've always sympathized with Jack and through the years have tried a number of ways to help him solve the problem.

Before personal computers came on the scene, we worked out a filing method using punched paper tape and a Teletype reader. It was quite slow but it was the best we could do at the time. We stuck with paper tape until late 1977, when we heard about an audio-tape controller that we could use with our home-brew S-100 bus system. We put all the information on inexpensive audio tape and used BASIC to write some unique programs that gave search capability and a better way of entering and storing data.

Our next step was to purchase a high-speed tape system and use a more sophisticated BASIC. I was able to write a BASIC database-management system that used multiple indexes and provided rapid search functions. We eventually switched to floppies, which, of course, greatly increased the speed of operations. Most recently we dramatically improved the software end of the system. We implemented Ashton-Tate's database system *dBase II*.

This is the relational database that I reviewed in this column several months ago. The latest, version 2.03, has a number of enhancements, such as allowing the use of as many as seven index files, memory functions similar to peek and poke, and a function to call machine language subroutines.

Because dBase II's command structure is very straightforward, we were able to translate the bulk of our database management system from BASIC to dBase, and at the same time reduce its size. We also found that we could be extremely elegant in the design.

One problem we had using BASIC, even after switching to a disk system, was queing up a list of names. Typically, what Jack likes to do after a model RR convention is enter the names of fellow hobbyists or manufacturers into the database. What happens is that the database ends up with a number of duplicates.

At first we tried to solve the problem by making a copy of the existing database and comparing it with the original, looking for matches on company and contact names. Each time a match was found, we were given the chance to delete it or save it (the desired record was written to a new file). With a clean database, we re-indexed by company name, contact, and zip code, making three separate index files.

But what we finally did was write a new command file in dBase II that would count the number of occurrences of a company name, contact, or zip code and display them as a list. For example:

```
(1) A BIG TRAIN CO.
    JOE MONEYBAGS
(2) HI-HO TRAINS, INC.
    SALLY WHISTLESTOP
(3) ETC.
    WHICH RECORD DO YOU WISH?
```

Basically, the dBase structure for this was to use the database and indexes desired, ask for a company, contact, or zip code to search for, count how many times it showed up, set up a loop, display the list, ask for which one you want, find it, skip a record, end the process, and display the information. The way this looks in general form is:

```
USE Mail INDEX Mail, Name, Zip Code
  ACCEPT 'Enter Company, Contact, Zip
    Code You Want' TO What
WAIT
  COUNT FOR Company = &What
    .OR Contact = &What
      .OR Zip = &What
*Store the count to variable count and
  make a loop
  *Display the data
ACCEPT 'Which Item Do You Want' TO
Where
  GET Where
    FIND &What
*The above moves the pointer to the top
  record of the list
*Now you move to it
  DO WHILE Where < > 0
STORE Where-1 TO Where
SKIP *This puts the pointer at the desired
  record
ENDDO *End the process of location
*Display the record
  DISP ON #
  DISP ON Company
  DISP ON Contact
        .
        .
  DISP Phone
```

Using dBase, we now have a pretty sophisticated database management system. Recently, both Jack and I implemented our databases on the Otrona Attache personal computer. I use mine when visiting companies and have expanded the system to enter product information.

As for Jack, he seems happy with the system now but I'm sure he'll come up with something else that he wants to do with it before too long. ◊

Rolling the Dice Subroutines for a Board Game Program

By Jim Keogh

WOULD you like to design a game for your microcomputer that would simulate the kind of games played on a board? It would be interesting to have all the fun and excitement of playing the cardboard version but on your computer. Before you start to create such a program, you must be prepared to include subroutines for a random "roll" of the dice. After all, most board games involve the roll of a pair of dice to determine the moves.

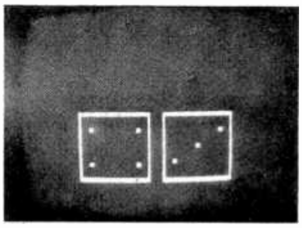
The subroutines given here each contain a different, but variable, function that can be easily combined with your own routines to give your program that extra punch. The subroutines are designed to have your microcomputer "draw" a pair of dice on the screen. With some slight modifications you will be able to roll the dice.

First, the subroutine draws two dice on the screen, one next to the other. You will notice that they are only two squares without any dots on their faces. Since we want the dots (the values of the dice) to change with every roll, the coding for the dots is listed separately from the outline of the dice. They are added to the program listing after you enter the dice routine.

Two random number generators are used to roll the dice—one for each die. The generators are set to select a number from one to six. When these numbers are selected by the computer, the program instructs the computer to move to the line(s) containing the coding to display the number on the die.

Each time the subroutine is activated, a different pair of numbers will appear on the screen in the dice. You can activate this subroutine as part of your own board game by having the computer follow the coding in the subroutine every time it is a player's turn to play the game.

To test these routines, add the "END" command to your code. Don't forget to remove it when you incorporate the routines into your game program. ◊



TRS-80

OUTLINE OF DICE

```
  1 CLS
 10 FOR A = 15498 TO 15518
 20 POKEA, 131
 30 NEXT A
 40 FOR A = 15523 TO 15543
 50 POKEA, 131
 60 NEXT A
 70 POKE 15498,151
 80 FOR A = 15562 TO 15818 STEP 64
 90 POKE A, 149
100 NEXT A
110 POKE 15518,171
120 FOR A = 15582 TO 15838 STEP 64
130 POKE A, 170
140 NEXT A
150 POKE 15818,181
170 FOR A = 15819 TO 15838
180 POKE A, 176
190 NEXT A
200 POKE 15838,186
210 FOR A = 15523 TO 15843 STEP 64
220 POKE A, 149
230 NEXT A
240 FOR A = 15543 TO 15863 STEP 64
250 POKE A, 170
260 NEXT A
270 FOR A = 15843 TO 15863
280 POKE A, 176
290 NEXT A
300 POKE 15863,186
310 POKE 15543,171
320 POKE 15523,151
330 POKE 15843,181
```

VALUES FOR LEFT DIE

```
1 = POKE 15700,131
2 = POKE 15565,140
    POKE 15771,140
3 = POKE 15565,140
    POKE 15771,140
    POKE 15700,131
4 = POKE 15565,140
    POKE 15771,140
    POKE 15757,140
    POKE 15579,140
5 = POKE 15565,140
    POKE 15771,140
    POKE 15757,140
    POKE 15579,140
    POKE 15700,131
6 = POKE 15565,140
    POKE 15771,140
    POKE 15757,140
    POKE 15579,140
    POKE 15693,131
    POKE 15707,131
```

VALUES FOR RIGHT DIE

```
1 = POKE 15725,131
2 = POKE 15590,176
    POKE 15796,140
3 = POKE 15590,176
    POKE 15725,131
    POKE 15796,140
4 = POKE 15590,176
    POKE 15796,140
    POKE 15782,140
    POKE 15604,176
5 = POKE 15590,176
    POKE 15725,131
    POKE 15796,140
    POKE 15782,140
    POKE 15604,176
6 = POKE 15590,140
    POKE 15796,140
    POKE 15782,140
    POKE 15604,176
    POKE 15718,131
    POKE 15732,131
```

APPLE II

OUTLINE OF DICE

```
10 HLIN 4, 18 AT 5
20 HLIN 4, 18 AT 19
30 VLIN 5, 19 AT 4
40 VLIN 5, 19 AT 18
50 HLIN 23, 37 AT 5
60 HLIN 23, 37 AT 19
70 VLIN 5, 19 AT 23
80 VLIN 5, 19 AT 37
```

VALUES FOR LEFT DIE

```
1 = PLOT 11, 12,
2 = PLOT 6, 7
    PLOT 16, 17
3 = PLOT 11, 12
    PLOT 6, 7
    PLOT 16, 17
4 = PLOT 6, 7
    PLOT 16, 17
    PLOT 16, 7
    PLOT 6, 17
5 = PLOT 11, 12
    PLOT 6, 7
    PLOT 16, 17
    PLOT 16, 7
    PLOT 6, 17
6 = PLOT 6, 12
    PLOT 16, 12
    PLOT 6, 7
    PLOT 16, 17
    PLOT 16, 7
    PLOT 6, 17
```

VALUES FOR RIGHT DIE

```
1 = PLOT 30, 12
2 = PLOT 25, 7
    PLOT 35, 17
3 = PLOT 30, 12
    PLOT 25, 7
    PLOT 35, 17
4 = PLOT 25, 17
    PLOT 35, 7
    PLOT 25, 7
    PLOT 35, 17
5 = PLOT 30, 12
    PLOT 25, 17
    PLOT 35, 7
    PLOT 25, 7
    PLOT 35, 17
6 = PLOT 25, 12
    PLOT 35, 12
    PLOT 25, 17
    PLOT 35, 7
    PLOT 25, 7
    PLOT 35, 17
```

COMPUTER HOTLINE

Answering your questions on computers and their use

By Stan Veit

IN THIS column, we select questions from readers that we feel will be most useful and answer them as best we can. We cannot, of course, answer all of the questions we receive on an individual basis, but here are some recent queries sent to the magazine. If you have a question, address it to the "Computer Hotline."

STRANGE HAPPENINGS IN APPLE

Q: *Strange things are happening to my Apple computer. I have the Language Card, Serial I/O Card and 80-Column Card installed—in addition to the disk controller. I use the computer a lot and it always works like a charm. However, every once in a while, something just stops running. I turn off the machine and pull the offending card, look at it, and put it back. Nine out of ten times it works after that! My dealer says this is common and he just cleans off the plug-in contacts on the board. Sometimes just pulling the board and replacing it is enough. My friends with TRS-80 Mod I tell me that they have card edge contacts that are not gold-plated and it is even worse. Can you explain what is happening?—Bob Paul, Orlando, FL.*

A: There are several explanations for this problem, but the most reasonable is "There is a Fungus Among Us." There are airborne spores such as yeast that can land on electrical contacts—and they grow there. Possibly they are attracted by the potential on the contacts. These fungi flourish in humid climates and they can form an insulating but invisible coating on the contacts. In this they can even push the contacts apart! Removing the boards and cleaning them usually works. Don't forget to turn off the computer before you pull any boards.

OSBORNE MODEM

Q: *I am tired of waiting for the Osborne Computer Co. to come out with the long-awaited modem. I want to get on the Compuserve net. How can I do this?—Jack Depler, Kansas City, MO.*

A: You can use any acoustic-coupler modem and connect an RS232 cable from the serial I/O port to the modem. You will also need communications software. The Micro Link by Wordcraft is distributed by Osborne for its computer. It is priced at $89.

WHAT KIND OF DISPLAY?

Q: *I am considering purchase of an IBM-PC Computer. However, I am confused as to what kind of video display to order. Can you solve my problem? Can I use an r-f modulator and my TV set? Should I get either their color interface and monitor or a monochrome interface and monitor? I will mainly use my computer for business and word processing—Robert Simmons, Westwood, NJ*

A: To start with, forget about the r-f modulator and use your TV set for watching TV. The modulator/TV works OK for games, but is not intended for serious computer work. If you are going to do a lot of graphics and little text, then you can go with a color interface and monitor. It has the complete character set on it and you can use it for alphanumerics. However, characters on a color monitor are not real sharp, and I have looked at several rather expensive ones.

If you are going to use IBM boards, and you eliminate the monochrome display/printer adapter in favor of the color graphics adapter board, you are going to add a separate printer adapter board. This is because the printer interface is on the monochrome board. If you are going to use the computer for text and numbers, get the monochrome display/printer adapter board and the monochrome (green) monitor. It is among the best video monitors around. This monitor is priced at \$335, which is reasonable for this quality monochrome monitor.

IS A FAN NECESSARY?

Q: *Do I need a fan on my Apple II? I see them advertised and my friend has just bought one. It does get warm inside my computer, but I have never had any trouble with it. If I decide to get one should I get one that hangs outside or fits inside?—Bill Knotts, Washington, DC*

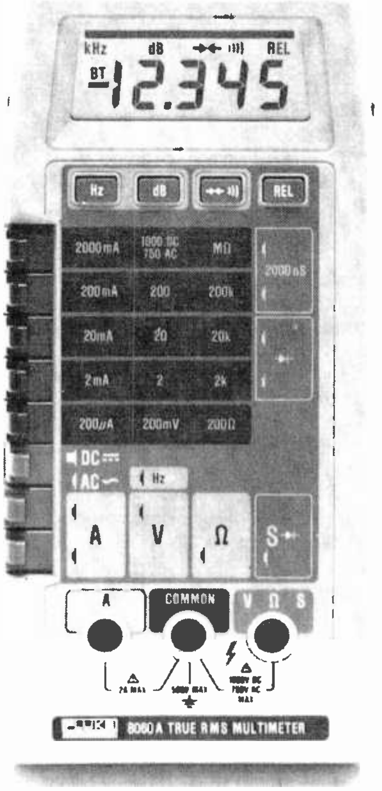
A: Apple didn't think you needed a fan so they did not provide one. They can cause electrical glitches while they cool your computer. However, Apple never envisioned Apple IIs with 128K memory boards, 80-column boards, and all the other wonderous plug-ins we now have. We have several Apple II's in the college where I teach some evenings, and the computer lab is in the basement where it can get very warm. The machines indeed overheated without the fans. To use fans you must plug up most of the vents in the case, and leave the ones used for air flow open, as directed in the fan installation drawing supplied with the fan assembly. I like the outside mounting fans that are mounted near the power supply. Don't install a fan unless you have a lot of hot running boards in your Apple, though. You will know when you need it! Remember that the motto in the computer fraternity is "Don't fix it if it isn't broken."

DEAR READERS:

Is there anyone out there who is using an IBM-PC computer with a cassette? If so I would like to hear about it.

Also, here's a correction for last month's column. There was a typographical error and a little "=" was dropped by the typesetter. Not a big thing, except the procedure will not work without the equal sign! Correct use of the CP/M STAT command is LST: = LPT:

Fluke Model 8080A Digital Multimeter



THE Model 8060A Digital Multimeter from John Fluke Mfg. Co., is a handheld, microcomputer-controlled 4½-digit test instrument for general-purpose use.

Besides the usual DMM functions of dc voltage, ac voltage, ac and dc current, and a wide range of resistance measurements, the Model 8060A breaks away from the pack with its ability to measure frequency to 200 kHz, and relative and dB measurements with almost any impedance.

The CPU uses a 4-bit bidirectional bus and four control lines to communicate with a custom CMOS LSI chip (called MAC for Measurement Acquisition Chip) that includes a dual-slope A/D converter and control logic. The latter includes a buffer, decoder, read/write logic, status and control registers, and logic control for the system. This chip also generates the drive for a piezoelectric transducer used for "eye-off" continuity measurements. The CPU also controls the measurement cycles, performs all calculations, and drives the LCD readout.

The Model 8060A fits within a shock-resistant plastic case 7.1" long, 3.4" wide, and 1.8" deep. It weighs 14.5 ounces. Four nonskid bumpers and a tilt bail are provided. Suggested retail price is $349.

General Description. When the 8060A is powered up, the internal microcomputer runs a 1.6-second diagnostic that checks everything from the LCD elements to the correct operation of the eight function and four pushbutton switches.

Dc voltage is measured in five ranges from 200 mV to 1 kV full scale at an input resistance of 10 megohms. By pushbutton control, this input resistance can be increased to 10,000 megohms on the two lower ranges (200 mV and 2 V).

Ac voltage is measured in five ranges from 200 mV to 750 V true rms. Input impedance is 10 megohms shunted by less than 100 pF. The internal true rms converter provides measurement of nonsinusoidal waveforms to 100 kHz. Ac indications can be in volts, relative dB, or dB referenced to 600 ohms.

Both ac and dc currents can be measured from 0.01 μA to 2A in five ranges.

Resistance is measured by a ratiometric method that compares the external unknown to an internal reference. Between 0.01 and 200,000 ohms, low power (250 mV) is used for in-circuit measurements. This ensures that no semiconductor junction will be turned on during measurements. In addition to the four selectable ranges, the 8060A autoranges between 100,000 ohms and 300 megohms.

As a frequency counter, the 8060A covers the range from 12 Hz to 200 kHz in four autoranges (with appropriate LCD annunciator change from Hz to kHz). Frequency resolution varies from 0.01 Hz in the 200-Hz range to 100-Hz resolution on the 200-kHz range. Updates are one per second. Since the multimeter front end is used in frequency measurements, signals up to 750 volts can be measured safely. Accuracy is 0.05% of reading.

Any reading on the 8060A can be stored as an "offset" for relative measurements. When the desired reference is selected (depressing the REL pushbutton), all subsequent readings are displayed as deviations from that reference. This simplifies alignment procedures as the display only shows any positive/negative deviation from the selected reference. Thus stage gain/loss is easily noted (in dB if desired). The 8060A also produces direct display over a 108-dB range that can be referenced to any of 16 impedances from 8 to 1200 ohms.

Another interesting feature is the instrument's visual/audible continuity tester. Either an LCD bar display or the tone from an internal piezoelectric transducer can be used to indicate continuity without having to watch the meter. To check semiconductor junctions, a constant-current diode test function is provided.

The conductance function of up to 2000 nanoseimens is basically an inverse resistance range from 500,000 ohms to 10,000 megohms. This makes it ideal for leakage or conductivity measurements.

Available accessories include a carrying case, high-voltage probes, high-frequency probes, temperature probes, current transformers, special test leads, and a variety of cables and adapters. The instrument


CERTIFICATE OF CALIBRATION

LOCKHEED ELECTRONICS COMPANY, INC.

...FLUKE

comes with a pair of color-coded (red/black) safety test leads.

User Comments. The Model 8060A Digital Multimeter was checked by the Lockheed Electronics Instrumentation Measurement Lab. (Plainfield, NJ) against standards traceable to the National Bureau of Standards and was found to meet or exceed specifications.

Although at first glance, the $349 price seemed a little steep for a

FLUKE MODEL 8080A MULTIMETER TECHNICAL SPECIFICATIONS

DC Voltage:
Ranges: 200 mV, 2, 20, 200, 1000 V.
Resolution: 0.01 mV, 0.1 mV, 1 mV, 10 mV, 100 mV, depending on range.
Accuracy: 0.04-0.05% of rdg. + 2 dig. depending on range.
Response Time: 1 second max. to rated accuracy within range.
Input Impedance: 10 megohms shunted by less than 100 pF.
Normal Mode Noise Rejection: Over 60 dB at 50/60 Hz.
Common Mode Noise Rejection: Over 120 dB at dc. 90 dB at 50/60 Hz (1 kilohm imbalance).
Overload Protection: 1 kV dc or peak ac continuous, except 20 s max on 200-mV and 2-V ranges above 300 V dc or rms.

DC Voltage, High-Impedance Mode: All specifications same as for dc voltage. Only 200-mV and 2-V ranges available. Accuracy is 0.05% rdg. + 2 dig.
Input Impedance: Over 1000 megohms, typically over 10,000 megohms.
Overload Protection: 300 V dc or rms continuous 20 s max, 300 to 1 kV dc or peak ac.

DC Voltage, dB Mode: Measurements are made in dBm referenced to 600 ohms or relative dB. All specifications same as for dc voltage except:
Dynamic Range: With full 0.01-dB resolution, 99.79 dB. Total specified dynamic range is 136.22 dB (160 µV to 1 kV).
Resolution: 0.01 dB for 19,999 to 1024 linear counts; 0.1 dB for 1023 to 128; 1 dB for 127 to 16 linear counts.
Accuracy: ±0.04 dB for 19,999 to 1024 linear counts; ±0.2 dB for 1023 to 128; ±1 dB for 127 to 16 linear counts.

AC Voltage: (true rms, ac coupled):
Ranges: 200 mV, 2 V, 20 V, 200 V, 750 V
Accuracy: 0.2% of rdg. +10 dig. to 3% +200 dig., depending on range, input voltage, and frequency.
Resolution: 0.01 mV to 100 mV, depending on range.
Input Impedance: 10 megohms shunted by less than 100 pF.
Common Mode Noise Rejection: over 60 dB at 50/60 Hz (10 kilohm imbalance).
Response Time: 5 s max., 12 s from overload.
Overload Protection: 750 V rms, 1 kV peak continuous except 20 s max on 200 mV above 300 V rms or 300 V dc. Input not to exceed volts/Hz product of 10^7.

AC Voltage, dB Mode (true rms, ac coupled):
Measurements are made in dBm referenced to 600 ohms or relative dB. All specifications same as ac voltage except the following:
Dynamic Range: With full 0.01-dB resolution, 97.30 dBm. Total specified dynamic range is 109.72 dBm (2.45 mV to 750 V ac rms).
Resolution: 0.01 dB to 1 dB depending on linear counts.
Accuracy: 0.1 to 2.2 dB depending on range and frequency.

Frequency: Range fully autoranging.
Ranges: 200 and 2000 Hz; 20 and 200 kHz.
Resolution: 0.01 to 10 Hz depending on range.
Accuracy: ±0.05% of rdg. + 1 dig.
Sensitivity: 20 mV or 10% of voltage range to 150 mV or 75% of voltage range depending on frequency range and whichever is greater.

Extended Frequency:
Range: 12 Hz to 700 kHz, typically
Resolution: 100 Hz above 200 kHz
Accuracy: ±0.05% of rdg. + 2 dig.
Sensitivity: Typically 100 mV at 200 kHz increasing to 4.5 V at 700 kHz in 200-mV range. Will measure a TTL signal (50% duty cycle) to 420 Hz (typical).

Resistance:
Ranges: 200 ohms, 2k, 20k, 200k, autoranging megohms (extends from 0.0001 to 300 megohms in 3 autoranges).
Response Time: Two seconds max for all ranges but megohms where it is 8 seconds max.
Overload Protection: 500 V dc or rms ac on all ranges.
Accuracy: 0.07% + 2 +0.02 ohm to 0.2% + 2, depending on range.
Resolution: 0.01 ohms to 1 kilohm depending on range.

Conductance:
Range: 200 nanoseimens (equivalent to resistance range from 500 kilohms to 10,000 megohms)
Resolution: 0.1 nanoseimen
Accuracy: ±0.5% of rdg. + 20 dig.
Open Circuit Voltage: Less than 1.5 V.
Overload Protection: 500 V dc or rms ac.

Continuity:
Ranges: All resistance ranges.
Threshold: Nominally 10% of range.
Response Time: 50 microseconds max. (10 µs typical)
Overload Protection: 500 V dc or rms ac

Diode Test:
Range: 2 V
Test Current: 1 mA ±10%
Accuracy:±0.05% of rdg. + 2 dig.
Response Time: 2 s max.
Overload Protection: 500 V dc or rms ac

DC Current:
Ranges: 200 µA, 2, 20, 200, 2000 mA.
Resolution: 0.01 to 100 µA, depending on range.
Accuracy: 0.2% of rdg. + 2 dig. to 0.3% of rdg. + 2 dig.
Overload Protection: 2A/250V fuse.

AC Current (true rms responding, ac coupled)
Ranges: 200 µA, 2, 20, 200, 2000 mA.
Resolution: 0.01 to 100 µA, depending on range.
Accuracy: 1% of rdg. + 10 dig. to 2% of rdg. + 40 dig., depending on range.
Overload Protection: 2A/250V fuse

General:
Max. Common Mode Voltage: 500 V dc or ac rms
Display Update Rate: 2.5 readings/second. For frequency, 1 reading/second. For dB, 1.4 readings/second.
A/D Converter: Dual Slope.

Environmental:
Operating Temperature: 0 to 50°C.
Storage Temperature: −35 to +60°C.
Accuracy Temperature Coefficient: 0.1 times applicable accuracy per °C (plus initial 23°C specification) for 0 to 18°C and 28 to 50°C.
Relative Humidity: 0 to 80% from 0 to +35°C. 0 to 70% RH for M range above 20 megohms.
Shock and Vibration: MIL-T-28800B.

DMM, after a week or so of use, we found it to be well worth the money. The conventional DMM functions (ac/dc volts and current, and resistance) are excellent and easy to set up using the interlocking pushbutton range/function switches. The visual/audible continuity tester was similar to the one on our older DMM, so there were no surprises here.

However, we were highly impressed with the other functions that are not available on other DMMS. We found the frequency-counter mode (although limited to 200 kHz) to be just as good as our relatively expensive bench instrument. Since we do a lot of work within the audio range, this was no problem.

With the 8060A, we simply attach the test leads to the circuit, measure the signal voltage level (in dB if desired); and, by merely touching a pushbutton, observe the frequency. This is something that cannot be done with a conventional frequency counter. The LCD display automatically changes from Hz to kHz (or vice-versa) as required by the signal. Because the 8060A is portable, it does not tie up valuable bench space to make measurements. And, since it is battery powered, we are looking forward to using it in the field.

The RELative function was really put to use since this was something we had not seen before. In this mode, you can measure a signal and, when you reach some desired level, simply touch the REL pushbutton and this level becomes the reference. The display drops to all zeros and displays only positive or negative changes from the selected reference. We found this mode to be the best way to keep an eye on stage-gain changes during alignments. No longer did we have to watch an LCD full of changing digits—only the relatively slight positive or negative changes that took place during the alignment. We could even do this with dB.

Although not covered on the front panel, the 8080A can be made to have a (typically) 10,000-megohm input impedance to reduce loading on high-impedance (CMOS) circuits. This also allows the instrument to be used as an electrometer for making extremely low current measurements.

The conductance portion is very useful for making leakage measurements to 10,000 megohms. Also not indicated on the front panel is the fact that the 8060A can be made to autorange between 2000 ohms and 300 kilohms.

The manual that accompanies the 8060A is excellent. It covers all operating instructions, maintenance, etc., and includes a wide variety of applications for this special DMM.

If you are looking for an excellent, state-of-the-art multimeter that wears several hats, and gives the "multi" prefix real meaning, check out the Fluke 8060A—a remarkable DMM. —*Les Solomon*

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New Developments in Fiber Optics

By Forrest M. Mims

EVERY new technology must endure a growth and maturation period during which prices are high, reliability is questionable, and availability is uncertain. For fiber optics, that unsettling time is rapidly approaching its end. Although major problems remain concerning standardization of components, couplers, termination devices, and fibers; the design, assembly, and installation of a fiber-optic-data and telecommunications link has become virtually routine.

The eventual impact of this new technology was nicely summed up in a recent Toshiba advertisement for its optical transmission devices. The headline read: "Exit the copper age. Enter the light years." Let's examine some recent developments in fiber-optic communications technology to see just how advanced it has become.

Low-Loss Fibers. A dozen years ago, Corning achieved an historic breakthrough by making the first glass fiber with a loss of 20 dB per kilometer. This accomplishment provided a major stimulus to the infant fiber-optic communications industry. Today several companies are making silica fibers having a loss of only 0.2 dB/km. In everyday terms, such ultra-low-loss fiber loses only half its initial optical power over a distance of 15 kilometers! This makes possible repeaterless fiber-optic links over distances exceeding 100 kilometers (or more than 62 miles).

Scientists at British Telecom's research laboratories and at Bell Laboratories in the United States have demonstrated repeaterless transmission over ultra-low-loss fibers more than 100 kilometers in length. The Bell Labs researchers, for example, transmitted with error a 274-megabit-per-second signal over a 101-kilometer length of fiber having a total loss of only 0.38 dB/km at 1.3 micrometers (μm).

The fiber used in the Bell Labs demonstration was assembled from four separate fibers spliced together using a flame fusion process (also known as heat welding). The transmitter was an InGaAsP buried heterostructure laser diode. Since the attenuation of the fiber at 1.5 μm is only 0.29 dB/km, work is underway to perfect emitters and detectors that operate well at this longer wavelength.

Non-Glass Fibers. Experimenters and budget-conscious industrial users who cannot afford glass fibers often turn to plastic fibers for short-range optical links. Such fibers are made from a core of polystyrene or polymethyl methacrylate clad with a polymer of lower refractive index. They have an attenuation of hundreds or thousands of dB/km.

The DuPont Company (Plastic Products and Resins Dept., Wilmington, DE 19898) is the leading manufacturer of plastic fiber in the United States. Some of DuPont's plastic fiber products can be conveniently purchased from Edmund Scientific (101 E. Gloucester Pike, Barrington, NJ 08007). Another domestic supplier of plastic fiber is General Fiber Optics (P.O. Box 82, Caldwell, NJ 07006).

Recently, Japan's Mitsubishi Rayon Co., Ltd. developed plastic fibers with an attenuation of about 200 dB/km at 590 nanometers. While this may seem very high when compared to low-loss silica fibers, it's a breakthrough for plastic.

Unfortunately, the semiconductor emitters which produce 590-nm radiation are not very efficient. In the 650-670-nm region where relatively efficient GaAsP red light-emitting diodes are available, the new fiber has an attenuation of about 300 dB/km. This is still fairly low for plastic and acceptable for data links of a few tens of meters.

The Mitsubishi fiber is sold under the ESKA trademark and the lowest loss variety is designated SH4001 and SH4002. The U.S. representative is the Nissho Iwai American Corporation (Broadway Plaza, Suite 1900, 700 South Flower St., Los Angeles, CA 90017).

While silica fibers hold the lead in performance at present, considerable research is underway to develop exotic new materials with even lower attenuation. For example,

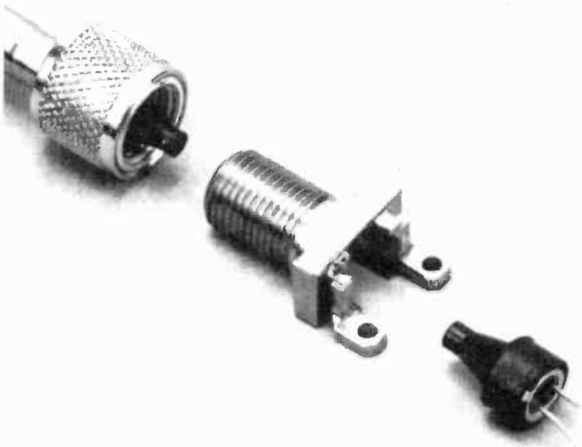

Fig. 1. This AMP metal bulkhead fiber-optic connector interfaces with Motorola emitters and detectors. (Motorola photo)

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zinc-chloride glass has an attenuation of only about 1 dB per 10^3 km in the 3.5-4.0 μm region. This is hundreds of times better than the best silica fibers. Even more spectacular are fibers made from halide compounds such as thallium bromide and KRS-5 having estimated losses as low as 10^{-5}dB/km in the 4.0-5.5-μm region. So far none of these super-low-loss fibers is available commercially.

The long wavelengths at which these exotic new fibers provide optimum results will require the development of new sources and sensors. If the new fibers, sources, and sensors can be developed, they may provide the potential for repeaterless fiber-optic links hundreds of miles in length.

Connecting Fibers. As with wire, optical fibers can be connected by permanent splices or by removable connectors. Notable advances have occurred in both areas.

Several companies sell fusion splicers that provide relatively quick joints in silica fibers. In some of these devices the heat required to melt the ends of the fiber to be joined is provided by an electric arc; in others a flame is utilized. In both cases, the requirement for precision manipulation of the fiber keeps the cost of fusion splicers high, typically several thousands of dollars or more.

A recent development which may eventually provide low-cost splicing for experimenters and hobbyists as well as industrial users is the Amox fiber-optics splice kit (American Fiber Optics Corporation, 1196 East Willow St., Signal Hill, CA 90806). Amox claims that in only eight minutes the ends of two fibers can be stripped of their coating, cleaved, and inserted into an epoxy-filled sleeve, which is then hardened with ultraviolet radiation from a lamp supplied with the kit. The average loss of such splices is said to be only 0.1 dB, about the same as for splices made with heat fusion.

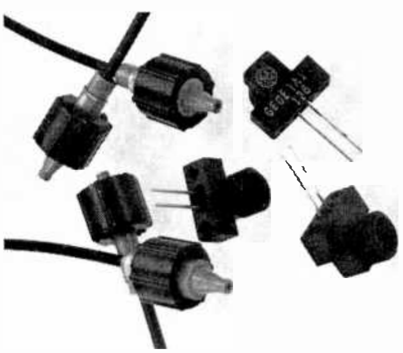


Fig. 2. General Electric emitters and detectors, DuPont Crofon fiber, and AMP Optimate connectors combine in lightwave links. (GE photo)

The Amox splice kit sells for $1995, a lofty price that will likely stimulate competition. It may ultimately provide a much more reasonably priced approach to cold splices.

Many new termination and splicing connectors for optical fibers have been developed in recent years. Since fiber-optic connectors must precisely align the cores of adjacent fibers to within a few microns, they usually cost more than comparable connectors designed to interconnect metallic conductors. There are some other constraints imposed upon fiber connectors. One is that although high coupling efficiency demands that the two opposing fiber faces be brought into close proximity, they must not make physical contact lest one face be scratched by the other. Another, is that the connector must be immune to contaminants such as dust and moisture which might otherwise obstruct the thin air gap betwen the two opposing fibers.

Even though prices for fiber connectors remain high, they are lower than those of a year ago. For example, Amphenol North America (2122 York Rd., Oak Brook, IL 60521) has introduced a line of mass-produced aluminum fiber-optic connector bodies that will cut metal-connector prices more than 50%. The new bodies are designed for use with existing Amphenol single-fiber connectors. Plastic connector prices are also falling.

Figure 1 shows a metal bulkhead connector made by AMP Inc. (Eisenhower Blvd., Harrisburg, PA 17105). This connector is designed to interface with a line of compatible emitters and detectors made by Motorola (P.O. Box 20912, Phoenix, AZ 85036). The resilient plastic in the connector's ferrule and the emitter's (or detector's) outer package provides excellent coupling between the fiber and the termination component's optical port.

Figure 2 shows several AMP plastic connectors designed to interface with a new line of General Electric emitters and detectors, the GFOE and GFOD series. The price of the connectors and components in Fig. 2 is remarkably low considering the prices for similar items just a few years ago. For example, General Electric offers for only $9.95 a design kit consisting of a GFOE1A GaAs emitter, a GFOD1A or 1B silicon detector, a one-meter length of DuPont Crofon™ 1040 fiber-optic cable terminated with AMP Optimate™ plastic connectors, and a complete assortment of specification sheets and application notes. The Optimate™ connectors attach within seconds to the threaded ports on the GFOD and GFOE terminal components. The kit can be ordered directly from General Electric (Semiconductor Products Dept., Optoelectronics, W. Genesee St., Auburn, NY 13021).

A designer kit similar to General Electric's cost $100 several years ago. And it did not include detectors and emitters housed in a self-contained threaded coupler. Instead, it used standard emitters and detectors cemented to fiber-optic bulkhead connectors.

You may wish to consider experimenting with such a kit. Many suitable transmitter and receiver circuits have been published in this magazine over the past several years (see the annual index for specific article and column topics). Also, I've included in "Engineer's Notebook II" (Radio Shack, 1982) an assortment of simple transmitter and receiver circuits, all of which have been built and tested.

Transmitter and Receiver Modules. If you're in a hurry and can afford the added expense, a wide range of preassembled fiber-optic transmitter and receiver modules is available. Figure 3, for example, shows the Augat© CL10 Fiberoptic Data Link. The CL10 is actually a group of modular components that can be selected for a variety of specific needs. This permits the selection of a one-piece integral transmitter or separate driver and emitter assemblies. Similarly, the CL10 provides a one-piece integral receiver or separate detector and preamplifier assemblies. For more information about the CL10 and various other fiber-optic modules, contact Augat (40 Perry Avenue, P.O. Box 1037, Attleboro, MA 02703).

Many other companies make preassembled fiber-optic modules. They include: Burr-Brown Research Corp. (6730 S. Tucson Blvd., Tucson, AZ 85706); General Optronics (3005 Hadley Rd., S. Plainfield, NJ 07080); Hewlett-Packard (Optoelectronics Div., 640 Page Mill Rd., Palo Alto, CA 94304); Math Associates (6 Manhasset Ave., Port Washington, NY 11050); and Meret (1815 24th St., Santa Monica, CA 90404).

For a complete listing of manufacturers of fiber-optic modules as well as related accessories (fibers, connectors, detectors, emitters, etc.), see the "Laser Focus Buyers' Guide" (1001 Watertown St., Newton, MA 02165). The price for the 1982 edition is $25, but you can find a copy in some technical libraries. Another excellent source, which also contains many articles about fiber optics, is the International Fiber Optics and Communications "Handbook and Buyers Guide" (Information Gatekeepers, 167 Corey Rd., Brookline, MA 02146). The price for the 1981-82 edition is a rather steep $45. But as with the other volume, you might be able to find it in some technical libraries.

Future Developments. Recently while writing an article about the current status of the fiber-optics industry, I was able to interview by telephone Dr. Charles Kao of ITT. It was Dr. Kao who, in 1965, first demonstrated the potential of practical communications by means of modulated light beams transmitted through optical fibers.

Dr. Kao told me there are three cornerstones to the new information age: computer technology, VLSI (very large scale integration) semiconductor technology, and fiber optics. "Fiber optics," he said, "depends on the other two. The other two, in a way, depend upon fiber optics for their growth."

If Dr. Kao is correct, we can expect to see many more exciting developments in fiber optics in coming months and years. Of course it's important to keep the role of fiber optics in perspective. Why, for instance, trip over cables, fiber or otherwise, that connect computers to nearby desktop terminals? Instead, simply bounce an infrared beam to and from the computer and its terminals. Ceilings and walls will provide suitable reflection points for the invisible beams. In short, while fiber optics is definitely a technological wave of the future, direct transmission through air will remain suitable for short-range optical links. ◇

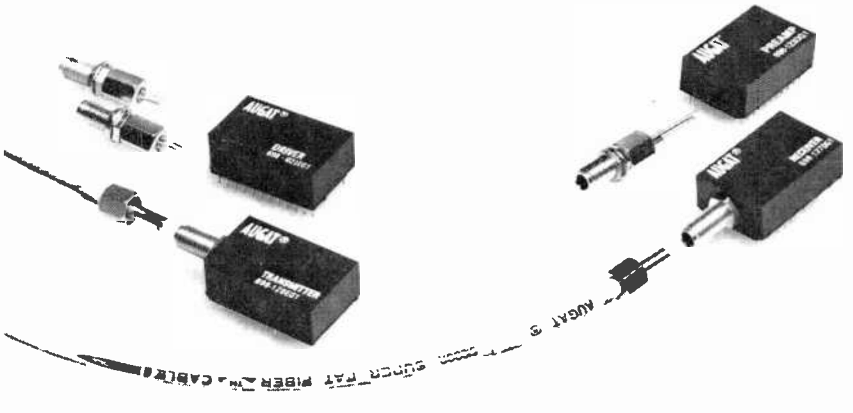


Fig. 3. This Augat CL10 Fiberoptic Data Link uses interchangeable modules with either integral or separate emitters and detectors.

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. Computers & 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.)*

Murphy Radio Type B71. Need any information available. Harold C. Gray, 1130 Woodward Avenue, Akron, OH 44310.

General Instruments Model AY-3-8900 TV interface chip. Need data manual. Ralph Johnson, 1837 Aglen St., Roseville, MN 55113.

Precision Model 120 VOM. Need schematic. J. Fuchs, 505 S. Oakwood Avenue, Brandon, FL 33511.

Sony Model TC-330 tape recorder. Need schematic, service manual and operating instructions. Enrique. M. Senra, 740 East 11th Place, Hialeah, FL 33010.

Weston Models 676, 682 and 785 tube testers. Need service data. Frank Krantz, 100 Osage Avenue, Somerdale, NJ 08083.

Hallicrafters Model SX32 receiver. Need schematic, parts list and service manual. Chris Reinhold, 110 Bottino Dr., Vicksburg, MS 39180.

Hickok Model 600A tube tester and **Javelin** Model MC 930 TV camera. Need schematics and service manuals. Dennis Lackey, Box 311, Winton, CA 95388.

Akai Model M-10 tape recorder. Need instruction manual. Stuart Vogelmann, 130 Indian Church Road, Buffalo, NY 14210.

Knight Model KG-375 analyzer and **Lafayette** Model 99-5015 signal generator. Need schematics and manuals. Adolf Naegeli, 9416-120th Ave., Kenoska, WI 53142.

Craig Model 6407 video tape recorder. Need video heads and service manual. DeWayne Fleming, Rt. 4, Box 202, Moberly, MI 65270.

Stewart-Warner Model R-181-A shortwave radio. Need schematic, parts list, tube source and service information. Bob Morris, 344 Elm Street, Syracuse, NY 13203.

Mercury Model 201 tube tester. Need all available tube charts. Ronald Pence, Rt. 3, Box 617, Grant, AL 35747.

Heathkit Model IM-1212 multimeter. Need manual and schematic. Larry Cook, 362 E. South St., Richland Center, WI 53581.

Dumont Type 90I engine scope. Need schematic, parts list, operation and service manuals. Joseph J. Calicchio, 226 Hutton Street, Jersey City, NJ 07307.

Titano Model 900 2-channel amplifier. Need schematic. Harry Pierce, Rt. 1, Box 232, Lamar, AK 72846.

Hygain Model 655 VHF. Need schematic and service manual. Mark Alan, Box 2923, Greenville, NC 27834.

Atari Model CX-2600. Need schematic diagram of circuit No. C010433. Guarionex A. Berrido, Corporacion Dom. Electricidad, Centro de Operaciones, Dpto. Sub. Estaciones, Calle Isabel Aguiar, Herrera, Santo Domingo, Republica Dominicana.

Sansui Model AU-111 amplifier. Need MC input transformer. G. Mileon, 14 Border St., Lynn, MA 01905.

Hallicrafters Model HT-37 transmitter. Need operation manual and service manual. Ken Bernard, Box 1304, Mount Dora, FL 32757.

Hickock Model 1805A oscilloscope. Need manual. Eiichi Takarada, 1423 Vassar Road, Rockford, IL 61103.

Precise Development Corp., Model 308 oscilloscope. Need manual and schematics. Ambrose Jacob, Enterprise Terrace, Kingston, RI 02881.

Akai Model GX4000D tape recorder. Need schematic and service manual. James O. Mosher, 3031 E. Dunham Dr., Wichita, KS 67216.

Barber Colman Model B door control. Need schematic and manual. Need receiver and transmitter. Bruce Myers, 9915 Oleander Ave., Vienna, VA 22180.

General Electric Model 35300B700A0 Term Net 300 terminal. Need schematics and service data. Brad DePriest, 736 First Place S.E., Salem, OR 07306.

Jenning Research 400 watt transistor amplifier. Need schematics and technical information. Horace Cambell, Electronic & Woodwork Center, 5311 Church Ave., Brooklyn, NY 11203.

Breting Model 14 shortwave receiver. Need schematic and service information. Harry J. Lookabill, 504 W. 86th Terrace, Kansas City, MO 64114.

Crescent Communications Corp., Model ZM-30/U bridge and **AEL Products, Inc.**, Model AN/USM-206 test set. Need schematics, and service/owner's manuals. Thomas Sahara, P.O. Box 23283, Honolulu, HI 96822.

MicroAce microcomputer. Need PCB link changes to use with Sinclair 8K PROM. Joe Cox, 408-47 Ave., Southwest, Calgary, Alberta, Canada T25-1C4.

Panasonic Model SE-440 AM/FM stereo tape cassette unit. Need schematic and service manual. Steve Kopec, 3823 W. 116th St., Chicago, IL 60655.

Telequipment Model S51B oscilloscope. Need schematic and owner's manual. Elmer Josephs, 7611 Oakland Ave., Minneapolis, MN 55423.

Pilot Model 602 receiver/amplifier. Need schematic and manual. Bob Cusack, 5717 Windsor Dr., Shawne Mission, KS 66205.

Aiwa Model TP708 4" tape recorder. Need drive belts.

Phillips Radio Model FN79803 and **Belltavia 23"**, Model 204A TV. Need schematics. Derek H. Rout, 3-137 Champion St., Christchurch, New Zealand.

Hallicrafters Model SR-500 transceiver. Need schematic diagram or any information available. Joubert G. Ortiz, Rua Sao Manoel 270, 9000, Porto Alegre, Brazil.

Tektronix Model 465 oscilloscope. Need operating instructions and schematic. Dennis Tapia, 585 So. Parker #B, Orange, CA 92668.

Acoustech Model 1 stereo amplifier. Need output transistors ST7175, schematic and manual. M. Veney, 7973 Richmond Highway #11, Alexandria, VA 22306.

Sound City Model L 120, Mark 4 power supply. Need schematic or any information useful for eliminating AC hum in power supply. Ed Cesar, 918-25th St., Santa Monica, CA 90403.

General Automation Model SPC-12 mini computer. Need manuals and utility/maintenance programs. George T. Adams, Box 5014, Wallingford, CT 06492.

Emerson Model CG318 AM shortwave radio. Need circuit diagram. Richard E. Gibbs, 118 Eighth Ave., Greenville, PA 16125.

Tektronix Model 541 oscilloscope. Need operation manual. Stewart Gibson, Box 4295, North Las Vegas, NV 89030.

Sperry Remington Model MS-1 phone answering machine. Need service manual and schematic. Hugh McAllorum, 3768 Cape Arago Highway, Coos Bay, OR 97420.

NRI Model 250 oscilloscope. Need schematic and manual. Mike Pace, Box 1125, Scottsboro, AL 35768.

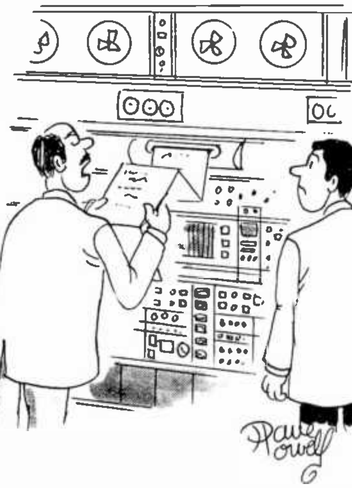
Tektronix Model 514 oscilloscope. Need instruction manual and schematic. Theodore Kangas, W8HV, 648 Elliott Ave., Ishpeming, MI 49849.

Motorola Model XM400-64 monitor. Need schematic. Ron Hackett, 1031 Main St., Port Jefferson, NY 11777.

Fordata Model 1210 telephone modem. Need schematic and operating manual. B. Hansen, 3073 Lower Mountain Road, Furlong, PA 18925.

Sun Model 1020 engine tester and Model SS-90 oscilloscope. Need schematics and alignment information. Paul Johnson, 1026 East Chestnut, Jeffersonville, IN 47130.

Thomas Model 8922A, serial 1209 organ. Need schematic and manual. Joe Connell, 527 Lawn Dr., Loves Park, IL 61111.



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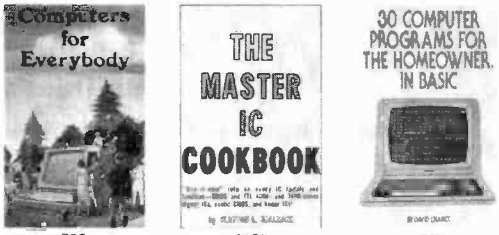

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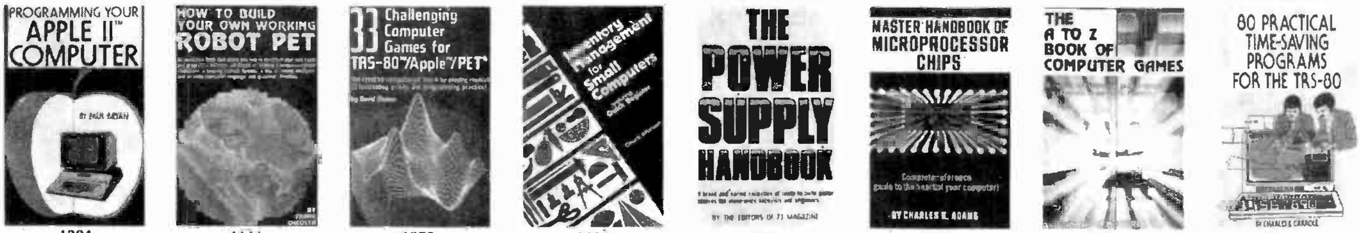

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Experimenting with Kodak's Disc Camera Part 2. Controlling the Camera Remotely

By Forrest M. Mims

LAST MONTH we examined the operation of Kodak's new line of disc cameras. We also described how the disc 4000 camera can be opened and modified for external triggering by means of three wires soldered to the camera's shutter switch connections.

We are now prepared to connect a variety of external control circuits to the camera. If you haven't yet modified your disc 4000 camera, it is essential that you do so in accordance with the instructions given in Part 1. The instructions provide important precautions concerning the camera's warranty and the potential shock hazard posed by the camera's flash capacitor. If you don't happen to have the November 1982 issue of this magazine, try your local library.

About the Circuits. I used a 9-V battery to power test versions of the various circuits described below. For special-purpose applications or when space and weight requirements are critical, you may wish to consider powering your circuit with the camera's internal 6-V lithium battery. I'll describe how this can be accomplished in the next installment of this three-part series.

Many of the trigger circuits with which we'll be experimenting are coupled to the disc camera by a LED-phototransistor optoisolator. The phototransistor's collector is connected to the blue and white leads from the modified camera. Its emitter is connected to the red lead.

As was noted in Part 1, the camera's shutter-release switch has three contacts. Pressing the shutter button lightly activates the strobe-capacitor charging circuit (blue plus white). Pressing the shutter button with a little more pressure begins the exposure/flash/film-advance sequence (blue plus white plus red).

Even though the current drain is low, you should connect a switch between the white lead and the junction of the blue lead and the optoisolator (or whatever component is used in its place). I prefer to use a dpst switch for this purpose, the second set of terminals serving as a power switch between the positive battery terminal and the circuit.

Finally, if you spend a lot of time bench testing any or all of the following circuits, you can save money by recycling the first film disc you expose during initial testing. Simply pop off the back side of the plastic holder and rotate the disc so frame number one shows in the window. Since the camera will not work without a disc installed, this procedure will save you the expense of using fresh film discs.

Adjustable Self Timer. The circuit in Fig. 1 will trigger the camera a specified time after *S1* is pressed and released (the time is adjustable). This will allow you to make special-purpose photographs or permit you to be a part of your own pictures.

The circuit consists of two monostable multivibrators connected so that the output from the first triggers the second following a time delay controlled by *R1* and *C1*. After the delay interval, which can be varied from a few seconds to a minute or so by means of potentiometer *R1*, the second monostable generates a fixed-duration pulse that triggers the camera.

The monostables are designed around the two timers in a 556 dual-timer chip. Although switch *S1* can be connected directly to the trigger input (pin 6) of the first timer, I've included capacitor *C2* so that the first monostable will time out even if *S1* remains closed.

When the circuit is at rest, *R2* pulls the trigger input high to prevent inadvertent false triggering from extraneous electrical noise. Resistor *R3* acts as a bleeder across *C2*. Without *R3* to discharge *C2* following the closing and opening of *S1*, the charge on *C2* would have to be shorted to ground or drained away through natural leakage paths.

The output from the first timer (pin 5) is coupled to the trigger input of the second timer (pin 8) via *C5*. Resistor *R4* pulls the second input high to prevent false triggering.

The first timer's output is also coupled via *R6*, to *LED1*. This LED glows when *S1* is closed and remains glowing for the duration of the first timer's cycle. It therefore serves as a "ready" light to indicate that the self timer has been actuated.

The fixed-duration pulse from the second timer must be long enough to trigger the camera (100 ms or more). This time interval is controlled by *R5* and *C6*.

The trigger pulse (pin 9) is coupled to the camera by

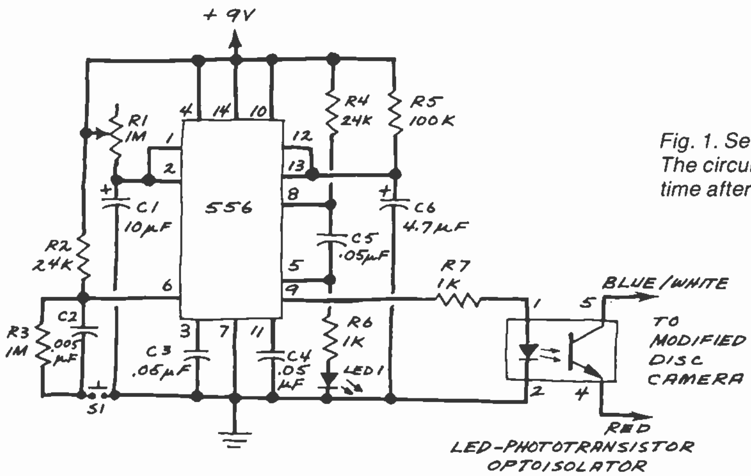


Fig. 1. Self timer for disc camera. The circuit triggers an adjustable time after S1 is pressed and released.

means of a LED-phototransistor optoisolator. Resistor *R7* limits current to the LED in the optoisolator. You can use any standard optoisolator in this and any of the following circuits that use them.

You can adjust *R1* to provide a time delay of up to a minute or so. For longer delays, increase *C1* to 100 μF. You should be able to obtain delays of at least several minutes or more.

Interval Timer. The circuit in Fig. 2 will convert a modified disc 4000 into an elapsed-time camera. By adjusting *R1*, you can take pictures at intervals ranging from a few seconds to several minutes. In this mode, the camera can record on a single film disc fifteen sequential images of such time-dependent subjects as an opening flower, a busy intersection, passing clouds, children at play, sports events, and many others.

Like the previous circuit, the interval timer requires both timers in a 556 chip. The first is connected as an astable multivibrator whose period of oscillation is controlled by *R1* and *C1*. The output from the oscillator triggers a monostable whose fixed-duration output pulse is controlled by *R3* and *C4*. For each cycle of the astable, the monostable provides a pulse having sufficient duration to trigger the disc camera via the optoisolator.

You'll find many interesting applications for this interval timer. For example, when *R1* is set to provide a trigger pulse about every 1.3 seconds (you may need to reduce *C1* to a few microfarads), you can record about 20 seconds or so of an athletic event, experiment, or other fast moving occurrence on a single film disc. Longer delays are well suited for recording slower events such as those mentioned earlier. Note that a 1.3-second delay is the minimum recycle time for the disc 4000.

Triggering the Disc Camera with Light. Many simple circuits can be devised which will permit a modified disc 4000 to be triggered by light. A light-triggered camera can be used to photograph lightning, people or objects breaking a light beam, or even intruders. Of course, such a camera can be triggered from a distance of tens or even hundreds of feet by pointing a visible or infrared source at its sensor.

A Light-Activated SCR Trigger Circuit. The light-activated SCR (LASCR) has long been used as a light sensor in slave flash units. In this role, one or more LASCR-controlled slave flashes are placed around an area to be photographed. The flash from the camera's strobe then triggers the LASCR equipped strobes to provide additional illumination.

Figure 3 shows a simple LASCR circuit for trigger-

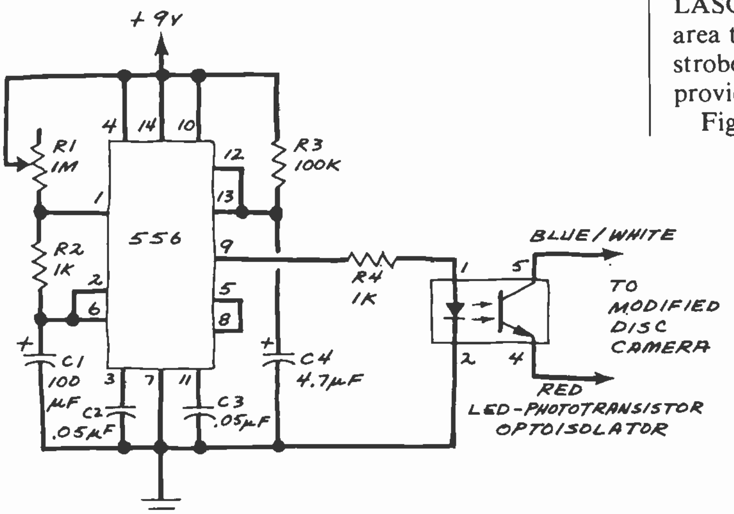


Fig. 2. Internal timer for disc camera

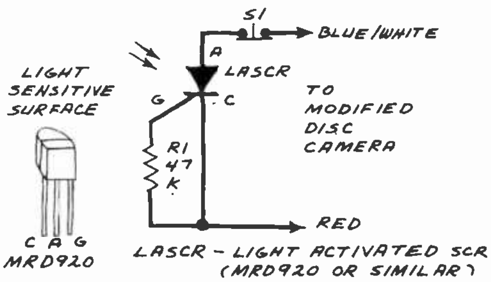


Fig. 3. Light-activated SCR trigger.

ing a modified disc 4000. Most strobes provide too brief a flash to allow the output from this circuit to trigger the camera. The circuit does, however, work well when triggered by flash bulbs, the beam from a flashlight, or a visible or infrared laser.

The LASCR I used is a Motorola MRD920. It's available from Motorola suppliers or Radio Shack (catalog number 276-1095A). It's necessary to open normally closed pushbutton switch *S1* after each operation since the current through the camera's switch leads is sufficient to keep the LASCR turned on after it has been illuminated. This means the camera will respond to an initial flash of light while ignoring subsequent flashes—at least until *S1* is pressed.

A Phototransistor Trigger. The simplest light-activated trigger for a modified disc 4000 is a single phototransistor connected across the shutter switch contacts as shown in Fig. 4. Many different silicon phototransistors (Fairchild FPT-100, Motorola MRD-310, Texas Instruments TIL-414, etc.) can be used in this application.

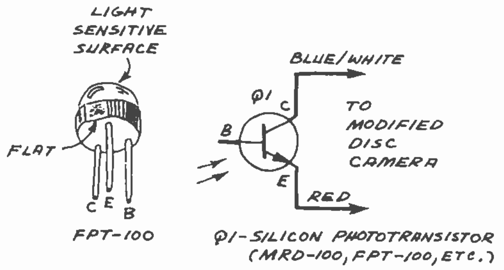


Fig. 4. Light-sensitive trigger for modified camera.

For best results, the phototransistor's active surface should be shielded from direct external light. A length of black, heat-shrinkable tubing works well. Black electrical tape can also be used, but the sticky inner surface of the tube formed by the tape will collect dust particles.

Light flashes having a duration under about 100 ms will not trigger the disc camera. Sweeping across the sensitive surface of the phototransistor with the beam from a flashlight, helium-neon laser, infrared-emitting diode, or diode laser works well. In all cases, the range can be increased substantially by collimating the light source to provide a very narrow beam. Of course it's more difficult to point a narrow beam at a small target over a range of a few hundred feet. But it can be done if you're patient. A tripod helps if your light source is invisible infrared.

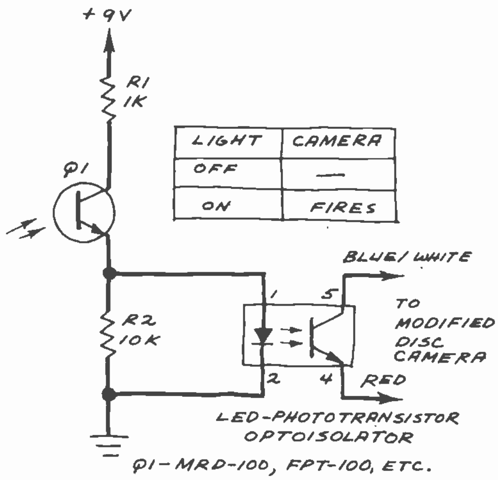
An Improved Phototransistor Trigger. Figure 5 shows how to isolate the phototransistor in Fig. 4 from the disc camera. In operation, when *Q1* is not illuminated, the LED in the optoisolator receives no forward bias. When *Q1* is turned on by an external light source, the LED in the optoisolator is biased through *R1*, the phototransistor in the optoisolator switches on, and the camera is triggered.

Like the preceeding phototransistor circuit, this trigger circuit will fire the camera every time you sweep a light beam across the phototransistor. The only restriction is that the phototransistor must be illuminated for 100 ms or so. Of course, the camera cannot be triggered during the 1.3-second recycle time following the making of an exposure.

A Break-Beam Phototransistor Trigger. Revising the circuit in Fig. 5 permits the modified disc 4000 to be triggered when a continuous beam illuminating *Q1*'s active surface is broken. In operation, when *Q1* is turned on by a continuous light source, the anode of the LED in the optoisolator is pulled low. When the beam is interrupted, *Q1* switches off, thereby allowing the optoisolator's LED to be forward biased through *R1*. This switches on the phototransistor in the optoisolator and triggers the camera.

Incidentally, very brief interruptions in the beam (less than about 100 ms) will not trigger the camera. This provides good protection from false triggering caused by falling leaves when used outdoors.

Xenon Strobe Activated Trigger. For applications where it's necessary to trigger the modified disc 4000



LIGHT	CAMERA
OFF	—
ON	FIRES

Fig. 5. Improved light-sensitive trigger.

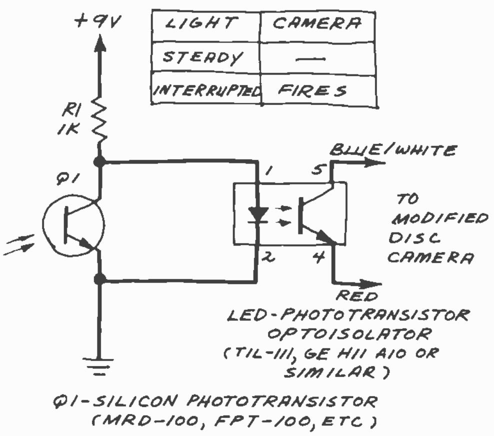
with a very brief flash of light, the incoming pulse must be stretched. Figure 7 shows one way this can be accomplished.

In operation, a 555 timer is configured as a monostable multivibrator which outputs a pulse of 100 ms or more when it has been triggered. A phototransistor connected to the trigger input of the 555 initiates the timing sequence when a brief light flash occurs. The output from the 555 is coupled to the modified disc 4000 via an optoisolator.

This pulse-stretching method can be used in other circuits designed to trigger the camera with a very brief event. For example, very intense pulses are produced by SH (single-heterostructured) diode lasers driven with high-current pulses. Substituting a fast-risetime PIN photodiode (TIL413 or similar) for the phototransistor would allow such a laser to trigger the camera from a considerable distance. The PIN diode should be connected in the *reverse* biased mode (anode to ground). The beam from the laser should be collimated with a small f/1 lens for best results.

Going Further. The circuits presented in this column are merely representative of methods for triggering a modified disc camera. You may wish to utilize one or more of the circuits in conjunction with other circuits to provide special-purpose triggering circuits. For example, a sound-triggered camera can be achieved by coupling the output from an audio amplifier into the 555 pulse stretcher shown in Fig. 7. Another possibility is a disc camera triggered by a tone-modulated light beam.

Perhaps the most interesting method of triggering the camera remotely is by means of radio control. This will be the subject of the third and final installment of this series. We will explore several radio control systems. And I'll describe how you can make fascinating aerial photographs by flying a radio-controlled disc camera from a kite or a helium-filled balloon. ◊



LIGHT	CAMERA
STEADY	—
INTERRUPTED	FIRES

Fig. 6. Break-beam trigger circuit.

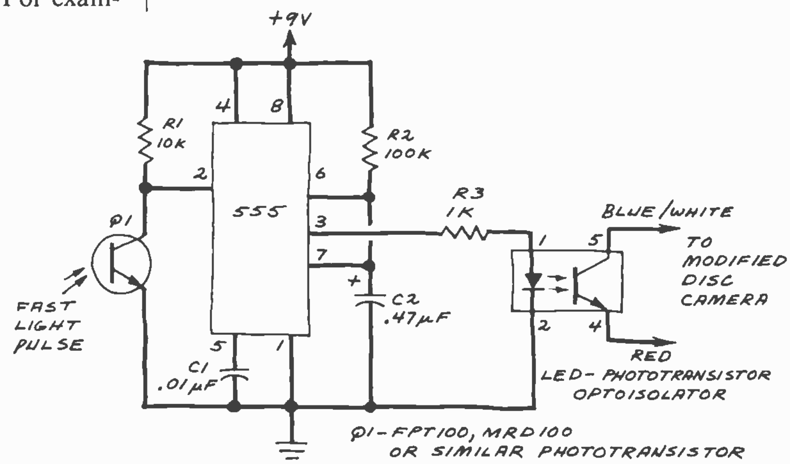


Fig. 7. Trigger activated by a xenon strobe.

1982 EDITORIAL INDEX

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PROJECT OF THE MONTH

A 000-to-999 Event Counter

By Forrest M. Mims

THE CIRCUIT in Fig. 1 functions as a simple 000-to-999 event counter. It can be used to count such events as rotations of a wheel or shaft, objects passing by a point, and even flashes of lightning. It can also be configured to count events whose amplitude exceeds a programmable threshold.

The key to the simplicity of this circuit is an MC14553B (or 4553) three-digit BCD counter, a CMOS LSI chip that typically consumes only about 0.02 μA (25° C) between counts. The 4553 includes a quad latch at the output of each of its three counters to provide storage of the current BCD count status. The outputs from the quad latches are steered to the chip's four BCD output pins by a time-division multiplexing arrangement.

Three digit-select outputs indicate which of the outputs of the counter latches has been steered to the BCD outputs. This provides a means for driving a three-digit multiplexed readout.

A high-to-low transition at the clock input (pin 12) of the 4553 advances the circuit one count. The BCD status of the count is converted into a seven-segment format by an MC14511B (or 4511) BCD-to-seven segment latch/decoder/driver. The 4511 can directly drive the segments of a common-cathode LED display at a maximum current of 25 mA. Like the 4553, it is a CMOS device with a very low quiescent current (about 0.01 μA at 25° C).

Digits of the three-digit LED readout are sequentially strobed by the three digit-select outputs (pins 2, 1 and 15) and transistors *Q1* through *Q3*. The strobe rate is controlled by an internal scan oscillator whose frequency is determined by *C1*. For special-purpose applications, the internal scan oscillator can be overridden by omitting *C1* and applying an external clock signal directly to pin 4.

Triggering the Counter. The counter circuit can be triggered by external logic signals or by a relay or magnetic reed switch. Buffering is generally not required since the 4553 provides an internal pulse-shaping stage at its clock input.

Figure 2A shows a simple phototransistor input stage you can connect to the counter to provide an optically triggered input. A light pulse of sufficient magnitude turns on *Q1*, which forces the clock input of the 4553 low and advances the count. With this input, the counter can be triggered by a flashlight, an infrared LED, a xenon strobe, or lightning.

To trigger the circuit by interrupting a continuous light source, as when counting objects such as people or cars, you can use Fig. 2B. Here the phototransistor is normally illuminated, thus keeping the clock input high. When the illuminator is interrupted, the phototransistor is turned off and the input to the 4553 is brought low, thus causing a count to occur.

In both modes of operation, lasers and collimated infrared-emitting diodes make excellent light sources. A low-power (e.g. 1-mW) helium-neon laser, for example, easily actuates the circuit over a range of tens of feet. Since their near-infrared emission more closely matches the peak spectral response of silicon phototransistors, collimated beams from GaAs, GaAs:Si, and AlGaAs LEDs and diode lasers can activate the circuit over longer ranges.

For more sensitivity, hence longer ranges, an op-amp gain stage can be inserted between the phototransistor and the 4553 clock input. In the count-when-interrupted mode, the circuit will register a count immediately when a continuous light falling on the phototransistor is blocked. In the count-when-flashed mode, the circuit will indicate a count at the *trailing* edge of a light flash.

Be sure direct sunlight does not strike the phototransistor or it may not work properly. If sunlight or bright ambient light is a problem, try a filter and a light shield. Reverse-biased PIN photodiodes such as the TIL413 (Radio Shack catalog number 276-144) are more immune to sunlight and can be used in place of the phototransistor. ◇

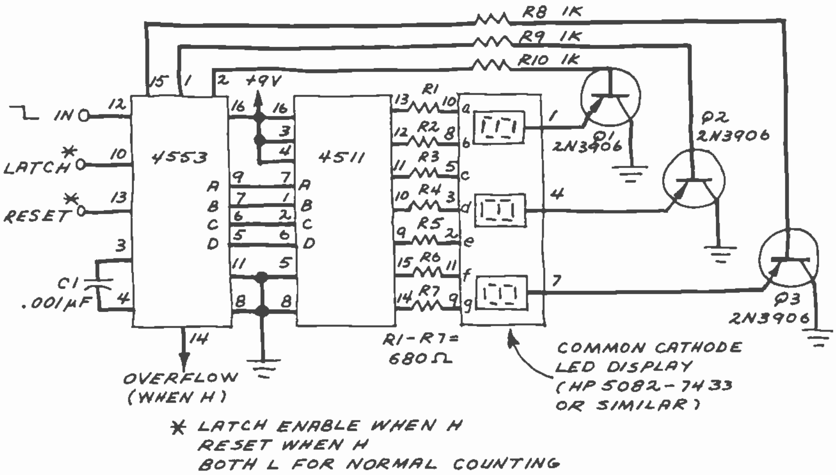

Fig. 1. Simplified block diagram of a 000-to-999 event counter.

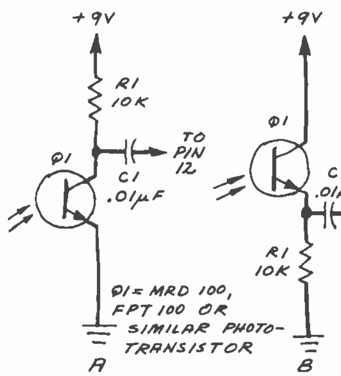

Fig. 2. Phototransistor inputs for 3-digit event counter.

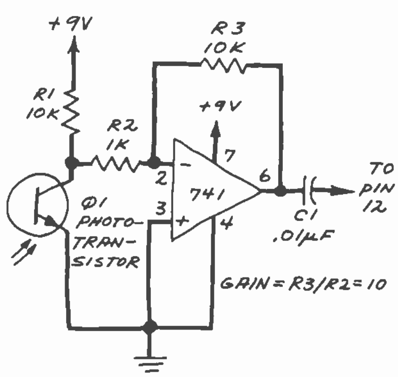

Fig. 3. Phototransistor gain stage for 3-digit event counter.

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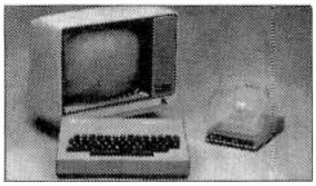

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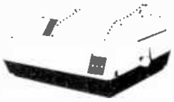

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☐ Editor/Assembler (Cassette version requires Level "B" and 8k (min.) of RAM — we suggest 16k "JAWS" — see above) $59.95 plus $2 P&I *

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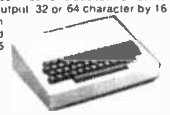

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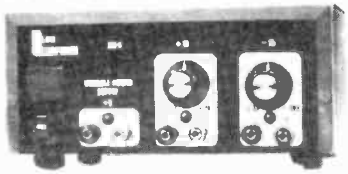

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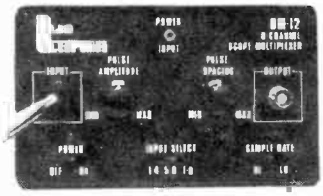

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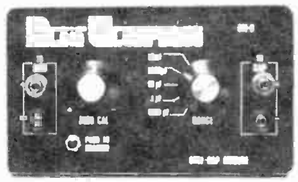

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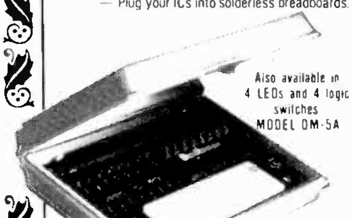

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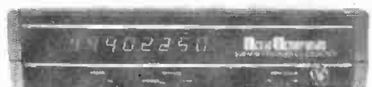

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CD4059	24	7.95
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CD4066	14	.39
CD4068	14	.39
CD4069	14	.29
CD4070	14	.39
CD4071	14	.29
CD4072	14	.29
CD4073	14	.29
CD4075	14	.29
CD4076	16	.79
CD4078	14	.49
CD4081	14	.29
CD4082	14	.29
CD4093	14	.49

CD4098	16	1.95
CD4506	16	1.19
CD4507	14	.39
CD4508	24	3.95
CD4510	16	.89
CD4511	16	.89
CD4512	16	.89
CD4514	24	1.79
CD4515	24	1.79
CD4516	16	.99
CD4518	16	.99
CD4519	16	.39
CD4520	16	.79
CD4526	16	1.19
CD4528	16	1.19
CD4529	16	1.19
CD4543	16	1.19
CD4562	14	6.95
CD4566	16	1.39
CD4583	16	2.49
CD4584	14	.59
CD4723	16	1.19
CD4724	16	1.19
MC14409	16	13.95
MC14410	16	13.95
MC14411	24	11.95
MC14412	16	13.95
MC14419	16	7.95
MC14433	24	13.95
MC14538	16	1.19
MC14541	14	1.19

MICROPROCESSOR COMPONENTS

MICROPROCESSOR CHIPS

Part No.	**Pins	Function	Price
CDP1802	40	CPU	$9.95
2650	40	MPU	14.95
iDM2901ADC	40	CPU—4-bit slice (Com. Temp. Gr.)	19.95
MCS6502	40	MPU w/Clock (65K bytes mem.)	9.95
MC6802CP	40	MPU w/Clock and RAM	7.95
INS8035N-6	40	MPU—8-bit (6MHz)	5.95
INS8039N-6	40	CPU-Sgl. chip 8-bit (128 bits Ram)	5.95
INS8040N-6	40	CPU (256 bytes RAM)	5.95
INS8070N	40	CPU (64 bytes RAM)	11.95
INS8073N	40	CPU w/Basic Micro Interpreter	14.95
P8085A	40	CPU	5.95

Z80, Z80A, Z80B, Z8000 SERIES

Z80	40	CPU (MK3880N)(780C) 2MHz	$4.95
Z80-CTC	28	Counter Timer Circuit	5.95
Z80-DART	40	Dual Asynchronous Rec./Trans.	11.95
Z80-DMA	40	Direct Memory Access Circuit	15.95
Z80-P10	40	Parallel I/O Interface Controller	5.95
Z80-S10/0	40	Serial I/O (TxCB and RxCB Bonded)	15.95
Z80-S10/1	40	Serial I/O (Lacks DTRB)	15.95
Z80-S10/2	40	Serial I/O (Lacks SYNCB)	15.95
Z80-S10/9	40	Serial I/O	15.95
Z80A	40	CPU (MK3880N-4)(780C-1) 4MHz	5.95
Z80A-CTC	28	Counter Timer Circuit	5.95
Z80A-DART	40	Dual Asynchronous Rec./Trans.	11.95
Z80A-DMA	40	Direct Memory Access Circuit	17.95
Z80A-P10	40	Parallel I/O Interface Controller	5.95
Z80A-S10/0	40	Serial I/O (TxCB and RxCB bonded)	16.95
Z80A-S10/1	40	Serial I/O (Lacks DTRB)	16.95
Z80A-S10/2	40	Serial I/O (Lacks SYNCB)	16.95
Z80A-S10/9	40	Serial I/O	16.95
Z80B	40	CPU (MK3880N-6) 6MHz	11.95
Z80B-CTC	28	Counter Timer Circuit	13.95
Z80B-P10	40	Parallel I/O Interface Controller	13.95
Z8001	48	CPU Segmented	51.95
Z8002	40	CPU Non-Segmented	55.95
Z8030	40	Serial Comm. Controller	44.95
Z8036	40	Counter/Timer & Parallel I/O Unit	29.95

6800/68000 SERIES

MC6800	40	MPU	4.95
MC6802CP	40	MPU with clock and RAM	7.95
MC6810AP1	24	128x8 Static RAM	3.95
MC6821	40	Peripheral Inter. Adapt (MC6820)	4.95
MC6828	24	Priority Interrupt Controller	15.95
MC6830L8	24	1024x8-bit ROM (MC68A30-8)	10.95
MC6850	24	Asynchronous Comm. Adapter	4.95
MC6852	24	Synchronous Serial Data Adapter	5.75
MC6860	24	0-600bps Digital MODEM	9.95
MC6862	24	2400bps Modulator	12.95
MC6880A	16	Quad 3-state bus. trans. (MC8T26)	2.25
MC68000L8	64	MPU 16-Bit (8MHz)	69.95
MC68488P	40	General Purpose Int. Adapter	8.95
MC68652P2	40	Multi. Protocol Comm. Controller	24.95
MC68661PB	28	Enhanced Prog. Comm. Int.	8.95

8080A SERIES

INS8080A	40	CPU	3.95
TMS5501	40	Synchronous Data Interface (SIRC)	14.95
INS8154	40	128 Byte RAM 16-Bit I/O	13.95
INS82C06	20	Octal D Flip Flop Tri-State (74C374)	2.49
DP8212	24	8-bit Input/Output (74S412)	2.25
DP8214	24	Priority Interrupt Control	3.95
DP8216	16	Bi-Directional Bus Driver	2.25
DP8224	16	Clock Generator/Driver	2.25
DP8226	16	Bus Driver	2.25
DP8228	28	System Cont./Bus Driver (74S428)	3.49
DP8238	28	System Controller (74S438)	4.49
INS8243	24	I/O Expander for 48 Series	5.95
INS8245	18	16-Key Keyboard Encoder (74C922)	4.49
INS8246	20	20-Key Keyboard Encoder (74C923)	4.95
INS8247	28	Display Controller (74C911)	8.95
INS8248	28	Display Controller (74C912)	8.95
INS8250N	40	Asyn. Comm. Element (INS8250)	10.95
DP8251	28	Prog. Comm. I/O (USART)	4.49
DP8253	24	Prog. Interval Timer	6.95
DP8255	40	Prog. Peripheral I/O (PPI)	4.49
DP8257	40	Prog. DMA Control	7.95
DP8259	28	Prog. Interrupt Control	6.95
DP8275	40	Prog. CRT Controller	29.95
DP8279	40	Prog. Keyboard/Display Interface	6.95
DP8303	20	8-Bit Tri-State Bi-Directional Trans.	3.95
DP8304	20	8-bit Bi-Directional Receiver	2.49
DP8307	20	8-bit Bi-Directional Receiver	2.49
DP8308	20	8-bit Bi-Directional Receiver	2.49
DP8310	20	Octal Latched Peripheral Driver	4.95
DP8311	20	Octal Latched Peripheral Driver	4.95

MICROPROCESSOR MANUALS & DATA BOOKS

M-Z80	User Manual	7.50
M-CDP1802	User Manual	7.50
M-2650	User Manual	5.00
10400	1982 Intel Data Book (1405 pg.)	14.95
30001	1981 Nat. CMOS Book (628 pg.)	6.95
30002	1980 Nat. Interface Book (640 pg.)	6.95
30003	1982 Nat. Linear Book (1952 pg.)	11.95
30005	1981 Nat. TTL Book (624 pg.)	9.95
30008	1980 Nat. Memory Data Book (464 pg.)	6.95
30011	1980 Nat. Linear Applications (736 pg.)	15.95
30013	1983 Zilog Data Book (641 pg.)	7.95
205610	1981 Intel Peripheral Design (828 pg.)	9.95

DYNAMIC RAMS

Part No.	**Pins	Function	Price
1103	18	1024x1 (300ns)	.99
4027	16	4096x1 (250ns)	2.49
4116N-2	16	16,384x1 (150ns)	1.89 - 8/14.95
4116N-3	16	16,384x1 (200ns)	1.69 - 8/12.95
4116N-4	16	16,384x1 (250ns)	1.49 - 8/10.95
4164N-150	16	65,536x1 (150ns)	7.95 - 8/59.95
4164N-200	16	65,536x1 (200ns)	7.49 - 8/54.95
MM5261	18	1024x1 (300ns)	.49 - 8/1.95
MM5262	22	2048x1 (365ns)	.49 - 8/1.95
MM5270	18	4096x1 (250ns) MK4096	4.95
MM5280	22	4096x1 (200ns) 2107	3.95
MM5290-2	16	16,384x1 (150ns)	1.89 - 8/14.95
MM5290-3	16	16,384x1 (200ns)	1.69 - 8/12.95
MM5290-4	16	16,384x1 (250ns)	1.49 - 8/10.95
MM5298-3	16	8192x1 (250ns)	1.69

STATIC RAMS

1101	16	256x1 (650ns)	1.49
2101	22	256x4 (450ns) 8101	2.49
2102	16	1024x1 (350ns)	.89
21L02	16	1024x1 (450ns) L.P.	1.49
2111	18	256x4 (450ns) 8111	2.95
2112	16	256x4 (450ns) MOS	2.95
2114	18	1024x4 (450ns)	1.95 - 8/13.95
2114L	18	1024x4 (450ns) L.P.	2.25 - 8/15.95
2114-2	18	1024x4 (200ns)	2.25 - 8/15.95
2114L-2	18	1024x4 (200ns) L.P.	2.49 - 8/17.95
2141-3	18	4096x1 (150ns)	3.95
2147	18	4096x1 (70ns)	4.95
2148	18	1024x4 (70ns)	8.95
TMS4044	18	4096x1 (450ns)	3.95
TMS4045	18	1024x4 (450ns)	3.95
5101	22	256x4 (450ns) CMOS	4.95
MM5257	18	4096x1 (450ns) 4044	4.95
HM6116P-3	24	2048x8 (150ns) CMOS	7.95
HM6116-4	24	2048x8 (200ns) CMOS	6.95
HM6116LP-4	24	2048x8 (200ns) L.P. CMOS	7.95
7489	16	16x4 (50ns) 3101	2.25
74C920	22	256x4 (250ns) CMOS (6551)	3.95
74C921	18	256x4 (250ns) CMOS	3.95
74C929	16	1024x1 (250ns) CMOS (6501)	3.95
74C930	18	1024x1 (250ns) CMOS (6518)	3.95
74S189	16	16x4 (35ns) 93405	1.95
74S200	16	256x1 (80ns) 93410	3.95
74S206	16	256x1 (60ns) 93411	3.95
74S289	16	16x4 (35ns) 3101	2.25
82S10	16	1024x1 (50ns) O.C. (93415)	3.95
82S25	16	16x4 (50ns) O.C. (74S289)	2.25

EPROMS

1702A	24	256x8 (1us)	4.95
2708	24	1024x8 (450ns)	3.95
2708-5	24	1024x8 (550ns) SM00246	2.95
TMS2516	24	2048x8 (450ns) 2716	6.95
TMS2532	24	4096x8 (450ns) NMC2532	9.95
TMS2564	28	8192x8 (450ns)	19.95
TMS2716	24	2048x8 (450ns) 3 voltage	7.95
2716	24	2048x8 (450ns)	4.95
2716-1	24	2048x8 (350ns)	6.95
2732	24	4096x8 (450ns)	9.95
27580	24	1024x8 (450ns) single +5V	2.95
MM2764	28	8192x8 (450ns)	16.95
MM2764-3	28	8192x8 (300ns)	19.95

PROMS

74S188	16	32x8 PROM O.C. (6330-1)	1.49
74S287	16	256x4 PROM T.S. (6301-1)	1.95
74S288	16	32x8 PROM T.S. (6331-1)	1.95
74S387	16	256x4 PROM O.C. (6300-1)	1.95
74S471	20	256x8 PROM T.S. (6309-1)	5.95
74S472	20	512x8 PROM T.S. (6349-1)	4.95
74S473	20	512x8 PROM O.C. (6348)	4.95
74S474	24	512x8 PROM T.S. (DM87S296N)	4.95
74S475	24	512x8 PROM O.C. (6340)	4.95
74S478	24	1024x8 PROM T.S. (TBP28S86)	8.95
74S570	16	512x4 PROM O.C. (6305)	2.95
74S571	16	512x4 PROM T.S. (6306)	2.95
74S572	18	1024x4 PROM O.C. (6352)	4.95
74S573	18	1024x4 PROM T.S. (82S137)	4.95
82S23	16	32x8 PROM O.C. (27S18)	2.95
82S115	24	512x8 PROM T.S. (27S15)	9.95
82S123	16	32x8 PROM T.S. (27S19)	2.95
82S126	16	256x4 PROM O.C. (27S20)	3.95
82S129	16	256x4 PROM T.S. (27S21)	3.95
82S130	16	512x4 PROM O.C. (27S12)	5.95
82S185	18	2048x4 PROM T.S. (TBP24S81)	9.95
DM87S180N	24	1024x8 PROM O.C. (82S180)	9.95
DM87S181N	24	1024x8 PROM T.S. (82S181)	9.95
DM87S184N	18	2048x4 PROM O.C. (82S184)	9.95
DM87S185N	18	2048x4 PROM T.S. (82S185)	9.95
DM87S190N	24	2048x4 PROM O.C. (82S190)	19.95
DM87S191N	24	2048x8 PROM T.S. (82S191)	19.95

DATA ACQUISITION

DC10		Mostek DC/DC Convert +5V to -9V	2.95
MC3470P	18	Floppy Disk Read AMP System	4.95
MC1408L7	16	7-bit D/A Converter (DAC0807LCN)	2.49
MC1408L8	18	8-bit D/A Converter (DAC0808LCN)	2.95
ADC0804	20	8-bit A/D Converter (1 LSB)	3.49
DAC0806	16	8-bit D/A Converter (0.78% Lin.)	1.95
ADC0809	28	8-bit A/D Converter (8-Ch. Multi.)	4.49
AY-5-1013A	40	30K BAUD UART (TR1602)	4.95

INTERSIL

*Evaluation Kits

Part No.	**Pins	Function		Price
7045IPI	28	CMOS Precision Timer		14.95
7045EV/Kit*	28	Stopwatch Chip, XTL		19.95
7106CPL	40	3½ Digit A/D (LCD Drive)		9.95
7106EV/Kit*	40	IC, Circuit Board, Display		34.95
7107CPL	40	3½ Digit A/D (LED Drive)		11.95
7107EV/Kit*	40	IC, Circuit Board, Display		29.95
7116CPL	40	3½ Digit A/D LCD Dis. HLD.		16.95
7117CPL	40	3½ Digit A/D LED Dis. HLD.		15.95
7201IUS		Low Battery Volt Indicator		2.25
7205IPG	24	CMOS LED Stopwatch/Timer		12.95
7205EV/Kit*	24	Stopwatch Chip, XTL		14.95
7206CJPE	16	Tone Generator		4.95
7206CEV/Kit*	16	Tone Generator Chip, XTL		7.95
7207AIPD	14	Oscillator Controller		5.95
7207AEV/Kit*	14	Freq. Counter Chip, XTL		7.95
7208IPI	28	Seven Decade Counter		15.95
7209IPA	8	Clock Generator		3.95
7215IPG	24	4 Func. CMOS Stopwatch CKT		13.95
7215EV/Kit*	24	4 Func. Stopwatch Chip, XTL		14.95
7216AIJI	28	8 Digit Univ. Counter C.A.		29.95
7216DIJI	28	8 Digit Freq. Counter C.A.		24.95
7216DIPI	28	8 Digit Freq. Counter C.C.		19.95
7217IJI	28	4 Digit LED Up/Down Counter C.A.		10.95
7217AIPI	28	4 Digit LED Up/Down Counter C.C.		11.95
7224IPL	40	LCD 4½ Digit Up Counter DRI		10.95
7226AIJL	40	8 Digit Univ. Counter		29.95
7226AEV/Kit*	40	5 Function Counter Chip, XTL		74.95
7240IJE	16	CMOS Bin Prog. Timer/Counter		4.95
7242IJA	8	CMOS Divide-by-256 RC Timer		2.25
7250IJE	16	CMOS BCD Prog. Timer/Counter		6.00
7260IJE	16	CMOS BCD Prog. Timer/Counter		5.25
7555IPA	8	CMOS 555 Timer		1.45
7556IPD	14	CMOS 556 Timer		2.20
7611BCPA	8	CMOS Op Amp Comparator	5MV	2.25
7612BCPA	8	CMOS Op Amp Ext. Cmvr.	5MV	2.95
7621BCPA	8	CMOS Dual Op Amp Comp.	5MV	3.95
7631CCPE	16	CMOS Tri Op Amp Comp.	10MV	5.35
7641CCPD	14	CMOS Quad Op Amp Comp.	10MV	7.50
7642CCPD	14	CMOS Quad Op Amp Comp.	10MV	7.50
7660CPA	8	Voltage Converter		2.95
8038CCPD	14	Waveform Generator		3.95
8048CCPE	16	Monolithic Logarithmic Amp		16.95
8069CCQ		50ppm Band—GAP Volt Ref. Diode		2.50
8211CPA	8	Volt Ref/Indicator		2.95
8212CPA	24	Volt Ref/Indicator		2.95
30009		1983 Intersil Data Book (1356 pages)		$9.95

74C—C/MOS

74C00	14	.35
74C02	14	.35
74C04	14	.29
74C08	14	.35
74C10	14	.35
74C14	14	.59
74C20	14	.35
74C30	14	.35
74C32	14	.39
74C42	16	1.39
74C48	16	1.95
74C73	14	.79
74C74	14	.69
74C85	16	1.95
74C86	14	.39
74C89	16	5.95
74C90	14	1.19
74C93	14	1.19

74C95	14	1.39
74C107	14	.89
74C151	16	2.49
74C154	24	3.49
74C157	16	2.25
74C160	16	1.19
74C161	16	1.19
74C162	16	1.19
74C163	16	1.19
74C164	14	1.49
74C173	16	.79
74C174	16	1.19
74C175	16	1.19
74C192	16	1.49
74C193	16	1.69
74C195	16	1.39

74C221	16	1.95
74C240	20	1.95
74C244	20	1.95
74C373	20	2.49
74C374	20	2.49
74C901	14	.59
74C903	14	.59
74C906	14	.59
74C911	28	8.95
74C912	28	8.95
74C915	18	1.19
74C917	28	8.95
74C922	18	4.49
74C923	20	4.95
74C925	16	5.95
74C926	18	5.95
80C95	16	.39
80C97	16	.39

NEW PRODUCT! 74HC High Speed CMOS

74HC00	14	.75
74HC02	14	.75
*74HCU04	14	.75
74HC08	14	.75
74HC10	14	.75
74HC20	14	.75
74HC27	14	.75
74HC74	14	.99
74HC75	16	.99
74HC86	14	.99
74HC109	16	1.39

74HC138	16	1.49
74HC139	16	1.49
74HC147	16	1.19
74HC151	16	1.19
74HC157	16	1.19
74HC160	16	1.79
74HC161	16	1.79
74HC164	14	1.79
74HC174	16	1.39
74HC175	16	1.39
74HC242	14	2.79

74HC243	14	2.79
74HC251	16	1.19
74HC266	14	.99
74HC280	14	4.95
74HC373	20	3.95
74HC374	20	3.95
74HC533	20	3.95
74HC534	20	3.95
74HC4075	14	.75
74HC4538	16	2.95
74HC4543	16	4.95

*74HCU04 is unbuffered. All others are buffered. Send $.30 for Data Sheet.

NEW Programmable Array Logic (PALS)

Part No.	**Pins	Function	Price
PAL10H8	20	Octal 10-Input AND-OR Gate Array (High Output)	$5.95
PAL12H6	20	Hex 12-Input AND-OR Gate Array (High Output)	5.95
PAL14H4	20	Quad 14-Input AND-OR Gate Array (High Output)	5.95
PAL10L8	20	Octal 10-Input AND-OR-Invert Gate Array (Low Output)	5.95
PAL12L6	20	Hex 12-Input AND-OR-Invert Gate Array (Low Output)	5.95
PAL14L4	20	Quad 14-Input AND-OR-Invert Gate Array (Low Output)	5.95
PAL16L8	20	Octal 16-Input AND-OR-Invert Gate Array (Low Output)	9.95
PAL16R8	20	Octal 16-Input Register AND-OR Gate Array	9.95
PAL16R6	20	Hex 16-Input Register AND-OR Gate Array	9.95
PAL16R4	20	Quad 16-Input Register AND-OR Gate Array	9.95
30012		1982 National PAL Data Book (176 pages)	$5.95

LINEAR

TL071CP	8	.79
TL072CP	8	1.39
TL074CN	14	1.95
TL081CP	8	.59
TL082CP	8	1.19
TL084CN	14	1.95
LM301CN	8	.35
LM302H		1.95
LM304H		1.95
LM305H		.99
LM307CN	8	.45
LM308CN	8	.69
LM309K		1.25
LM310CN	8	1.75
LM311CN	8	.69
LM312H		2.49
LM317T		1.19
LM317K		3.95
LM318CN	8	1.95
LM319N	14	1.95
LM320K-5		1.35
LM320K-12		1.35
LM320K-15		1.35
LM320T-5		.89
LM320T-12		.89
LM320T-15		.89
LM323K		5.95
LM324N	14	.59
LM337T		1.95
LM338K		6.95
LM339N	14	.69
LM340K-5		1.35
LM340K-12		1.35

LM340K-15		1.35
LM340T-5		.79
LM340T-12		.79
LM340T-15		.79
LM348N	14	.99
LM350K		4.95
LF355N	8	1.10
LF356N	8	1.10
LM370N	14	4.49
LM373N	14	3.95
LM377N	14	1.95
LM380N	14	.89
LM381N	14	1.79
LM382N	14	1.39
LM384N	14	1.79
LM386N-3	8	.89
TL494CN	16	2.95
TL496CP	8	1.19
NE510A	14	4.95
NE529A	14	2.95
NE531V	8	2.95
NE536H		8.95
NE540H		4.95
NE544N	14	2.95
NE550A	14	1.95
NE555V	8	.35
LM556N	14	.69
NE564N	16	2.95
LM565N	14	1.19
LM566CN	8	1.49
LM567V	8	.89

NE570N	16	3.95
LM703CN	8	1.19
LM709N	14	.49
LM710N	14	.69
LM711N	14	.79
LM723N	14	.55
LM733N	14	1.00
LM739N	14	1.95
LM741CN	8	.35
LM747N	14	.69
LM748N	8	.59
LM1310N	14	1.49
LM1458CN	8	.59
LM1488N	14	.69
LM1489N	14	.69
LM1496N	14	1.95
LM1800N	16	1.49
LM1889N	18	1.95
LM1896N	14	2.95
LM2002T		1.49
LM3189N	16	1.59
LM3900N	14	.59
LM3905CN	8	1.19
LM3909N	8	.99
LM3914N	18	3.49
LM3915N	18	3.49
LM3916N	18	3.49
RC4136N	14	1.25
RC4151NB	8	1.95
ICL8038B	14	3.95
LM13080N	8	1.19
LM13600N	16	1.19

MORE AVAILABLE

CONNECTORS

DB25 — D Subminiature (meets RS232)

Part No.	Description	Price
DE9P	9 Pin Plug	$1.79
DE9S	9 Pin Socket	1.95
DA15P	15 Pin Plug	1.95
DA15S	15 Pin Socket	2.95
DB25P	**25 Pin Plug (Meets RS232)**	**2.49**
DB25S	**25 Pin Socket (Meets RS232)**	**3.25**
DB25P-831	25 Pin Right Angle Plug	4.95
DB25S-831	25 Pin Right Angle Socket	5.25
DC37P	37 Pin Plug	4.95
DC37S	37 Pin Socket	5.95
DD50P	50 Pin Plug	5.95
DD50S	50 Pin Socket	8.95

Accessories

DE-9H	Hood for DE-9 Series Connectors	$1.19
DA-15H	Hood for DA-15 Series Connectors	1.29
DB25H	Hood for DB25 Series Connectors	1.25
DC37H	Hood for DC37 Series Connectors	1.39
DD50H	Hood for DD50 Series Connectors	1.49
D20418-2	2 screws for mtg. connectors to a panel	.79

Solder Eyelet/Wire Wrap Edge Card

Part No.	Cnts.	Sp.	Description	Price
15/30SE	15/30	.156	Solder Eyelet	$1.79
18/36SE	18/36	.156	Solder Eyelet	1.95
22/44SE	22/44	.156	Solder Eyelet	2.49
22/44PC	22/44	.156	PC type (no mtg. ears)	.99
50/100SE	50/100	.125	Solder Eyelet	9.95
22/44WW	22/44	.156	Wire Wrap - Level 3	4.95
67031-5	22/44	.156	WW (Pins .0625x.03x.75)	3.95
R-681-1	50/100	.125	Wire Wrap - Level 3	7.95
R-681-2	50/100	.125	Wire Wrap - Level 1	6.95

RF Coaxial Connectors

Part No.	Description	Price
PL259	UHF Plug	$ .89
SO239	UHF Panel Receptacle	.69
PL258	UHF Straight Adapter	.89
UG175/U	UHF Reducing Adapter	.49
UG88/U	BNC Plug	1.49
UG89/U	BNC Jack	1.69
UG306/U	BNC Angle Adapter	2.49
UG260/U	BNC Plug	1.49
UG1094/U	BNC Bulkhead Receptacle	.89

IC SOCKETS

For Socket Required, See Column After The IC Part No.

LOW PROFILE (TIN) SOCKETS

	1-9	10-99	100-999
8 pin LP	.16	.14	.13
14 pin LP	.17	.15	.14
16 pin LP	.19	.17	.16
18 pin LP	.26	.24	.23
20 pin LP	.30	.27	.25
22 pin LP	.31	.28	.26
24 pin LP	.33	.30	.28
28 pin LP	.40	.37	.35
36 pin LP	.46	.42	.39
40 pin LP	.49	.46	.43

— Soldertail Standard Tin & Gold Also Available —

WIRE WRAP (GOLD) SOCKETS LEVEL #3

	1-9	10-99	100-999
8 pin WW	.49	.45	.42
10 pin WW	.65	.62	.59
14 pin WW	.65	.62	.59
16 pin WW	.69	.65	.61
18 pin WW	.89	.85	.79
20 pin WW	1.09	1.05	.99
22 pin WW	1.25	1.19	1.15
24 pin WW	1.29	1.23	1.18
28 pin WW	1.59	1.50	1.45
36 pin WW	1.85	1.75	1.69
40 pin WW	1.99	1.89	1.79

CAPACITOR CORNER

50 VOLT CERAMIC DISC CAPACITORS

Value	1-9	10-99	100+	Value	1-9	10-99	100+
10 pf	.08	.06	.05	.001µF	.08	.06	.05
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

MINI. ALUMINUM ELECTROLYTIC CAPACITORS

Axial	1-99	100-499	500+	Radial	1-99	100-499	500+
.47/50V	.16	.14	.10	.47/25V	.15	.13	.12
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
470/25V	.54	.49	.45	100/50V	.37	.34	.31
1000/16V	.79	.69	.61	220/16V	.25	.21	.19
2200/16V	.89	.79	.69	470/25V	.35	.31	.27

$10.00 Minimum Order — U.S. Funds Only
California Residents Add 6½% Sales Tax
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2708,2716,2732 & 2764 EPROM Programmer

JE664 EPROM PROGRAMMER

8K TO 64K EPROMS — 24 AND 28 PIN PACKAGES

Self-Contained — Requires No Additional Systems for Operation

NEW!

• Programs, validates, and checks for properly erased EPROMs • Emulates PROMs or EPROMs • RS232C Computer Interface for editing/program loading • Loads data into RAM by keyboard • Changes data in RAM by keyboard • Loads RAM from an EPROM • Compares EPROMs for content differences • Copies EPROMs • Power Input: 115VAC, 60Hz, ◄ 10W power consumption • Enclosure: Color-coordinated, light tan panels w/molded mocha brown end pieces • Size: 15-5/8"L x 8¾"D x 3½"H • Wt.: 5¾ lbs.

JE664-A EPROM Programmer $995.00
Assembled & Tested (Includes JM16A Module)

JE665 — RS232C INTERFACE OPTION — The JE665 RS232C Interface Option implements computer access to the JE664's RAM. Sample software written in BASIC provided for TRS 80* Model I, Level II Computer. Baud rate: 9600. Word Lgth: 8 bits - odd parity. Stop bits: 2. Option may be adapted to other computers.

JE664-ARS EPROM Prog. w/JE665 Option $1195.00
Assembled and Tested (Includes JM16A Module)

EPROM JUMPER MODULES — The JE664's JUMPER MODULE (Personality Module) is a plug-in Module that pre-sets JE664 for proper programming pulses to the EPROM & configures EPROM socket connections for that particular EPROM.

Part No.	EPROM	EPROM MANUFACTURER	PRICE
JM08A	2708	AMD, Motorola, National, Intel, TI	$14.95
JM16A	2716, TMS2516	Intel, Motorola, National, NEC, TI	$14.95
JM16B	TMS2716	Motorola, TI (+5,-12,+12)	$14.95
JM32A	TMS2532	Motorola, TI	$14.95
JM32B	2732	AMD, Fujitsu, NEC, Hitachi, Intel	$14.95
JM64A	MCM68764, MCM68L764	Motorola	$14.95
JM64B	2764	Intel	$14.95
JM64C	TMS2564	TI	$14.95

CONSUMER PRODUCTS

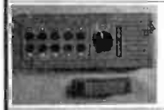
SECURITY ALARM SYSTEMS

Home Alarm System

• Self-installation • Presettable w/individual 3-digit code — no key nec. • Instant or 10-sec. delayed warning system • Alarm system incl. window & door contacts • One 9V battery required (not incl.) Low power consumption (0.01mA) • Loud audible alarm (90db) • Delayed exit feature • System complete w/one control station with built-in siren and test button, 4 magnetic contact sets & connecting wires for entire system

ST-05 Home Alarm System **$59.95**

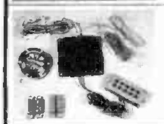
Door Security System



• Coded door alarm • Instant or 7-second delay system • Alarm activated as door is opened • Can be de-activated by pressing personal code. • Power: One 9V battery (not incl.). • System includes one personal coded keyboard and one magnetic sensor

ES-07 Door Alarm **$29.95**

Anti-Theft Auto Alarm System



• Audible horn is activated when door or trunk is opened • Alarm sounds for 3 min. — unless turned off by secret 3-digit code • Wire cutting will not deactivate alarm • Code set by owner • Uses only 0.01mA power • System complete w/one black-box control unit, one personal coded keyboard, 2 sets of sensors, one audible horn; & wiring (incl. one 10A fuse)

CA-06 Auto Alarm **$59.95**

DIGITAL QUARTZ TIME PEN

• 5-Function: Hours, Minutes, Seconds, Month, Day • Liquid Crystal Display • 1/8" digits • Battery included • Uses standard Parker ink refills • Ultra-slim design (5¼" x ¼")

771LK	Black/Gold Trim	$9.95 each
771SG	Stainless Steel/Gold Trim	$9.95 each
771LR	Red/Gold Trim	$9.95 each

STICK-ON CLOCK

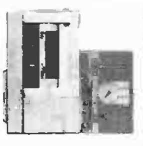
5-Function LCD Quartz Digital

• Hours • Minutes • Seconds • Month • Day • Flashing Colon • Ideal for car, kitchen, bathroom, office, etc. • 1/4" digits • Runs 2 years on 1 battery (incl.) • Size: 1-3/8" Round. Specify color: Red/ST-001R; White/ST-001W; Black/ST-001B

#ST-001 (Specify letter) **$4.95 each or 2/$8.95**

Stereo Cassette Player

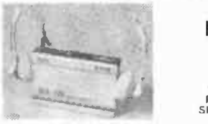
with FM Stereo Tuner Pack



• Lightweight Headphones
• Cr02/Metal/Normal Tape Selector
• Anti-Rolling Mechanism

FEATURES: • Blue carrying case, shoulder strap, belt strap, lightweight headphones, FM stereo tuner pack & instruction manual • Talkline • Tone selector • Cr02/Metal/Normal tape selector • LED operation indicator • Built-in microphone • Stop/eject, play, rewind/review, fast forward/cue, tape/radio selector functions • Vol. control • Ext. power input jack • Headphone jack • Auto-stop mechanism (shuts off player when tape ends) • Anti-rolling mechanism (prevents sound from quivering when walking, jogging, etc.) • Weight: 13 oz. • Requires 4 AA batteries (not included) • Size: 6"L x 4"W x 1-1/8"H

Model TWF-802 .... $69.95
AM3-4 AA Alkaline Batteries .... 4/$3.95



UTIC

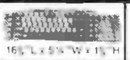
Mini Stereo AM/FM Receiver

WITH HEADPHONES
For Joggers, Cyclists, Skaters & Sports Events

FEATURES: Lightweight headphones. Left/right balance control. Full fidelity stereo sound. Additional black soft carrying case and shoulder strap. Belt clip (hands free). Operates on 3 AA cell batteries (not incl. - see below). Compact size: 3-1/8"H x 4-7/8"L x 1"D. Wt. 6 oz.

Model 2830 .... $29.95
AM3-3 AA Alkaline Batteries .... 3/$2.95

KEYBOARDS — POWER SUPPLIES



MICRO SWITCH 69-KEY KEYBOARD
Data Entry Keyboard, Encoded Output: 8-bit Parallel EBC DIC, Switching: Hall Effect, 24-pin Edge Card Connection, Complete w/Pin Connection. Can easily be modified to ASCII code.
Part No. KB69S012-2 (Fits into DTE-20 Enclosure) .... $19.95 each

MICRO SWITCH 85-KEY KEYBOARD
Word Processing Keyboard, 26 Pin Edge Card Connection. Supply Voltage +5VDC. Main Keyboard is QWERTY. Additional Key Pads for Cursor and word processing functions.
Part No. 85S018-1 .... $29.95 each

MICRO SWITCH 88-KEY KEYBOARD (PARALLEL)
Data Entry Keyboard used in a Diablo 1640 Terminal. Supply Voltage: +5V, -12V. Switching: Hall Effect — 10-pin Edge Card Connection. Schematic Included. Uses 8048 Encoder Chip.
Part No. 88S022 (Fits Into DTE-20 Enclosure) .... $69.95 each

POWER SUPPLY +5VDC @ 1 AMP REGULATED *Transaction Tech*
Output +5VDC @ 1A (also +30VDC) reg. Input 115VAC 60Hz. 2-tone (black/beige) self-enclosed case, 6 ft., 3 cond. black power cord. 6½"W x 7"D x 2¼"H. Wt. 3 lbs. Data sheet incl.
Part No. PS51194 .... $19.95 each

POWER SUPPLY +5VDC @ 1 AMP REGULATED *B Industries*
Output +5VDC @ 1 amp, +36-42VDC adj. 400mA or less, 30VAC (isol.) @ 1.5 amp. Input 115VAC 60Hz. Circ. brkr. re-set button. Blk. self-encl. case w/4 rubber feet, 6 ft., 3 cond. blk. pow. cord. On/off switch. 6¾"W x 7¼"D x 3-7/8"H - wt. 7 lbs. Data sheet included.
Part No. PS407D .... $24.95 each

POWER SUPPLY +5VDC @ 3 AMP REGULATED *Deltron*
Input: 115VAC, 47-440Hz. Output: 5VDC Adjustable @ 3 amp, 6VDC @ 2.5 amp. Adjustable current limit, Ripple & Noise: 1MV rms, 5MV p-p — 2 mounting surfaces. UL recognized. Size: 4"W x 4½"L x 2-7/16"H - wt. 2 lbs. Data sheet included
Part No. DPS-1 .... $29.95 each

MULTI-VOLTAGE POWER SUPPLY +5,+12,—12VDC REGULATED
Input: 105-125VAC, 47-63Hz/205-250VAC, 47-63Hz. Output: +5VDC @ 2 amps Adj., 5VDC @ 50mA Fixed, +12VDC @ 1 amp Adj., —12V @ 2 amp adj. Overvoltage protection. Size: 12½"L x 4-7/8"W x 3¾"D. Data sheet included.
Part No. RA0250 .... $39.95 each

POWER SUPPLY +5VDC @ 7.5 AMP, 12VDC @ 1.5 AMP SWITCHING
Input: 115VAC, 50-60Hz @ 3 amp/230VAC, 50Hz @ 1.6 amp. Fan volt./power supply select switches (115/230VAC). Output: 5VDC @ 7.6 amp, 12VDC @ 1.6 amp. 8 ft. blk. pow. cord. 11½"W x 13¼"D x 3¼"H. Wt. 6 lbs.
Part No. PS94VO .... $49.95 each

POWER SUPPLY 4-Channel Switching Power Supply
Microprocessor, mini-computer, terminal, medical equipment and process control applications. Input: 90-130VAC 47-440Hz. Output: +5VDC @ 5A, -5VDC @ 1A; +12VDC @ 1A, -12VDC @ 1A. Line reg.: ±0.2%. Ripple: 30mV p-p. Load reg.: ±1%. Overcurrent protection. Adj: 5V main output ± 10%. 6-3/8"L x 1-7/8"W x 4-15/16"H. Wt. 1½ lbs.
Part No. FCS-604A .... $69.95 each

POWER SUPPLY Adjustable Switching 4-24VDC to 5 Amps
Adj. 4-24VDC; 5VDC @ 5A, 6VDC @ 4.8A, 9VDC @ 4.1A, 12VDC @ 3.3A, 18VDC @ 1.9A, 24VDC @ .5A. Overvoltage Protection. Input: 115VAC 50/60Hz. Output variations within 20mV. 8.25"L x 4.25"W x 2.25"H. Wt. 3.25 lbs.
JE224 Kit .... $79.95 each
JE224A Assembled & Tested .... $99.95 each

SORENSEN Regulated Power Supplies

SOC 2-6 (Pictured)

Sorensen's open construction (SOC) power supplies are series-regulated solid-state systems, designed to provide reg. DC voltages at 6 levels (2-28 v/range). These units are open-framed on sturdy black anodized aluminum for excellent mounting.

FEATURES: 115/208/230VAC Input @ 50-63Hz. Low Ripple: 1.5mVrms, 5mV P-P maximum. Adjustable current limit. Voltage adjustment control. All schematics and specifications supplied with unit. Series A,B,C,E have three mounting surfaces (Series F, bottom mounting only).

Part No.	Series	Output Voltage Adjustment Range min.	max.	Output Current amps (Adc) @40°C	@50°C	@60°C	Size (Inches)	Weight	Price
SOC 2-6	B	1.9	2.1	6.0	4.9	3.8	5.62 x 4.88 x 2.90	4.3 lbs.	$19.95
SOC 2-26	F	1.9	2.1	26.0	21.5	17.5	16.00 x 4.88 x 4.88	16 lbs.	29.95
SOC 5-18	E	4.75	5.25	18.0	16.0	12.0	14.00 x 4.88 x 2.75	12 lbs.	39.95
SOC 5-25	F	4.75	5.25	25.0	21.5	17.5	16.00 x 4.88 x 4.88	16 lbs.	49.95
SOC 12-11	E	11.4	12.6	11.0	9.2	6.8	14.00 x 4.88 x 1.62	12 lbs.	44.95
SOC 15-6	C	14.25	15.75	6.0	4.2	3.5	7.00 x 4.88 x 3.37	6.6 lbs.	39.95
SOC 15-9.8	E	14.25	15.75	9.8	7.8	5.6	14.00 x 4.88 x 1.62	12 lbs.	44.95
SOC 15-13	F	14.25	15.75	13.0	10.6	8.0	16.00 x 4.88 x 4.88	16 lbs.	49.95
SOC 28-0.8	A	26.6	29.4	0.8	.64	.45	4.00 x 4.88 x 1.62	2 lbs.	24.95

BUG BOX™ — 30 individual compartments • Stores 60 8-pin or 30 14- or 16-pin DIPs • Heavy duty injection molded plastic • Clear plastic cover slides & locks • Cover marked w/numbers 1-30 • Compartment size: 1" x 3.75" x .5" deep • Box size: 4.9" x 3.3" x .6" • Weight: 1.75 oz.

BUG BOX™

Please specify color code: (B) Blue, (R) Red, (W) White, (Y) Yellow

Part No./Color Code	QTY	PRICE
BGX-001-( )	1	$ 2.29
BGX-010-( )	10	19.99
ANTI-STATIC		
BGX-001-( )AS	1	$ 3.29
BGX-010-( )AS	10	28.89

BUG CAGE™ — 12 locations store Bug Boxes, Big Bug Boxes or Bug Trays • Modular and interlocking • Heavy duty injection molded plastic • Each cage has 6 slip-on locations • 2 cages per pkg. • Cage size: 5-1/8" x 5" x 3-7/8" • 4 colors available — please specify color code: (B) Blue, (R) Red, (W) White, (Y) Yellow

Part No./Color Code	Price
BGC-001-( ) 2 Cages (6 loc. ea.)	$11.95/pkg.

BUG TRAY™ — Stores In Bug Cage • Molded plastic • Three styles: Open (1 compartment 3.05" x 4.6" x .6"); Vertical (5 compartments .5" x 4.6" x .6"); and Horizontal (8 compartments .4" x 3.95" x .6") • Ideal for tools, hardware, components, etc. • Tray size: 3.55" x 5.05" x .6" • Black color only

PART NO.	DESCRIPTION	PRICE
BTH-001	Horizontal Bug Tray	$1.95
BTV-001	Vertical Bug Tray	1.95
BTO-001	Open Bug Tray	1.95
BTX-003	1 of each Bug Tray (3)	4.98

BUG BOX™ STORAGE SYSTEMS

BUG CAGE™ (BGC-001-____) with Bug Boxes

LSI BIG BUG BOX™ — Designed to store large IC's, Resistors, Capacitors and Diodes • Divided into three compartments measuring 1" x 4.15" x .5" deep • Three vertical and three horizontal dividers included • Heavy duty injection molded plastic • Box size: 4.9" x 3.3" x .6" • Weight: 1.75 oz.

LSI BIG BUG BOX™

Please specify color code: (B) Blue, (R) Red, (W) White, (Y) Yellow

PART NO./COLOR CODE	QTY	PRICE
BLX-001-( )	1	$ 3.29
BLX-010-( )	10	28.79
ANTI-STATIC		
BLX-001-( )AS	1	$ 4.29
BLX-010-( )AS	10	37.89

BACK PACK™ — Self-adhesive labels for the back of ICs • Shows exact internal logic in relation to IC pins • 532 labels in each package (including several blank labels) • Each package for 8, 14, 16, 24, 28 and 40-pin ICs • Combo package includes 1,068 labels for TTL and CMOS ICs • Microprocessor package contains 744 labels

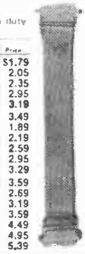
Part No.	Description	Price
BPT-012	TTL	$7.95
BPC-012	CMOS	8.95
BPM-012	Combo	14.95
BPU-012	Microprocessor	9.95

Custom Jumpers! JUMPER AND CABLE ASSEMBLIES *Custom Cables!*

STANDARD DIP JUMPERS

All jumpers use low profile dip plugs with heavy duty pins for repeated disconnect applications.

JAMECO Part No.	AP Cross Reference	No. Pins	Description	Wire Length	Price
DJ14 1	924102 12	14	single end	12"	$1.79
DJ14 2	924102 24	14	single end	24"	2.05
DJ14 3	924102 36	14	single end	36"	2.35
DJ14 1 14	924106 12	14	double end	12"	2.95
DJ14 2 14	924106 24	14	double end	24"	3.19
DJ14 3 14	924106 36	14	double end	36"	3.49
DJ16 1	924112 12	16	single end	12"	1.89
DJ16 2	924112 24	16	single end	24"	2.19
DJ16 3	924112 36	16	single end	36"	2.59
DJ16 1 16	924116 12	16	double end	12"	2.95
DJ16 2 16	924116 24	16	double end	24"	3.29
DJ16 3 16	924116 36	16	double end	36"	3.59
DJ24 1	924122 12	24	single end	12"	2.69
DJ24 2	924122 24	24	single end	24"	3.19
DJ24 3	924122 36	24	single end	36"	3.59
DJ24 1 24	924126 12	24	double end	12"	4.49
DJ24 2 24	924126 24	24	double end	24"	4.95
DJ24 3 24	924126 36	24	double end	36"	5.39
DJ40 1	924132 12	40	single end	12"	5.39
DJ40 2	924132 24	40	single end	24"	6.19
DJ40 3	924132 36	40	single end	36"	6.89
DJ40 1 40	924136 12	40	double end	12"	9.49
DJ40 2 40	924136 24	40	double end	24"	10.29
DJ40 3 40	924136 36	40	double end	36"	10.95



STANDARD DB25 SERIES CABLES

Now you can order DB25 P or S connectors with the cable necessary to fit your application. Choose from our standard flat cable in 4 foot lengths. Call today.

STANDARD CABLES

Part No.	Cable Length	Connectors	Price
DB25P-4	4 feet	1 DB25P	$7.95
DB25S-4	4 feet	1 DB25S	8.49
DB25P-4-P	4 feet	2 DB25P	13.49
DB25P-4-S	4 feet	1 DB25P/1 DB25S	13.75
DB25S-4-S	4 feet	2 DB25S	13.95

$10.00 Minimum Order — U.S. Funds Only
California Residents Add 6½% Sales Tax
Postage — Add 5% plus $1.50 Insurance
Send S.A.S.E. for Monthly Sales Flyer!

Spec Sheets — 30¢ each
Send $1.00 Postage for your
FREE 1983 JAMECO CATALOG
Prices Subject to Change

Call for Quantity Discounts

Mail Order Electronics • Worldwide

Jameco ELECTRONICS

NEW! Telex Number Telex 176043

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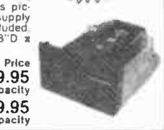
PHONE ORDERS WELCOME — (415) 592-8097

12/82

5¼" Mini-Floppy Disc Drive

FOR TRS-80 MODEL I (Industry Standard)

Perlec Computer Corp.



Features single or double density. Recording mode: FM single, MFM double density. Power: +12VDC (±0.6V) 1.6 amps max., 5VDC (±0.25V) 0.8 amps max. Unit as pictured at left (does not incl. case, power supply or cables). 30-page data book included. Weighs 3½ pounds. Size: 5¾"W x 8"D x 3¼"H

Limited Quantity!

Part No.	Price
FD200 Single-sided, 40 tracks, 250K bytes capacity	$179.95
FD250 Double-sided, 35 tracks, 438K bytes capacity	$199.95

EXPAND YOUR TRS-80

to 16K, 32K, or 48K

**Model 1 = From 4K to 16K Requires (1) One Kit
Model 3 = From 4K to 48K Requires (3) Three Kits
Color = From 4K to 16K Requires (1) One Kit

**Model 1 equipped with Expansion Board up to 48K Two Kits Required
— One Kit Required for each 16K of Expansion —

TRS-80 16K Conversion Kit

Kit comes complete with 8 each MM5290 (UPD416/4116) 16K Dynamic RAM (*ns) and documentation for conversion.

TRS-16K2 *150ns	$14.95
TRS-16K3 *200ns	$12.95
TRS-16K4 *250ns	$10.95

TRS-80 Color 32K or 64K Conversion Kit

Kit comes complete with 8 ea. 4164-2 (200ns). 64K Dyn. RAMs & conversion documentation. Converts TRS-80 color computers from 4K-32K Memory or 16K-64K Memory.

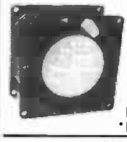
TRS-64K2 (200ns) $54.95

Universal Computer Keyboard Enclosure

"DTE" Blank Desk-Top Enclosures are designed for easy modification. High strength epoxy molded end pieces in mocha brown finish. Sliding rear/bottom panel for service/component access. Top/bott. panels .080" thick alum. alodine type 1200 finish (gold tint color) for best paint adhesion after modification. Vented top & bottom panels for cooling efficiency.

DTE-20 Panel width 20" $34.95

Sprite-style Fan



• 36cfm free air delivery
• 3.125" sq. x 1.665" depth
• 10 yrs. cont. duty at 20°C
• 115V 50/60Hz
• For Apple users

Metal Frame

PWS2107U Cleaned & tested (used) .... $ 9.95 ea.
*PWS2107F New .... $14.95 ea.

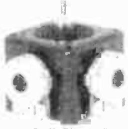
Muffin-style Fan

• 105cfm free air delivery
• 4.68" sq. x 1.50" depth.
• 10 yrs. cont. duty at 20°C
• Impedance protected, ambients to 70°C
• 115V 50/60Hz 14W Wt. 17 oz.

Metal Frame

MU2A1-U Cleaned & tested (used) .... $9.95 ea.
*MU2A-1N New .... $14.95 ea.

JOYSTICKS

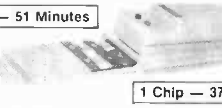


JS-5K (Pictured)

JS-5K	5K Linear Taper Pots	$5.25
JS-100K	100K Linear Taper Pots	$4.95
JS-150K	150K Linear Taper Pots	$4.75
JVC-40	40K (2) Video Controller in Case	$4.95

UV-EPROM Eraser

8 Chips — 51 Minutes



1 Chip — 37 Minutes

Erases 2708, 2716, 2732, 2764, 2516, 2532, 2564. Erases up to 8 chips within 51 minutes (1 chip in 37 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 9.00" x 3.70" x 2.60". Complete with holding tray for 8 chips.

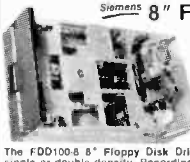
UVS-11EL Replacement Bulb $16.95
DE-4 UV-EPROM Eraser $79.95

Wall Transformers AC and DC Types

AC250 (Pictured)

Part No.	Input	Output	Price
AC 250 (above)	117V/60Hz	12VAC 250mA	$3.95
AC 500	117V/60Hz	12VAC 500mA	$4.95
AC1000	117V/60Hz	12VAC 1 amp	$5.95
AC9004	117V/60Hz	9.2VAC 2.5 amp	$3.95
DC 800	120V/60Hz	8VDC 400mA	$1.95
DC6912	120V/60Hz	6,9,12VDC 300mA	$8.95
DC5490	117V/60Hz	9.5VDC 275mA	$2.95
DC900	120V/60Hz	9VDC 500mA	$3.95
DC1200	120V/60Hz	12VDC 300mA	$2.95
DV9200	117V/60Hz	9VAC 200mA	$3.25

Siemens 8" Floppy Disk Drive



• Single-Sided
• 77 Tracks
• 400/800K Bytes Capacity
• Industry Standard

The FDD100-8 8" Floppy Disk Drive (Industry Standard) features single or double density. Recording mode: FM single, MFM double density. Transfer rate: 250K bits/sec. single density; 500K bits/sec. double density. The FDD100-8 is designed to work with the single-sided soft sectored IBM Diskette I, or eq. disk cartridge. Hard-sectored option available. Power: 115/230VAC @ 50-60Hz, +24VDC @ 1.7 amps max., +5VDC @ 1.2 amps max. Unit as pictured above (does not include case, power supply, or cables). Size: 8.55"W x 14"L x 4.5"H. Weighs 12 lbs. Incl. 96-pg. manual.

Part No.		Price
FDD100-8	Buy 1 for	$269.95 each
FDD100-8	Buy 2 for	$259.95 each
FDD100-8	*Buy 10 for*	*$249.95 each*

CIRCLE NO. 35 ON FREE INFORMATION CARD

CIRCLE NO. 32 ON FREE INFORMATION CARD

74LS00

74LS00	.24	74LS86	.39	74LS169	1.75	74LS323	2.75
74LS01	.25	74LS90	.55	74LS170	1.49	74LS324	1.75
74LS02	.25	74LS91	.89	74LS173	.69	74LS352	1.29
74LS03	.25	74LS92	.55	74LS174	.55	74LS353	1.29
74LS04	.24	74LS93	.55	74LS175	.55	74LS363	1.35
74LS05	.25	74LS95	.75	74LS181	2.15	74LS364	1.95
74LS08	.28	74LS96	.89	74LS189	8.95	74LS365	.49
74LS09	.29	74LS107	.39	74LS190	.89	74LS366	.49
74LS10	.25	74LS109	.39	74LS191	.89	74LS367	.45
74LS11	.35	74LS112	.39	74LS192	.79	74LS368	.45
74LS12	.35	74LS113	.39	74LS193	.79	74LS373	.99
74LS13	.45	74LS114	.39	74LS194	.69	74LS374	.99
74LS14	.59	74LS122	.45	74LS195	.69	74LS377	1.39
74LS15	.35	74LS123	.79	74LS196	.79	74LS378	1.18
74LS20	.25	74LS124	2.90	74LS197	.79	74LS379	1.35
74LS21	.29	74LS125	.49	74LS221	.89	74LS385	1.90
74LS22	.25	74LS126	.49	74LS240	.95	74LS386	.45
74LS26	.29	74LS132	.59	74LS241	.99	74LS390	1.19
74LS27	.29	74LS133	.59	74LS242	.99	74LS393	1.19
74LS28	.35	74LS136	.39	74LS243	.99	74LS395	1.19
74LS30	.25	74LS137	.99	74LS244	.99	74LS399	1.49
74LS32	.29	74LS138	.55	74LS245	1.49	74LS424	2.95
74LS33	.55	74LS139	.55	74LS247	.75	74LS447	.37
74LS37	.35	74LS145	1.20	74LS248	.99	74LS490	1.95
74LS38	.35	74LS147	2.49	74LS249	.99	74LS624	3.99
74LS40	.25	74LS148	1.35	74LS251	.59	74LS668	1.69
74LS42	.49	74LS151	.55	74LS253	.59	74LS669	1.89
74LS47	.75	74LS153	.55	74LS257	.59	74LS670	1.49
74LS48	.75	74LS154	1.90	74LS258	.59	74LS674	9.65
74LS49	.75	74LS155	.69	74LS259	2.75	74LS682	3.20
74LS51	.25	74LS156	.69	74LS260	.59	74LS683	3.20
74LS54	.29	74LS157	.65	74LS266	.55	74LS684	3.20
74LS55	.29	74LS158	.59	74LS273	1.49	74LS685	3.20
74LS63	1.25	74LS160	.69	74LS275	3.35	74LS688	2.40
74LS73	.39	74LS161	.65	74LS279	.49	74LS689	3.20
74LS74	.35	74LS162	.69	74LS280	1.98	74LS783	24.95
74LS75	.39	74LS163	.65	74LS283	.69	81LS95	1.49
74LS76	.39	74LS164	.69	74LS290	.89	81LS96	1.49
74LS78	.49	74LS165	.95	74LS293	.89	81LS97	1.49
74LS83	.60	74LS166	1.95	74LS295	.99	81LS98	1.49
74LS85	.69	74LS168	1.75	74LS298	.89	25LS2521	2.80
						25LS2569	4.25

IC SOCKETS

	1-99	100
8 pin ST	.13	.11
14 pin ST	.15	.12
16 pin ST	.17	.13
18 pin ST	.20	.18
20 pin ST	.29	.27
22 pin ST	.30	.27
24 pin ST	.30	.27
28 pin ST	.40	.32
40 pin ST	.49	.39
ST = SOLDERTAIL		
8 pin WW	.59	.49
14 pin WW	.69	.52
16 pin WW	.69	.58
18 pin WW	.99	.90
20 pin WW	1.09	.98
22 pin WW	1.39	1.28
24 pin WW	1.49	1.35
28 pin WW	1.69	1.49
40 pin WW	1.99	1.80
WW = WIREWRAP		
16 pin ZIF	6.75	call
24 pin ZIF	9.95	call
ZIF = TEXTOOL (Zero Insertion Force)		

CONNECTORS

RS232 MALE	2.95
RS232 FEMALE	3.50
RS232 FEMALE RIGHT ANGLE	5.25
RS232 HOOD	1.25
S-100 ST	3.95
S-100 WW	4.95

DIP SWITCHES

4 POSITION	.85
5 POSITION	.90
6 POSITION	.90
7 POSITION	.95
8 POSITION	.95

7400

7400	.19	74132	.45
7401	.19	74136	.50
7402	.19	74141	.65
7403	.19	74142	2.95
7404	.19	74143	2.95
7405	.25	74145	.60
7406	.29	74147	1.75
7407	.29	74148	1.20
7408	.24	74150	1.35
7409	.19	74151	.55
7410	.19	74152	.65
7411	.25	74153	.55
7412	.30	74154	1.25
7413	.35	74155	.75
7414	.49	74156	.65
7416	.25	74157	.55
7417	.25	74159	1.65
7420	.19	74160	.85
7421	.35	74161	.69
7422	.35	74162	.85
7423	.29	74163	.69
7425	.29	74164	.85
7426	.29	74165	.85
7427	.29	74166	1.00
7428	.45	74167	2.95
7430	.19	74170	1.65
7432	.29	74172	5.95
7433	.45	74173	.75
7437	.29	74174	.89
7438	.29	74175	.89
7440	.19	74176	.89
7442	.49	74177	.75
7443	.65	74178	1.15
7444	.69	74179	1.75
7445	.69	74180	.75
7446	.69	74181	2.25
7447	.69	74182	.75
7448	.69	74184	2.00
7450	.19	74185	2.00
7451	.23	74186	18.50
7453	.23	74190	1.15
7454	.23	74191	1.15
7460	.23	74192	.79
7470	.35	74193	.79
7472	.29	74194	.85
7473	.34	74195	.85
7474	.33	74196	.79
7475	.45	74197	.75
7476	.35	74198	1.35
7480	.59	74199	1.35
7481	1.10	74221	1.35
7482	.95	74246	1.35
7483	.50	74247	1.25
7485	.59	74248	1.85
7486	.35	74249	1.95
7489	2.15	74251	.75
7490	.35	74259	2.25
7491	.40	74265	1.35
7492	.50	74273	1.95
7493	.35	74276	1.25
7494	.65	74279	.75
7495	.55	74283	2.00
7496	.70	74284	3.75
7497	2.75	74285	3.75
74100	1.75	74290	.95
74107	.30	74293	.75
74109	.45	74294	.85
74110	.45	7435	2.25
74111	.55	74365	.65
74116	1.55	74366	.65
74120	1.20	74367	.65
74121	.29	74368	.65
74122	.45	74376	2.20
74123	.49	74390	1.75
74125	.45	74393	1.35
74126	.45	74425	3.15
74128	.55	74426	.85
		74490	2.55

CMOS

4000	.29	4528	1.19
4001	.25	4531	.95
4002	.25	4532	1.95
4006	.89	4538	1.95
4007	.29	4539	1.95
4008	.95	4543	1.19
4009	.39	4555	.95
4010	.45	4556	.95
4011	.25	4581	1.95
4012	.25	4582	1.95
4013	.38	4584	.75
4014	.79	4585	.75
4015	.39	4702	12.95
4016	.39	74C00	.35
4017	.69	74C02	.35
4018	.79	74C04	.35
4019	.39	74C08	.35
4020	.75	74C10	.35
4021	.79	74C14	.59
4022	.79	74C20	.35
4023	.29	74C30	.35
4024	.65	74C32	.39
4025	.29	74C42	1.29
4026	1.65	74C48	1.99
4027	.45	74C73	.65
4028	.69	74C74	.65
4029	.79	74C76	.80
4030	.39	74C83	1.95
4034	1.95	74C85	1.95
4035	.85	74C86	.39
4040	.75	74C89	4.50
4041	.75	74C90	1.19
4042	.69	74C93	1.75
4043	.85	74C95	.99
4044	.79	74C107	.89
4046	.85	74C150	5.75
4047	.95	74C151	2.25
4049	.35	74C154	3.25
4050	.35	74C157	1.75
4051	.79	74C160	1.19
4053	.79	74C161	1.19
4060	.89	74C162	1.19
4066	.39	74C163	1.19
4068	.39	74C164	1.39
4069	.29	74C165	2.00
4070	.35	74C173	.79
4071	.29	74C174	1.19
4072	.29	74C175	1.19
4073	.29	74C192	1.49
4075	.29	74C193	1.49
4076	.79	74C195	1.39
4078	.29	74C200	5.75
4081	.29	74C221	1.75
4082	.29	74C373	2.45
4085	.95	74C374	2.45
4086	.95	74C901	.39
4093	.49	74C902	.85
4098	2.49	74C903	.85
4099	1.95	74C905	10.95
14409	12.95	74C906	.95
14410	12.95	74C907	1.00
14411	11.95	74C908	2.00
14412	12.95	74C909	2.75
14419	7.95	74C910	9.95
4502	.95	74C911	8.95
4503	.65	74C912	8.95
4508	1.95	74C914	1.95
4510	.85	74C915	1.19
4511	.85	74C918	2.75
4512	.85	74C920	17.95
4514	1.25	74C921	15.95
4515	1.79	74C922	4.49
4516	1.55	74C923	4.95
4518	.89	74C925	5.95
4519	.39	74C926	7.95
4520	.79	74C927	7.95
4522	1.25	74C928	7.95
4526	1.25	74C929	19.95
4527	1.95	74C930	19.95

Prices Slashed!
74S00

74S00	.32	74S163	1.95
74S02	.35	74S168	3.95
74S03	.35	74S169	3.95
74S04	.35	74S174	.95
74S05	.35	74S175	.95
74S08	.35	74S181	3.95
74S09	.40	74S182	2.95
74S10	.35	74S188	1.95
74S11	.35	74S189	6.95
74S15	.35	74S194	1.49
74S20	.35	74S195	1.49
74S22	.35	74S196	1.49
74S30	.35	74S197	1.49
74S32	.40	74S201	6.95
74S37	.88	74S225	7.95
74S38	.85	74S240	2.20
74S40	.35	74S241	2.20
74S51	.35	74S244	2.20
74S64	.40	74S251	.95
74S65	.40	74S253	.95
74S74	.50	74S257	.95
74S85	1.99	74S258	.95
74S86	.50	74S260	.79
74S112	.50	74S274	19.95
74S113	.50	74S275	19.95
74S114	.55	74S280	1.95
74S124	2.75	74S287	1.90
74S132	1.24	74S288	1.90
74S133	.45	74S289	6.89
74S134	.50	74S301	6.95
74S135	.89	74S373	2.45
74S138	.85	74S374	2.45
74S139	.85	74S381	7.95
74S140	.55	74S387	1.95
74S151	.95	74S412	2.98
74S153	.95	74S471	4.95
74S157	.95	74S472	4.95
74S158	.95	74S474	4.95
74S161	1.95	74S482	15.25
74S162	1.95	74S570	2.95
		74S571	2.95

LED DISPLAYS

HP 5082-7760	.6"	CC	1.29
MAN 72	.3"	CA	.99
MAN 74	.3"	CC	.99
FND-357 (359)	.375"	CC	.75
FND-500 (503)	.5"	CC	.99
FND-507 (510)	.5"	CA	.99

LED LAMPS

	1-99	100-up
Jumbo Red	.10	.09
Jumbo Green	.18	.15
Jumbo Yellow	.18	.15

LINEAR

LM301	.34	LM381	1.60	LM1310	1.49
LM301H	.79	LM382	1.60	MC1330	1.69
LM307	.45	LM383	1.95	MC1349	1.89
LM308	.69	LM384	1.95	MC1350	1.19
LM308H	1.15	LM386	.89	MC1358	1.69
LM309H	1.95	LM387	1.40	LM1414	1.59
LM309K	1.25	LM389	1.35	LM1458	.59
LM310	1.75	LM390	1.95	LM1488	.69
LM311	.64	LM392	.69	LM1489	.69
LM311H	.89	LM394H	4.60	LM1496	.85
LM312H	1.75	LM399H	5.00	LM1558H	3.10
LM317K	3.95	NE531	2.95	LM1800	2.37
LM317T	1.19	NE536	6.00	LM1812	8.25
LM318	1.49	NE555	.34	LM1815	5.20
LM318H	1.59	NE556	.65	LM1818	2.90
LM319H	1.25	NE558	1.50	LM1820	3.50
LM319	1.25	NE561	19.95	LM1830	3.50
LM320	(see 7900)	NE562	6.00	LM1871	5.49
LM322	1.65	NE564	2.95	LM1872	5.49
LM323K	4.95	LM565	.99	LM1877	3.25
LM324	.59	LM566	1.49	LM1889	1.95
LM329	.65	LM567	.89	LM1896	1.75
LM331	3.95	NE570	3.95	LM2877	2.05
LM334	1.19	NE571	2.95	LM2878	2.25
LM335	1.40	NE592	2.75	LM2900	.85
LM336	1.75	LM703	.39	LM2901	1.00
LM337K	3.95	LM709	.59	LM3900	.59
LM337T	1.95	LM710	.75	LM3905	1.25
LM338K	6.95	LM711	.79	LM3909	.98
LM339	.99	LM723	.49	LM3911	2.25
LM340	(see 7800)	LM723H	.55	LM3914	3.95
LM348	.99	LM733	.98	LM3915	3.95
LM350K	4.95	LM741N-8	.35	LM3916	3.95
LM350T	4.60	LM741N-14	.35	MC4024	3.95
LM358	.69	LM741H	.40	MC4044	4.50
LM359	1.79	LM747	.59	RC4136	1.25
LM376	3.75	LM748	.59	RC4151	3.95
LM377	1.95	LM1014	1.19	LM4250	1.75
LM378	2.50	LM1303	1.35	LM4500	3.25
LM379	4.50	LM1304	1.19	LM13080	1.29
LM380	.89	LM1305	1.49	LM13600	1.49
LM380N-8	1.10	LM1307	.35	LM13700	1.49

H = TO-5 CAN   T = TO-220   K = TO-3

VOLTAGE REGULATORS

7805T	.89	78L05	.69	7905K	1.49
7808T	.89	78L12	.69	7912K	1.49
7812T	.89	78L15	.69	7915K	1.49
7815T	.89	78H05K	9.95	7924K	1.49
7824T	.89	78H12K	9.95	79L05	.79
7805K	1.39	7905T	.99	79L12	.79
7812K	1.39	7908T	.99	79L15	.79
7815K	1.39	7912T	.99	LM323K	4.95
7824K	1.39	7915T	.99	UA78S40	1.95
		7924T	.99		

T = TO-220   K = TO-3   L = TO-92

TRANSISTORS DIODES

PN2222	NPN SWITCH	TO-92	10/1.00	100/8.99
PN2907	PNP SWITCH	TO-92	10/1.25	100/10.99
2N2222	NPN SWITCH	TO-18	.25	50/10.99
2N2907	PNP SWITCH	TO-18	.25	50/10.99
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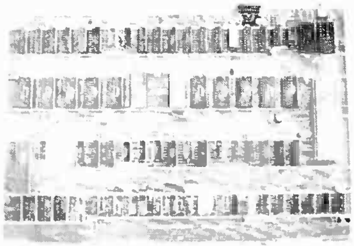

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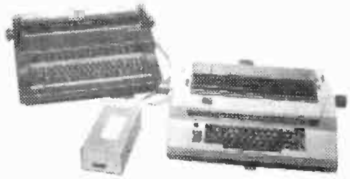

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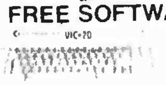

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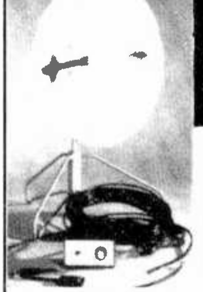

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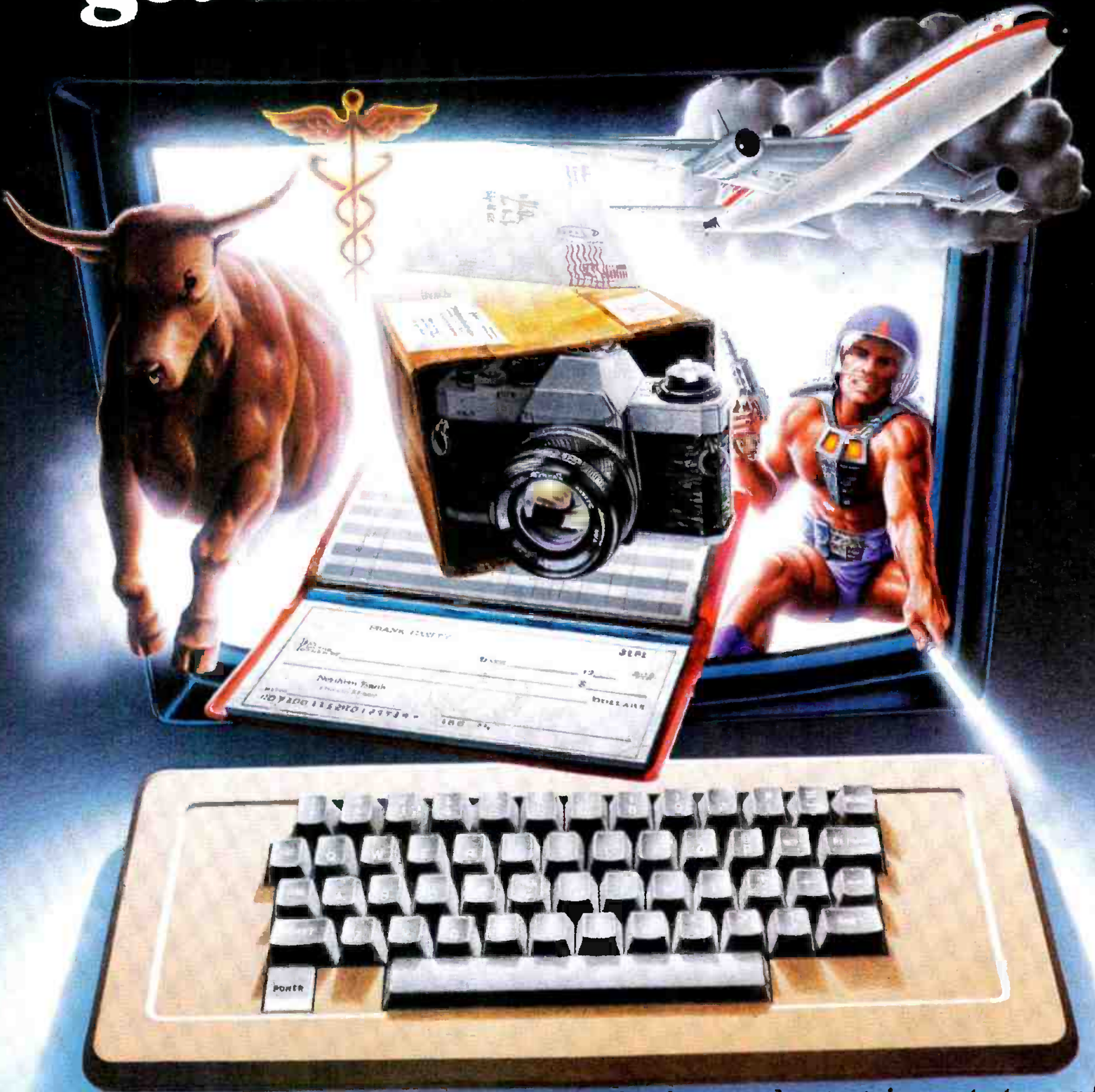

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