Popular Electronics®

WORLD'S LARGEST SELLING ELECTRONICS MAGAZINE OCTOBER 1982/$1.25

Video Accessories for VCRs & TV

Evaluating the Low-Cost VIC-20 Computer

How to Extend Test Meter Ranges

Communication Networks for Computers

Tests in this Issue:

Toshiba TTL Video Camera

Denon DR-F7 Stereo Cassette Deck

BBC-Metrawatt Digital Multimeter

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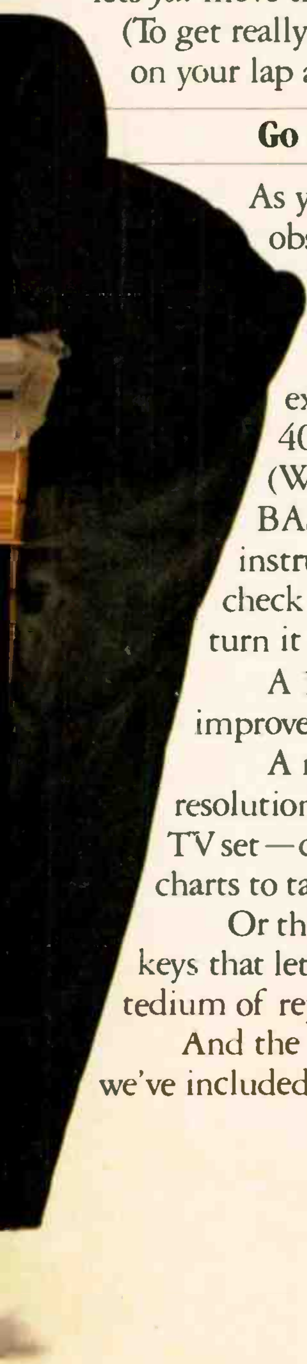

Stop in a store near you. Take a look.

You'll be instantly taken with some of the features that make the IBM Personal Computer so different.

Like the non-glare screen—easy on the eyes during those number-crunching tasks like payroll and general ledger.

80 characters a line—with upper and lower case letters for a quick and easy read.

And the flexibility of a system that lets *you* move the components around at will. (To get really comfortable, try the keyboard on your lap and put your feet up.)

Go ahead, compare.

As you progress from casual observer to comparison shopper, you'll want the inside story of the IBM Personal Computer.

Like user memory expandable up to 512KB. And 40KB of permanent memory. (Which not only includes the BASIC language, but diagnostic instructions that automatically check the system every time you turn it on.)

A 16-bit microprocessor that can improve speed and productivity.

A mix of crisp text and high-resolution color graphics on your own TV set—clearly helpful for creating charts to target forecasts and trends.

Or the 10 programmable function keys that let you bid goodbye to the tedium of repetitious tasks.

And the list goes on. Which is why we've included a box (at right) that tells all.

There's more than meets the eye.

Some of the best things about the IBM Personal Computer aren't part of the computer.

Like the instruction manuals that help you set up your system and teach you to use it with the greatest of ease.

IBM PERSONAL COMPUTER SPECIFICATIONS

User Memory
16K-512K bytes*

Microprocessor
16-bit, 8088*

Auxiliary Memory
2 optional internal diskette drives, 5¼", 160K bytes or 320K bytes per diskette

Keyboard
83 keys, 6 ft. cord attaches to system unit*
10 function keys*
10-key numeric pad
Tactile feedback*

Diagnostics
Power-on self testing
Parity checking*

Display Screen
High-resolution*
80 characters x 25 lines
Upper and lower case
Green phosphor screen*

Operating Systems
DOS, UCSD p-System, CP/M-86†

Languages
BASIC, Pascal, FORTRAN, MACRO Assembler, COBOL

Printer
Bidirectional*
80 characters/second
12 character styles, up to 132 characters/line*
9 x 9 character matrix*

Permanent Memory
(ROM) 40K bytes*

Color/Graphics
Text mode:
16 colors*
256 characters and symbols in ROM*
Graphics mode:
4-color resolution: 320h x 200v*
Black & white resolution: 640h x 200v*
Simultaneous graphics & text capability*

Communications
RS-232-C interface
Asynchronous (start/stop) protocol
Up to 9600 bits per second

*ADVANCED FEATURES FOR PERSONAL COMPUTERS

And an expanding library of software programs that meet IBM's demanding specifications.

Programs for business. Education. The lab and the home. Programs that make the IBM Personal Computer *your* tool for modern times.

See for yourself.

The quality, power and performance of the IBM Personal Computer are what you'd expect from IBM. The price isn't.

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CIRCLE NO. 53 ON FREE INFORMATION CARD

OCTOBER 1982 VOLUME 20, NUMBER 10

Popular Electronics

WORLD'S LARGEST-SELLING ELECTRONICS MAGAZINE

The Electronic World

Feature Articles

Construction Articles

Equipment Reviews

Columns

Departments

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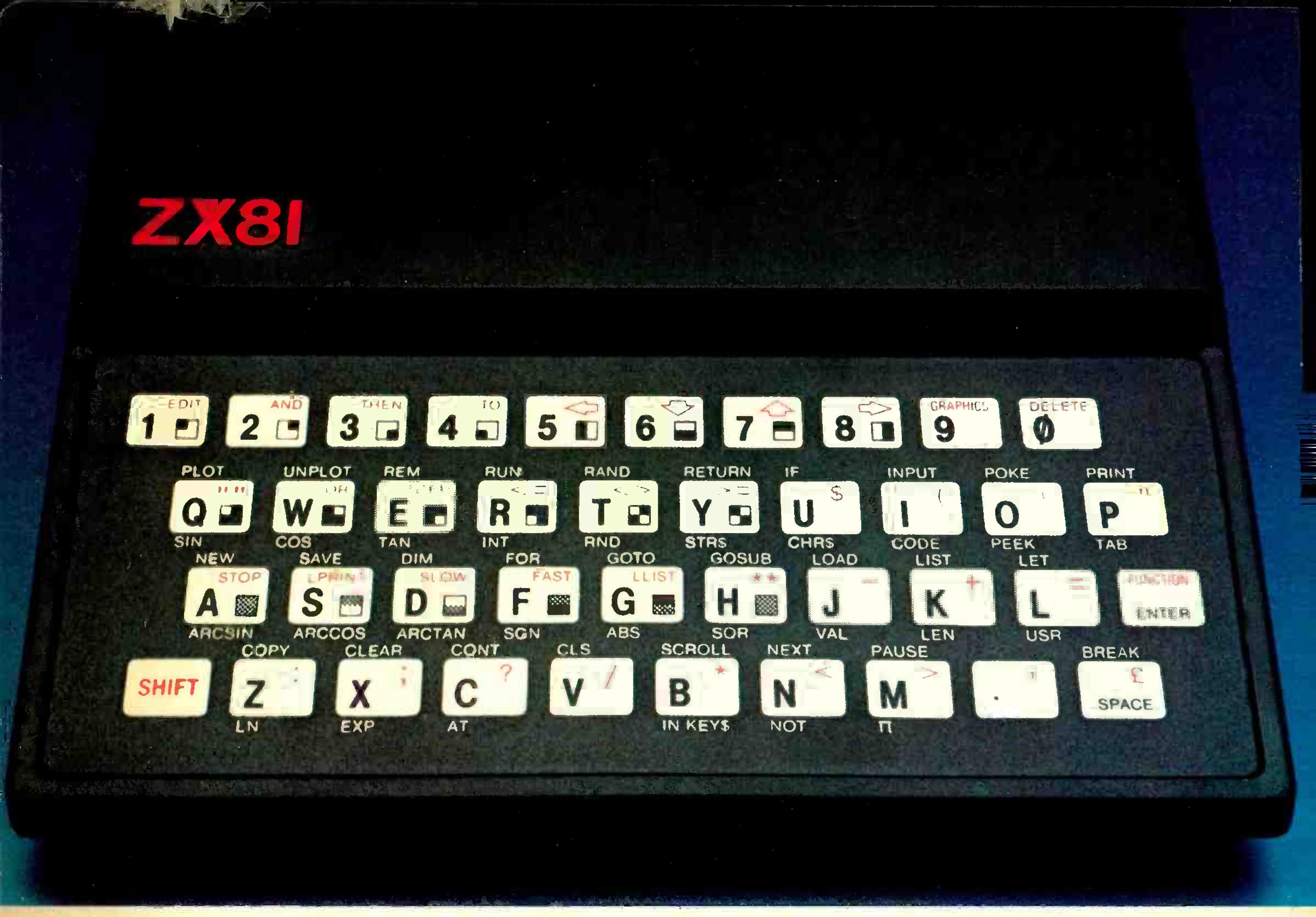


THE $99.95 PERSONAL COMPUTER.

Introducing the Sinclair ZX81.

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

The Sinclair ZX81 is the most powerful, yet easy-to-use computer ever offered for anywhere near the price: only $99.95* completely assembled.

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

A breakthrough in personal computers.

The ZX81 is a major advance over the original Sinclair ZX80 – the first personal computer to break the price barrier at $200.

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

Just look at what you get:

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

The ZX81 is also very convenient to use. It hooks up to any television set to produce a clear 32-column by 24-line display. It comes with a comprehensive programming guide and operating manual designed for both beginners and experienced computer users. And you can use a regular cassette recorder to store and recall programs by name.

Sinclair technology is also available in Timex/Sinclair computers under a license from Sinclair Research Ltd.

Order at no risk.**

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

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

Introducing the ZX81 kit.

If you really want to save money, and you enjoy building electronic kits, you can order the ZX81 in kit form for the incredible price of just $79.95.* It's the same, full-featured computer, only you put it together yourself. We'll send complete, easy-to-follow instructions on how you can assemble your ZX81 in just a few hours. All you have to supply is the soldering iron.

A leader in microelectronics.

The ZX81 represents the latest technology in microelectronics. More than 10,000 are sold every week. In fact, the ZX81 is the fastest selling personal computer in the world.

We urge you to place your order for the ZX81 today.

To order.

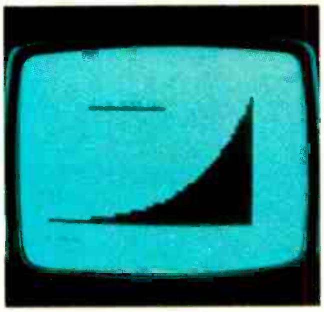
To order, simply call toll free. Or use the coupon below. Remember, you can try it for 10 days at no risk.** The sooner you order, the sooner you can start enjoying your own computer.

Call toll free 800-543-3000.

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

These numbers are for orders only. If you just want information, please write: Sinclair Research Ltd., 2 Sinclair Plaza, Nashua, NH 03061.

*Plus shipping and handling. Price includes connectors for TV and cassette, AC adaptor, and FREE manual.
**Does not apply to ZX81 kits.



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

16K MEMORY MODULE: Like any powerful, full fledged computer, the ZX81 is expandable. Sinclair's 16K memory module plugs right onto the back of your ZX81. Cost is $49.95, plus shipping and handling.

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ZX81	$99.95		
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MAIL TO: Sinclair Research Ltd., One Sinclair Plaza, Nashua, NH 03061.

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Address ____________________

City ____________ State ____________ Zip ____________

*U.S. dollars

EDITORIAL

Meet Computers & Electronics

In the first issue of POPULAR ELECTRONICS, October 1954, editor-in-chief Oliver Reed introduced you to a new magazine concept, observing that it was devoted to the science of electronics at the "How it works," "How to do it," and "How to use it" level. Remarkably, this charter has not swerved over the years. What has changed, however, is the continually evolving editorial content that greets you each month with the newest twists and turns occuring in electronics . . . new devices, new circuit applications, new equipment.

As the lineal editorial descendent of Olly, I have an equally important announcement to make as we enter our 29th year: THIS IS THE LAST ISSUE OF POPULAR ELECTRONICS!

Yes, it's true! Next month you will see us with a new name—COMPUTERS & ELECTRONICS. This title more appropriately describes who we are in an age when computers are certain to command more and more of your active interests. I'll be celebrating this change with you in November and succeeding issues by preparing a large number of *extra* editorial pages devoted to the fast-paced computer field. Thus, you'll be getting more for your money while still enjoying all the other areas of electronics that give you so much learning and working pleasure: construction projects, audio, video, communications, test instruments, and the latest in applied electronics technology.

Here's an example of the exciting computer editorial lineup awaiting you next month—features we could not have ordinarily included without extra pages!

- A modestly priced computer board kit that generates eyeboggling shades of color and black-and-white video.
- Pitting computer clones against the original.
- Examining point-graphics software packages.
- Comparing competing disk drives.
- A hard look at Motorola's popular MC68000 16-bit microprocessor.

Add to the foregoing a host of informative columns: "Les Solomon on Hardware"; "Stan Veit on Software"; a Q & A section to respond to readers' hardware and software problems; "Computer Bits"; and more. I know you'll like these columns because we're not only turning your favorite writers on to computers, we're also turning them loose. You'll be reading about new computer hardware and software, written with a refreshing candor you'll appreciate . . . by writers who have deep experience in the small-computer field and who sharpen their computer knowledge daily.

Our technical director, Les Solomon, for example, is considered by many to be the grandaddy of personal computers, while Stan Veit, a long-time technical writer and computer instructor, was one of the pioneer computer store owners in the country. Forrest Mims, a major author of computer and electronics books, will lead the way in the computer devices area in "Solid State" (as well as continuing to write "Experimenter's Corner" and "Project of the Month"). And Carl Warren will continue to share his special insights to computer equipment as he travels across the country visiting manufacturers.

Of course, you'll still get Julian Hirsch's reliable audio product reviews, only there'll be more than before, served up with a welcome forthrightness. The same applies to test reports by Dr. Walter Buchsbaum (Sc.D.) in the video area.

Some of you among our 400,000+ readers might bemoan the name change for sentimental reasons. You'll soon recognize, though, that this is a natural evolution that complements what's happening in electronics today.

When I joined POPULAR ELECTRONICS some ten years ago, I was determined to carve out a new-development path for the magazine. Even at that time, I recognized that success in this direction would make the magazine's name an anachronism because our contents would be more sophisticated than before and attract a more knowledgeable and deeply inquisitive reader who wants to be at the leading edge of practical electronics. Not "popular" at all in terms of mass appeal.

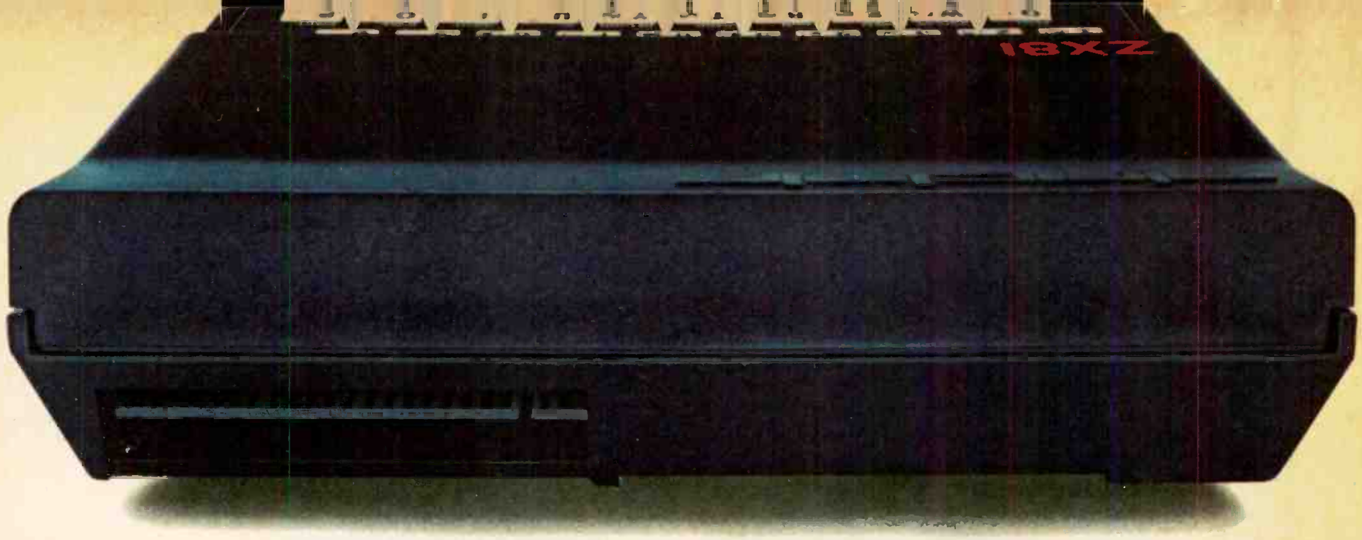
This evolution started in our August 1973 issue with plans on how to make a low-cost sweep function generator. After a series of exciting "breakthrough" articles, I featured a two-IC $39.50 professional ASCII keyboard and encoder on the April 1974 cover. Here was the springboard for a brand new field for our readers, I determined—computers! A poor man's version of Data General's "Nova," I thought at the time.

Initiating a search for a powerful, modestly priced computer kit that would match commercially available models selling at rather high prices (with my technical editor, Les Solomon, as point man) led to another important change. To accommodate the larger schematics we'd be required to print, our 6" by 9" page size was expanded to an 8½" by 11" format in the August 1974 issue.

Just in time, too, because our cover story for January 1975 featured the $397 Altair computer kit, the shot that reverberated 'round the world, acknowledged to have spearheaded the beginning of a new industry—personal computers. This publishing triumph was followed by a series of remarkable articles: the first low-cost modem; the first small-computer color graphics system; the first integrated computer system; the first widely used tiny computer (the "ELF"); and so on.

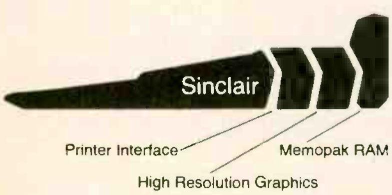
For more of the foregoing electronics excitement and challenge, follow COMPUTERS & ELECTRONICS as it travels a new bend in the road, supported by more pages and a larger editorial staff. I'm confident you'll enjoy reading it as much as my staff and I enjoy putting it together.

Art Salsberg



BEHIND EVERY GOOD SINCLAIR IS A MEMOPAK

If you own a Timex-Sinclair 1000 or ZX81 computer, you should have a Memopak behind it. From increased memory to high resolution graphics, Memotech has a Memopak to boost your system's capabilities. Every Memopak peripheral comes in a black anodised aluminum case and is designed to fit together in "piggy back" fashion to enable you to continue to add on and still keep an integrated system look.



Order at no risk

All Memotech products carry our 10 day money back guarantee. If you're not completely satisfied, return it in ten days and we will give you a full refund.
And every Memotech product comes with a six month warranty. Should anything be defective with your Memopak, return it to us and we will repair or replace it free of charge. Dealer inquiries welcome. To order any Memotech product call our toll-free number **800/662-0949** or use the order coupon.

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	*Price	Qty.	Total
64K RAM	$179.95		
32K RAM	109.95		
16K RAM	59.95		
Centronics Parallel Printer Interface	104.95		
RS232 Printer Interface	139.95		
High Resolution Graphics	144.95		
Shipping and handling	4.95		$4.95

* All prices quoted in U.S. dollars
** Colorado residents please add sales tax
☐ Check ☐ MasterCard ☐ Visa

Tax**
Total

Account No. ______ Exp. ______

Name

Address

City State Zip

Memopak 64K RAM The 64K RAM extends the memory of your Sinclair by 56K to a full 64K. It is directly addressable, user transparent, is neither switched nor paged and accepts such basic command as 10 DIM A (9000). The Memopak 64K turns your Sinclair into a powerful computer suitable for business, recreational and educational use. No additional power supply is required.

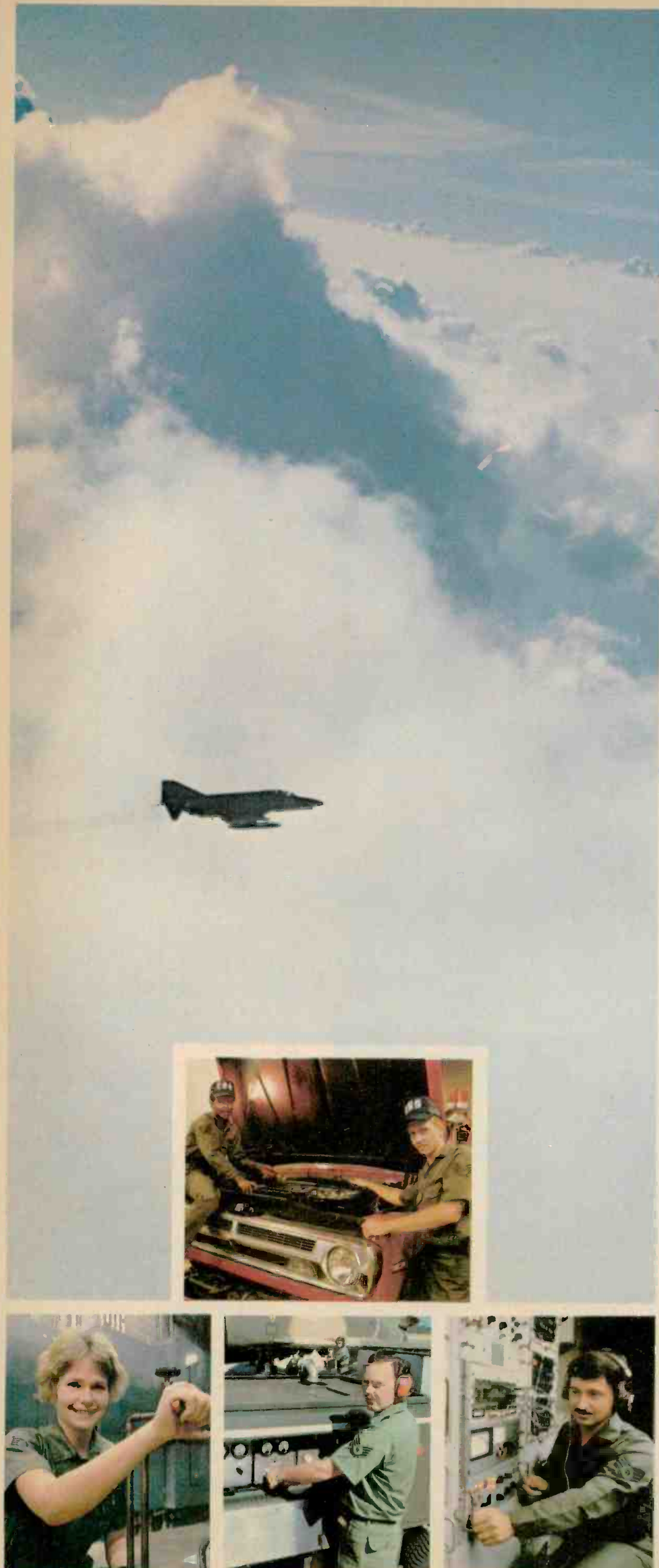
Memopak 32K RAM The 32K RAM Memopak offers your Sinclair a full 32K of directly addressable RAM. Like the 64K Memopak, it is neither switched nor paged and enables you to execute sophisticated programs and store large data bases. It is also fully compatible with Sinclair's or Memotech's 16K RAM to give you a full 48K of RAM.

Memopak 16K RAM The Memopak 16K RAM provides an economical way to increase the capabilities of your Sinclair. And at the same time, it enables you to continue to add on other features with its "piggy back" connectors. It is compatible with the Sinclair 16K or a second Memopak 16K or Memopak 32K to give 32K or 48K of RAM respectively.

Memopak High Resolution Graphics The Memopak HRG contains a 2K EPROM monitor and is fully programmable for high resolution graphics. The HRG provides for up to 192 by 248 pixel resolution.

Memopak Printer Interface The memotech centronics parallel or RS232 printer interface paks enable your Sinclair to use a wide range of compatible printers (major manufacturers' printers available through Memotech at significant savings). The resident software in the units gives the ASCII set of characters. Both Memopak printer interfaces provide lower case character capabilities. The RS232 Interface is also compatible with modems.

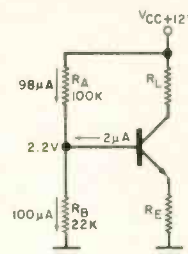
New products coming soon Memotech will soon be introducing four new Sinclair compatible products: a high quality, direct connection keyboard, a digitizing tablet, a 16K EPROM and a disk drive. Watch for our future advertisements.



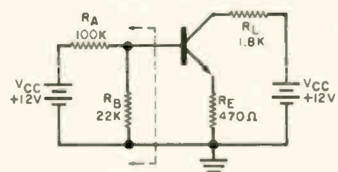
LETTERS

Analyzing Transistor Circuit

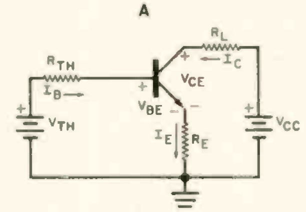
I was trying to analyze the transistor troubleshooting quiz (April, 1982) when I suddenly realized it was impossible. Resistor RB drops 2.2 V and draws 100 uA. Resistor RA drops 9.8 V and draws 98 uA (see diagram). This means there is no forward-bias base current from base to emitter but rather a reverse current of 2 uA from emitter to base. Thus the transistor is cut off. Collector voltage should be 12 V, not 6 V as was given; and emitter voltage should be 0 V instead of 1.6 V.—*Bruce Reed, Springfield, MO.*



Your analysis of the circuit is incorrect. Note that the circuit can be redrawn as shown in Fig. A. It can now be simplified by taking the Thevenin equivalent of the circuit to the left of the transistor (Fig. B).



A



B

The Thevenin voltage is $V_{CC}(R_2/R_1 + R_2)$, while the Thevenin resistance is $R_1R_2(R_1 + R_2)$. You are now left with a circuit that has two loops. By using Kirchhoff's voltage law, you can now solve for I_B.—Ed.

Watch Out for Side Effects

The application of energy saving devices in the home requires an analysis of possible side effects as well as savings in first costs and fuel. For instance, in "New Vacation Thermostat, Set to Just Above Freezing, Saves Heating Costs" (August 1982), the author describes temperature settings that might drop the temperature to 35° or 40°F—in a home that was formerly never below 65°. A few examples of side effects that might occur are: killing of house plants; cracking of walls and ceilings; aquarium heaters not able to keep the water warm enough; and possible dropping of temperatures even further due to temporary power failures. The possible savings of utilizing such a device could easily be offset by any one of these effects.—*Earl C. Haag, York, PA.*

Out of Tune

In "A new, Effective Anti-Burglary System" (June 1982), *C5* and *C6* should be 0.0022 μF; *C23* should be 0.05 μF; a 22-μF, 50-V capacitor (*C25*) should be added between pin 13 of *IC2* and ground; *IC2* and *IC3* should be listed as 556; *Q7* should be listed as a type 2N6121; *R27* should not be listed under 1 kilohm; *R37* should be shown on the pc layout between the base of *Q5* and ground; *D13* should be shown between *D9* and ground; and the capacitor labelled *Q1* in Fig. 4 should be *C21*.

NEW PRODUCTS

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

High-Resolution Color Monitor

Designed with an RGB video input and a commercial grade CRT, the new portable 13" Color III monitor from Amdek is reported to provide high-resolution graphics (260 H x 300 V; 80 x 24 characters) for Apple II and Apple III personal computers. The interface between the computer and monitor is effected by what Amdek calls a Digital Video Multiplexor (DVM) with four discrete channels: one for existing Apple text, two for graphics (low and high resolution, respectively), and another for a supplemental 80-character/line video text board. The DVM is also color programmable, allowing the red, blue, and green signals to be selectively turned on or off by the Apple's software. Display colors include yellow, cyan, magenta, and white (in addition to red, green, and blue). User controls on the monitor are ON/OFF, VOLUME UP/DOWN, BRIGHTNESS, CONTRAST, and VERTICAL HOLD. Dimensions are 17" W × 14½" H × 15" D. $569.

CIRCLE NO. 91 ON FREE INFORMATION CARD

Programmable Turntable

The new CP-1028R direct-drive automatic single-play turntable from Onkyo permits up to eight selections to be programmed in any order. An optoelectronic sensor detects record size and counts the spaces between the bands to select a particular musical piece. A repeat function permits the playing of any one piece indefinitely. The turntable has front panel, soft-touch controls, and a digital display for the automatic programming mode. It uses an electronic servo-con-

trolled brushless dc motor to drive the 12¼" aluminum die-cast platter. Speed is adjustable ±3% (aided by a LED that shows red for slow or fast, green for correct speed). Wow and flutter are rated at 0.028%, Wrms and S/N is given as 72 dB. The tonearm is made of static-balanced black anodized aluminum. The cartridge is a V-magnet type (Model OCH55V) with optical sensing. Frequency response is 18 to 25,000 Hz; output voltage is 4 mV; and tracking force is specified at 2g with a 0.6 mil round diamond stylus. Size is 16½" W × 5⅜" H × 14⅜" D. $260.

CIRCLE NO. 92 ON FREE INFORMATION CARD

Power Supply for Digital Circuits

The B&K Precision Model 1654 power supply, designed to work with digital circuits, provides a continuously variable 2-to-6-volt output, adjusted by a vernier control. The unit is reported to be able to sense the voltage through a load and compensate accordingly if the potential drops below a given threshold (the 1654 has a reserve power rated at 10 A max.). A convection cooling system is said to permit operation at ambient temperatures up to 40°C. Output connections are flexible—either terminal can be referenced to an external voltage or connected to a chassis or earth ground. For very high current requirements, two supplies can be paralleled. $395.

CIRCLE NO. 93 ON FREE INFORMATION CARD

Portable Data Terminal

Radio Shack has entered the portable terminal market with its new PT-210. Designed for applications where hard copy from a computer or videotex service is needed, the terminal incorporates a ASCII typewriter keyboard, thermal printer, and a 110/300 baud (Bell 103A compatible) acoustic telephone coupler. The keyboard generates a total of 99 codes, including 67 printable characters, 32 terminal control characters, and offers a switch-selectable digital keypad. It operates in half- and full-duplex modes, and at odd, even, or no parity. The non-impact thermal printer uses a 35-element (5 × 7) matrix and has variable contrast control. Seventy-one characters are printable, with lower-case letters automatically printed as their upper-case equivalents. Each 8" line

can include up to 80 characters, and carriage return is automatic at the 81 column of any line. Printing speed is 50 cps, with six lines per vertical inch. Indicators include a ¼-s tone bell, a power-on lamp, a carrier-detect lamp, and a character error-detect lamp. An optional plug-in RS232C Interface Module is said to facilitate the use of the terminal as a "front end" (to a computer or peripheral) dumb terminal and/or printer. Dimensions of the PT-210 are 15½" × 14½" × 5"; weight is 15 lb with a 100' roll of 8½"-wide thermal paper installed. Cost is $995; the Interface Module (76-1002) is $70.

CIRCLE NO. 94 ON FREE INFORMATION CARD

Quartz-Synthesizer Receiver

The amplifier section of Sansui's Z-5000 Quartz Synthesizer Compu-Receiver is rated at 70 W/ch into 8 ohms, with a frequency response from 20 to 20,000 Hz at 0.007% THD. S/N is given as 100 dB. The tuner section uses PLL quartz digital synthesizer tuning, giving a rated S/N of 74 dB with a THD of 0.2%. Sensitivity is 10.8 dBf. There are 16 station presets (8 AM/8 FM) with station scanning, a choice of auto or manual tuning, a digital fluorescent frequency display, and a LED peak power meter. The Z-5000 provides front panel selection for two speaker pairs, two tape monitor circuits with dub-

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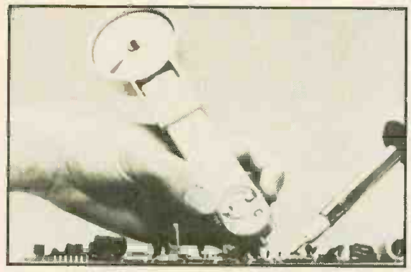
CIRCLE NO. 25 ON FREE INFORMATION CARD

bing capability, and microphone mixing. The frequency display converts to a quartz clock (when the appropriate button is pushed) with a built-in 3-memory program timer. $500.

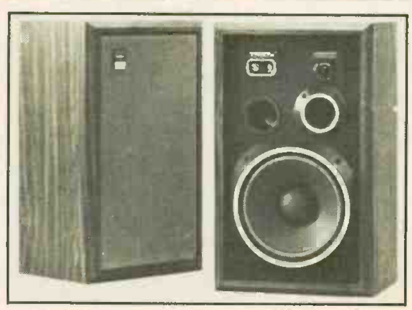
CIRCLE NO. 95 ON FREE INFORMATION CARD

Hand-Held Solder Dispenser



A solder dispenser said to increase soldering productivity by as much as 30% has been introduced by the Granite Corporation. Named "Speedy Feeder" (Model SD-1), it feeds out wire solder when the control wheel is turned. According to Granite, the solder can be dispensed faster and more continuously than with the fingers. An optional solder magazine that clips on the end of the dispenser is also available. It holds 60 feet of 22 SWG solder, and can accommodate solder widths up to 14 SWG. $7.50; solder magazine (Model SM-1) is $2.50. **Address:** Granite Corp., 24200 Burbank Blvd., Woodland Hills, CA 91367.

Koss Floor-Standing Loudspeaker



The Model 110 is a three-way, four-driver speaker system with dual tweeters. It has a rated frequency response of 20 to 30,000 Hz; an impedance of 8 ohms; a minimum power requirement of 10 W/ch; and a maximum power-handling capability of 100 W. The 110's vented driver system features a 10" woofer, 1¾" midtweeter, and two 1¼" tweeters. Dimensions of the walnut-grain vinyl cabinet are 23" H × 14" W × 10 ¼" D. Weight is 18.5 lb. $150 each.

CIRCLE NO. 96 ON FREE INFORMATION CARD

8/16-Bit Microcomputer

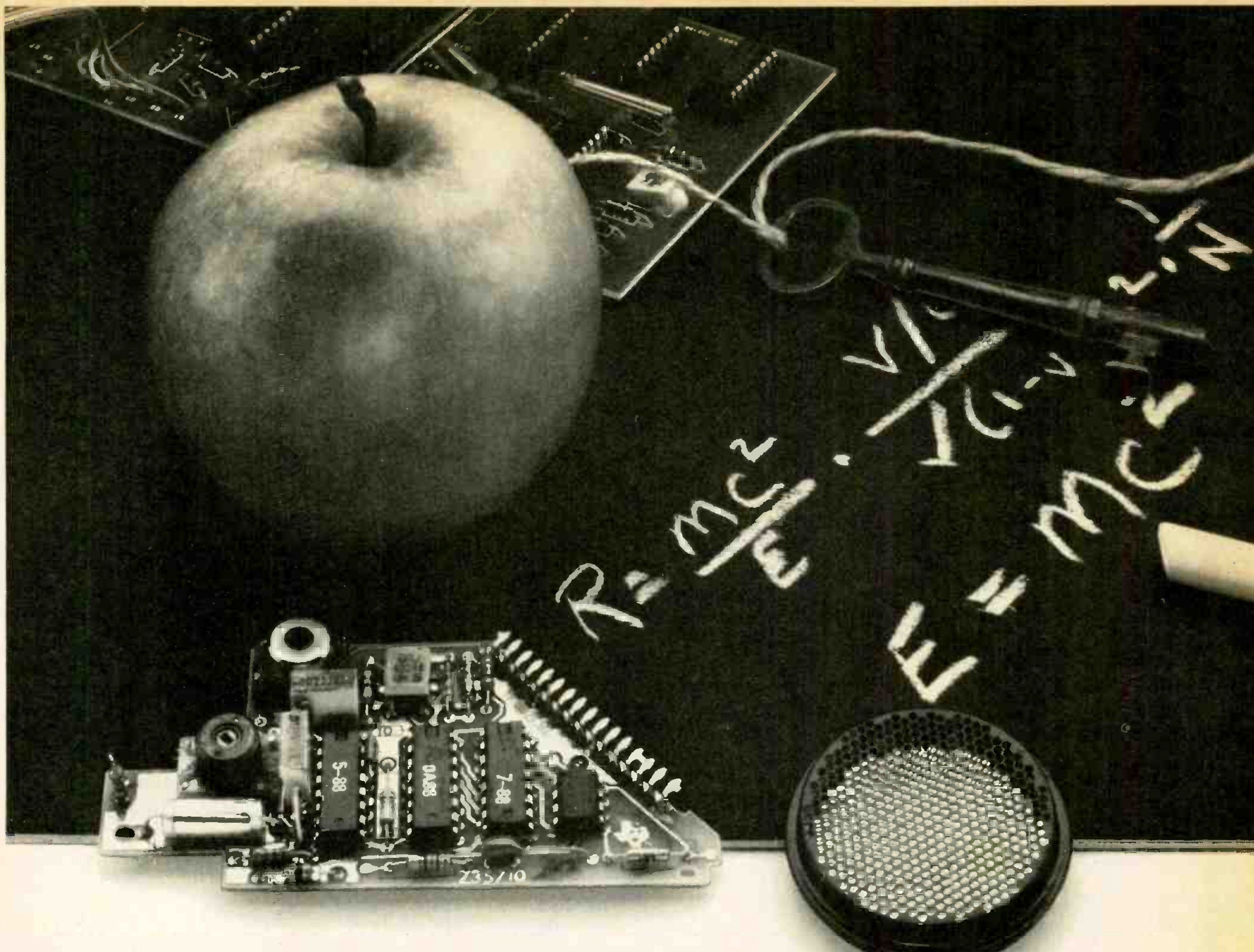
Vector Graphic has introduced a new small-business and professional microcomputer that uses both Z80 8-bit and 8088 16-bit microprocessors. Called the Vector 4, it of-

fers a choice of operating systems, including CP/M, MS-DOS, and Oasis. The Vector 4's main memory (128K using 64K RAM chips, expandable to 256K) is time-shared between the CPU and the video display controller, allowing the screen memory to be moved anywhere in the main memory. (Access to the entire memory is reported to be possible in increments as small as 2K.) High-resolution graphics are provided by a 640H × 312V pixel display. Alphanumeric characters are displayed using a high-density matrix of 16H × 13V dots per character cell. Display of charts, graphs, and drawings is claimed to be enhanced by four levels of gray scale with 320 × 132 pixels of resolution (or by 16 levels with 160 × 312 pixels). The Vector 4 also generates standard RGB signals to drive a color monitor, while its own CRT uses a high-contrast green phosphor screen. Parallel interfaces for Centronics, Qume, and NEC printers are provided along with RS232 serial printer and modem interfaces. Features include a programmable tone generator with speaker and a detached keyboard that has a dedicated microprocessor, 15 programmable function keys, cursor control keys, and a 10-key numeric pad. The Vector 4 uses a single-board microprocessor, but also has three S-100 card slots for adding peripherals. The unit is available in two models: the Model 4/20 with dual floppy-disk drive and a 630K-byte capacity on each 5¼" disk, and the 4/30 with a single 630K-byte floppy disk drive, and a Winchester hard disk with 5M-byte capacity. In addition to CP/M, standard Vector 4 software includes Microsoft Basic 80, SCOPE program editor, RAID program debugger, and ZSM assembler. The 4/20 is $4495; the 4/30 is $5995.

CIRCLE NO. 97 ON FREE INFORMATION CARD

A/D Hybrid Tuner

JVC's T-K20(L) quartz-locked digital synthesizer AM/FM tuner features an analog dial, but employs digital circuitry to tune in stations. An up/down button raises or lowers the tuned frequency in predetermined steps for manual tuning or, in the automatic mode, tunes to the next station up or down



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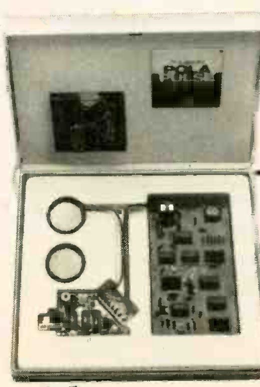

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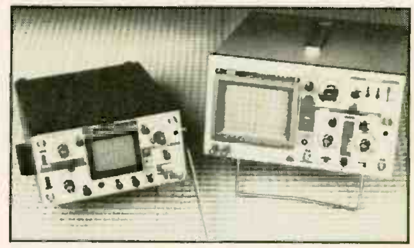
the dial. Six FM and six AM stations can be preset for one-touch recall and a 16-LED "digilog" shows the frequency against a graduated tuning scale. Other features of the T-K20(L) include station identification tags and a detachable low-impedance AM loop antenna. Manufacturer's specs (for the FM section) include an alternate channel selectivity of 60 dB; THD (stereo) of 0.3%; S/N (stereo, IHF-A) at 70 dB; and a frequency range from 20 to 12,500 Hz. $180.

CIRCLE NO. 98 ON FREE INFORMATION CARD

Portable Dual-Trace Scope



The Model 315P from A. W. Sperry Instruments is a portable ac/dc, 15-MHz, dual-trace oscilloscope with a built-in battery pack. It has three glass-epoxy circuit boards (said to permit easy servicing) and comes with two test probes (1X and 10X). Features include: automatic battery recharge, high sensitivity (2 mV/div), a high-intensity CRT with internal graticule, front-panel trace rotation adjustment, video/sync separator, and XY display modes. Added or subtracted signals can be observed by using the "invert" knob; and a 5X magnification expands sweep to 0.1 μs/div. Rated rise time is 24 ns; maximum input voltage is 600 V p-p or 300 V dc + ac peak; input impedance is 1 megohm ±5%; and channel isolation is said to be better than 60 dB at 1 kHz. Operating temperature is 0° to 40°C at up to 90% humidity. Weight is 12.1 lb. $950.

CIRCLE NO. 99 ON FREE INFORMATION CARD

Shortwave Antenna

MFJ introduces its Active Outdoor Receiving Antenna with whip. It is reported to give improved reception of signals in the 50-kHz to 30-MHz range. At lower frequencies it is said to be equivalent to an outside wire antenna hundreds of meters long, and at high frequencies to have a high-gain amplifying action. A high dynamic range r-f amplifier is mounted at the antenna for maximum signal-to-noise ratio. A 20-dB attenuator switch on the control unit is designed to prevent receiver overload, and a separate switch permits use of an auxiliary antenna when the main unit is off. Another switch allows a user to select between two receivers; and there is a gain control and power on/off LED indicator. The control unit measures 6" × 2½" × 5" and the remote unit is 3" × 2" × 4". The telescoping whip is 4.5' long when extended. It operates on 12 V dc or 117 V ac with optional adapter (MFJ-1312). $130

CIRCLE NO. 100 ON FREE INFORMATION CARD

Introducing incredible tuning accuracy at an incredibly affordable price: The Command Series RF-3100 31-band AM/FM/SW receiver.* No other shortwave receiver brings in PLL quartz synthesized tuning and all-band digital readout for as low a price.** The tuner tracks and "locks" onto your signal, and the 5-digit display shows exactly what frequency you're on.

RF-6300 8-band AM/FM/SW

There are other ways the RF-3100 commands the airways: It can travel the full length of the shortwave band (that's 1.6 to 30 MHz). It eliminates interference when stations overlap by narrowing the broadcast band. It improves reception in strong signal areas with RF Gain Control. And the RF-3100 catches Morse communications accurately with BFO Pitch Control.

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It's no longer enough to be just a programmer or a technician. With microcomputers moving into the fabric of our lives (over 250,000 of the TRS-80™ alone have been sold), interdisciplinary skills are demanded. And NRI can prepare you with the first course of its kind, covering the complete world of the microcomputer.

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With NRI training, the programmer gains practical knowledge of hardware, enabling him to design simpler, more effective programs. And, with advanced programming skills, the technician can test and debug systems quickly and easily.

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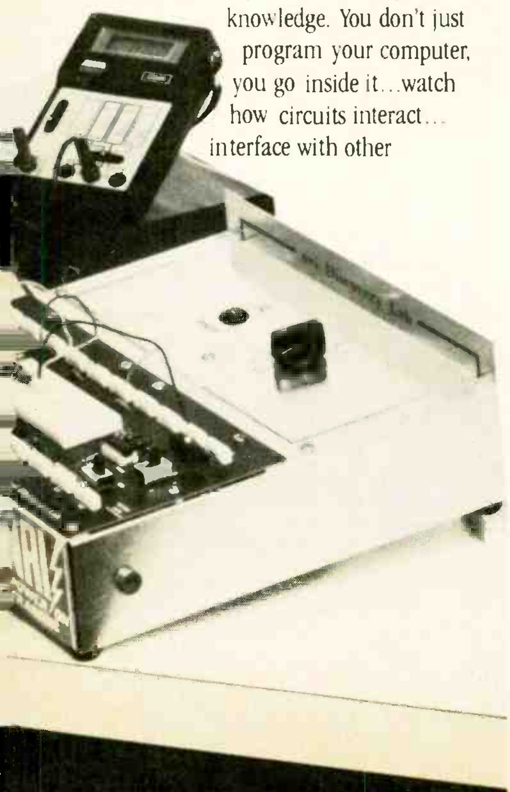
You Explore the New TRS-80 Model III Inside and Out

NRI training is hands-on training, with practical experiments and demonstrations as the very foundation of your knowledge. You don't just program your computer, you go inside it...watch how circuits interact... interface with other systems...gain a real insight into its nature.



You also work with a professional 4-function multimeter, featuring full portability and a 3½-digit liquid crystal display. Using it along with the exclusive NRI Discovery Lab® and your TRS-80, you perform over 60 separate experiments. You learn how to troubleshoot and gain greater understanding of the information your testing procedures give you.

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Along with your multimeter and the NRI Discovery Lab, this latest concept in advanced microcomputers is yours to learn with, yours to keep and use for your own personal programs, business use, and other applications.

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Audio Product of the Month

CHOSEN BY THE EDITORS OF POPULAR ELECTRONICS

Denon Model DR-F7 Cassette Deck

THE Denon DR-F7 is a versatile, three-head, two-motor cassette deck, featuring metal tape compatibility, Dolby B and Dolby C noise reduction, and an automatic microprocessor-controlled tape optimization system. The DR-F7 presents a clean, uncluttered appearance, free from the arrays of lights and LEDs found on many of today's audio components. Program levels are displayed on two large illuminated meters, and light-touch buttons are pressed to operate the tape transport functions through solenoid action.

The Denon DR-F7 is about 17"W × 12½"D × 4⅝"H, and weighs 16½ pounds. Suggested retail price is $500.

General Description. The permalloy recording and playback heads of the Denon DR-F7, which are magnetically and electrically separate, are mounted in a common housing that fits into the normal head opening on the edge of the cassette. Since the two head gaps are made parallel during manufacture, a single azimuth adjustment sets both of them correctly. The separate heads provide a recording gap width of 4 micrometers, and a very narrow playback gap of only 0.5 micrometers for extended high frequency response.

The electronic portions of the machine, including its Dolby noise reduction circuits, are duplicated for the recording and playback functions. This makes it possible to monitor the playback from a tape a fraction of a second after it is recorded.

The capstan is driven by a "Flat Twin" direct-drive servo-controlled motor, whose high operating frequency of 906 Hz minimizes mechanical vibration. The tape hubs are driven by a single dc motor through an idler system that does not use slip clutches, and tape tension is continually monitored and adjusted by a servo system.

The FTS (Flat Tuning System) microprocessor is activated by pressing a front panel button before making a recording. This records a series of test tones on the tape with a range of bias levels, using the playback level to establish the optimum bias. The recording level is similarly adjusted, matching the sensitivity of the tape to the level requirements of the Dolby circuits. The bias and sensitivity settings are automatically stored in the computer memory, and the tape rewinds to the point where the process began. A small green LED next to the FTS button blinks while the calibration is in progress, and remains lit when the operation is completed.

The entire process takes less than 6 seconds. A PRESET button provides typical fixed recording adjustments for the basic tape types, as selected by the TAPE SELECT switch. Alternate operations of this button toggle between the preset values and the optimized values so that either can be used.

The amplifiers of the Denon DR-F7 are direct-coupled throughout, and are operated from a split ±12-volt power supply. According to Denon, this results in an amplifier with very low distortion and wide dynamic range. The level meters, calibrated from −20 to +6 dB, are augmented by three LEDs which read the higher of the two channel levels. They flash at levels of 0 dB, +5 dB, and

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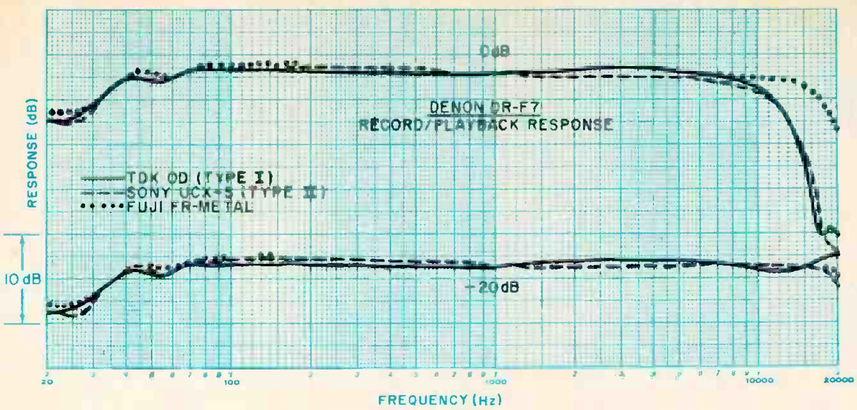

Record/playback responses at 0 and −20 dB of three tape types.

+8 dB, and provide instant warning of excessive peak levels as well as assurance that the average level is correct (shown by frequent flashing of the 0-dB light).

The six transport control buttons operate somewhat differently from those on most cassette decks. Pressing RECORD activates the meter display for setting recording levels, but tape motion does not start until the "play" button (identified by a single arrow pointing in the direction of tape travel) is also pressed.

The combined PAUSE/MUTE button stops the tape when touched during playback, and pressing "play" restores normal operation. During recording, pressing the PAUSE/MUTE button removes the recording signal from the heads, but continues the tape motion to record a silent portion on the tape for as long as the button is held in. Only when it is released does the tape stop. To resume recording, only the "play" button need be pressed.

A "flying start" recording from the playback mode is made by holding in the "play" button while pressing RECORD. The control buttons can be pressed in any sequence without first pressing STOP. Colored lights on the RECORD, play, and PAUSE/MUTE buttons show their current status. The DR-F7 can be operated unattended (in playback or recording modes) by using an external clock timer and setting the recorder's TIMER switch. A small pushbutton activates the MPX filter for recording FM stereo broadcasts from a tuner with inadequate filtering of the 19-kHz pilot carrier signal. Another button connects either the input program or the playback signal to the line outputs.

Laboratory Measurements. The playback equalization of the Denon DR-F7 was measured with BASF standard test tapes. The response, identical for the 70- and 120-microsecond time constants, was ±1 dB from 31.5 to 18,000 Hz.

To check the effectiveness of the FTS system, we measured the record/playback response with a number of different tapes. The differences between competitive tapes were negligible. We selected the following for the full series of tests: Type I (ferric) TDK OD; Type II (high bias or chrome) Sony UCX-S; Type IV (metal) Fuji FR-Metal. No tests were made with a Type III (ferrichrome) tape, although the recorder is designed to use them with the "normal" ferric tape settings.

At the usual −20-dB recording level, the frequency response curves were virtually identical for all the tapes. It was within ±2 dB from about 32 to 20,000 Hz. At a 0-dB recording level, the two ferric tapes produced identical curves, quite flat to 10,000 Hz and rolling off to −10 dB between 14,000 and 15,000 Hz. As expected, the metal tape was outstanding at 0 dB. Its response was ±2 dB from 38 to 13,000 Hz, and down only 7 dB at 20,000 Hz. This was a better response (at 0 dB) than we have measured from many cassette recorders (using ferric tape) at −20 dB. The response of the MPX filter was perfectly flat up to 15,000 Hz, and down about 25 dB at 19,000 Hz.

We checked the "tracking" of the Dolby B and C systems by measuring the frequency response of the machine at input levels of −10, −20, −30, and −40 dB, with and without the noise reduction activated. Ideally, there should be no change in response from using the noise reduction, but because of level mismatches and imperfect flatness in the basic recorder frequency response, variations up to ±2 dB over the frequency range are not uncommon, and are considered acceptable.

With Dolby B, the response was changed by less than ±0.5 dB up to 20,000 Hz at the three higher levels. Even at −40 dB, the change was no more than 1 dB up to 15,000 Hz, and 1.5 dB up to 20,000 Hz. Using Dolby C, the changes were greater, with the largest errors occuring at the higher signal levels. The worst case was at −20 dB, where the error was 2 to 3 dB over much of the audio range. At −40 dB, however, the tracking was within 0.5 dB overall up to 20,000 Hz.

For a 0-dB indicated recording level, the required input at 1000 Hz was 72 millivolts (line) or 0.225 millivolts (microphone). The maximum playback output was between 0.57 and 0.62 volts, depending on the tape. The microphone input overloaded at a safe 77 millivolts.

The third harmonic playback distortion from a 1000-Hz 0-dB recording was −47 dB with Type I tape, and −54 to −55 dB with the others. With each of the tapes, it was necessary to record at +10 dB to measure 3% (−32 dB) playback distortion. The unweighted playback signal-to-noise ratio, referred to that signal level, was 54 dB with Type I tape and 56 dB with the others. A CCIR/ARM

CONTROLS AND INDICATORS

Transport Controls
- RECORD
- PAUSE/MUTE
- > Play
- ■ Stop
- > > Fast Forward
- < < Rewind

Pushbuttons
- EJECT: Swings open cassette door for loading or removing cassette.
- POWER: Switches power to recorder.
- RESET: Resets mechanical index counter to 000.
- START-FTS: Initiates automatic tape optimization cycle.
- PRESET: Selects internal bias and level settings; on alternate operations selects FTS values.
- MONITOR: Selects TAPE or SOURCE for line output program.
- MPX FILTER: Switches in 19-kHz MPX filter.

Knobs
- TAPE SELECT: Sets equalization and approximate bias range for type of tape.
- DOLBY NR: Selects B or C Dolby, or off.
- OUTPUT LEVEL: Adjusts line output level for both channels.
- INPUT LEVEL: Concentric recording level adjustments for both channels.

Other Features:
- TIMER: Slide switch with positions for "play," "off," and "rec."
- REMOTE: Socket for optional remote control unit.
- Tape index counter.
- MIC: Two ¼" jacks for microphones. Plugging in microphone replaces rear line input with mic signal.
- PHONES: Stereo headphone jack.
- Level meters: Two meters, reading both record and play levels.
- PEAK LEVEL: Three LEDs, flashing at 0, +5, +8 dB.

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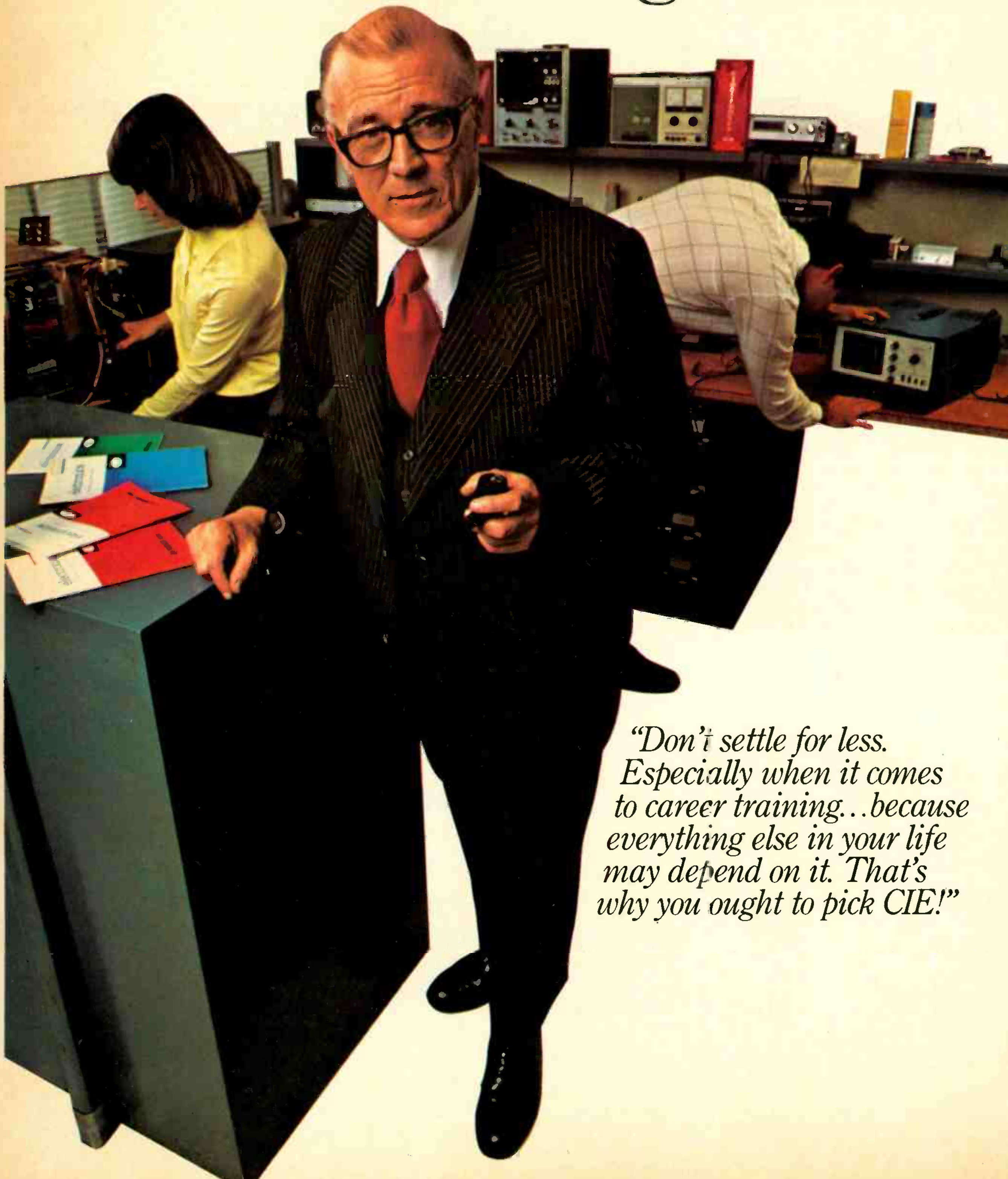

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weighted measurement, using Dolby B, was 66.3 dB for Type I, and about 69 dB with the other two tapes. Finally, using Dolby C, the weighted S/N reading was 76 dB with Type I, 78.5 dB with Type II, and 77.5 dB with Type IV. The noise through the microphone inputs was 7 dB greater at maximum gain, but was insignificant at settings even slightly below maximum.

The meter calibrations place the standard Dolby level of 200 nWb/m at +3 dB, and a Dolby calibration tape gave exactly that reading on both channels. The 0-dB peak light came on at exactly 0 dB indicated meter input, and the +5-dB light was equally accurate. The +8-dB light came on at an indicated +9-dB input. The meter ballistics matched VU standards, reading 100% of steady-state values with 0.3-second bursts of 1000 Hz once per second.

The tape speed error was less than 0.2%. The flutter (JIS, or weighted rms) was 0.065%, and the weighted peak flutter (CCIR) was ±0.1%. The fast speeds rewound a C60 cassette in 66 seconds, in either direction. Crosstalk between the two pairs of tape tracks was −60 dB at 1000 Hz.

User Comment. Tests show that the Denon DR-F7 is an outstanding cassette recorder. In fact, few other recorders in its price range can match its combination of wide frequency response, low distortion, high S/N, and operating flexibility. Taping FM broadcasts and most LP records resulted in subjectively perfect copies.

We also put the DR-F7 through a very severe test, dubbing dbx encoded records (originally from digital tape masters) through a dbx decoder and using the Dolby C noise reduction of the Denon recorder. The sonic differences between the input and output programs were very small. Dolby C does not give quite as much noise reduction as dbx, and we had a little difficulty (even with metal tape) in avoiding compression of the very high frequencies at maximum amplitude. Nevertheless, the Denon machine gave a very good account of itself in this rather extreme test; nor was there undue compression when the 85-to-90-dB dynamic range of the input program was fed into the 80-dB range of the cassette deck.

The FTS is easy to use and works so effectively, that there is no reason not to use it before every recording. Under ordinary conditions, the "preset" mode is actually redundant.

By any standards, the Denon DR-F7 is an excellent recorder, and it is an especially fine value at its moderate price. —*Julian Hirsch*

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Popular Electronics Tests

Toshiba IK-1900 TTL Video Camera

STANDARD home movie cameras are slowly being displaced by video cameras and accompanying video cassette recorders. Toshiba's IK-1900 video camera makes such a transition particularly comfortable owing to some imaginative engineering. It incorporates "through-the-lens" full-color viewing much as home movie cameras (and single-lens-reflex cameras) do, as compared to the traditional black-and-white electronic viewfinder incorporated in other high-quality video cameras. A byproduct of this is light weight (4.4 lb), less bulk, and lower-than-usual cost (suggested retail price, $899). An ac adapter is available for $70.

General Description. The optics consist of an F1.6 Nikon lens (Nikkor 12.5 mm to 100 mm), including a motorized 8X zoom function plus a wide-range "macro" adjustment for really tight close-ups.

The display in the viewfinder is framed to show the exact color picture area that will be picked up by the camera. Four separate indicators are located in a concentric area surrounding the frame. The letter "U" lights up in red whenever the picture is underexposed, and the letter "V" is illuminated to indicate that the VCR is "on" and recording. To warn the user that the battery voltage is low, the letter "B" is lit. The fourth indication, the letter "W," is used for white balance (as will be explained later).

Power to the camera is supplied either by the VCR (ac or battery) or by a separate ac adapter that also provides audio and video signal line amplifiers. In addition, the camera contains a built-in lens filter that can be switched in or out to adjust for sunlight (outdoors) or incandescent light (indoors). A three-position EXPOSURE switch can be set for NORMAL, bright background (B.L.C.), and CLOSED. In the closed position, the camera tube is protected from excessively bright light. There is also a small lever that opens and closes a shutter to protect the viewfinder. Zooming can be either manual, by rotating a lever on the lens assembly, or motorized, by depressing either the "W" (wide angle) or "T" (telephoto) button at the top of the camera.

Among the well-thought-out features of the Toshiba IK-1900 are a folding handgrip with a convenient locking and releasing lever and a VCR control trigger that is duplicated at the bottom of the handgrip for use when the camera is tripod mounted. A rolling knob above the eyepiece allows adjustment for fine focus of the eyepiece, and the rubber eyecap can be turned up to fit the person wearing eye glasses. A rubber lens hood is incorporated to avoid intense reflections.

The only adjustment that caused us some confusion was the white balance. The term refers to the mixture of colored light that appears as white to the human eye. A coarse correction for the difference in white under outdoor and indoor conditions is provided by the FILTER switch. Next to it, however, is the WHITE BALANCE switch that can be set to MANUAL or AUTO.

In the AUTO mode, the WHITE BALANCE switch must be depresssed and held there for at least one or two seconds while the camera is focused on a white object. Once this is done, the correct setting is "memorized," as indicated by the illumination of the letter "W" in the viewfinder frame. When shooting conditions or lighting levels change, this procedure must be repeated to ensure optimum color.

In the MANUAL mode, which can be

CHALLENGING COMPUTER GAME BOOKS

Creative Computing GUIDE TO THE VIDEO ARCADE GAMES

An all-new, field-tested manual filled with savvy advice and sound tips on how to beat video arcade games. Authors David Lubar and Owen Linzmayer spent thousands of hours playing games, taking notes and finding the most effective strategies for winning. The result is a player's guide to the 20 most popular games, from Donkey Kong and Pac-Man to Missile Command and Centipede. You'll learn about: *collisions*, and how various games deal with them... *bonuses*, and why you should be cautious about going for them... *rates of fire*, and how they vary... *wraparound*... *horizontal and vertical motion*... *distractions* ... *goals*, and why it's important to set them. For beginners and experts alike. Detailed illustrations to help you figure out the tactics described. Paperbound. 112 pages.

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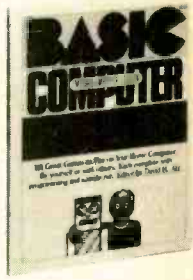

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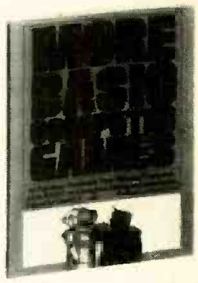

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used when one forgets how to set the white balance, the user adjusts the white balance control potentiometer for best picture on a color TV screen—not in the viewfinder. No effect can be seen in the viewfinder because the adjustment affects the video output signal rather than the optical image.

The IK-1900 is also supplied with an extendable, high-impedance directional boom microphone mounted on an accessory shoe at the top of the camera. A separate input jack is available for an external microphone. The camera comes with a 2.5-meter cable, and an optional extension cable increases this distance potential from a VCR to 10 meters (33 ft).

Performance Tests. Two characteristics are generally considered key in measuring video camera performance. One is sensitivity and the other is the signal-to-noise ratio. Sensitivity refers to the illumination on a white target with 60% reflectance vs. the camera signal output. The S/N in dB is defined as 20 times the log of the ratio of the peak-to-peak video signal to the rms noise signal. (See Table.)

We used as reference the video output signal at the 1-V peak-to-peak level specified by the manufacturer. This output was obtained with an illumination as low as about 40 lumens per square meter (lux), though the letter "U" in the viewing frame indicated underexposure. Using 80 lumens resulted in satisfactory pictures and exposure indication. According to our test, the signal-to-noise ratio of this camera was about 46 dB. The lens opening was F1.6 for both tests. These results correspond closely to the manufacturer's specifications and indicate that the camera provides satisfactory sensitivity and good S/N.

Horizontal resolution was established by focusing on a wedge test pattern. We measured about 240 lines, somewhat less than the specified 260 lines but still an excellent figure. Using a dolly-mounted, professional video camera side-by-side with the IK-1900, we aimed both cameras at our color test pattern and observers agreed that color reproduction, linearity, and overall picture quality of the two screens were about equally excellent. When lighting levels were reduced, the picture from the Toshiba IK-1900 deteriorated earlier than the more costly camera, even though we switched the Toshiba's filter and readjusted the white balance.

Next we tried the zoom, both manual and motorized, and found it to work as specified. The "macro" feature on the IK-1900 was tested on a printed label with the camera held as close as two inches away. We were able to focus perfectly.

We recorded the test pictures as well as indoor and outdoor scenes on a Sony Betamax VCR, using ordinary speech for audio test signals. On playback, both video and sound proved fine, with the directional qualities of the boom microphone clearly apparent.

PERFORMANCE TEST RESULTS
TOSHIBA IK-1900 VIDEO CAMERA

Sensitivity: (A) 50 lux for 1 V p-p (underexposed)
(B) 80 lux for 1 V p-p (normal)
Video S/N: 46 dB
Horizontal Resolution: 240 lines
Horizontal Linearity: Excellent
Vertical Linearity: Excellent
Color Fidelity: Excellent (indoors, proper white balance)
Power Required: 6 W at 12 V dc

Comments. The Toshiba IK-1900's through-the-lens viewing format makes it a distinctive home video camera that's especially easy to use. What you see is essentially what you get since the user views a scene in full color rather than black and white. The camera's light weight is most welcome, too.

Overall construction appeared to be good, though the lavish use of plastic leaves us to believe it is not too rugged. (One would not want to drop any camera, of course, even if made like a battleship.) The boom mike, in particular gives the impression of some fragility owing to its material.

Performance, both in picture quality and operation, is average or better. Nikon optics lend a sense of prestige for those who appreciate such things.

The rather low price for a good-performing camera such as this should appeal to many who will trade off a tiny monitor screen (for field playback of a video recording in black and white), features such as fade in and fade out, titling, etc., for the savings. If one does not use a color TV monitor with its inherently high resolution, this video camera has sufficient good attributes to make it attractive to amateur video recordists.

—*Walter Buchsbaum*

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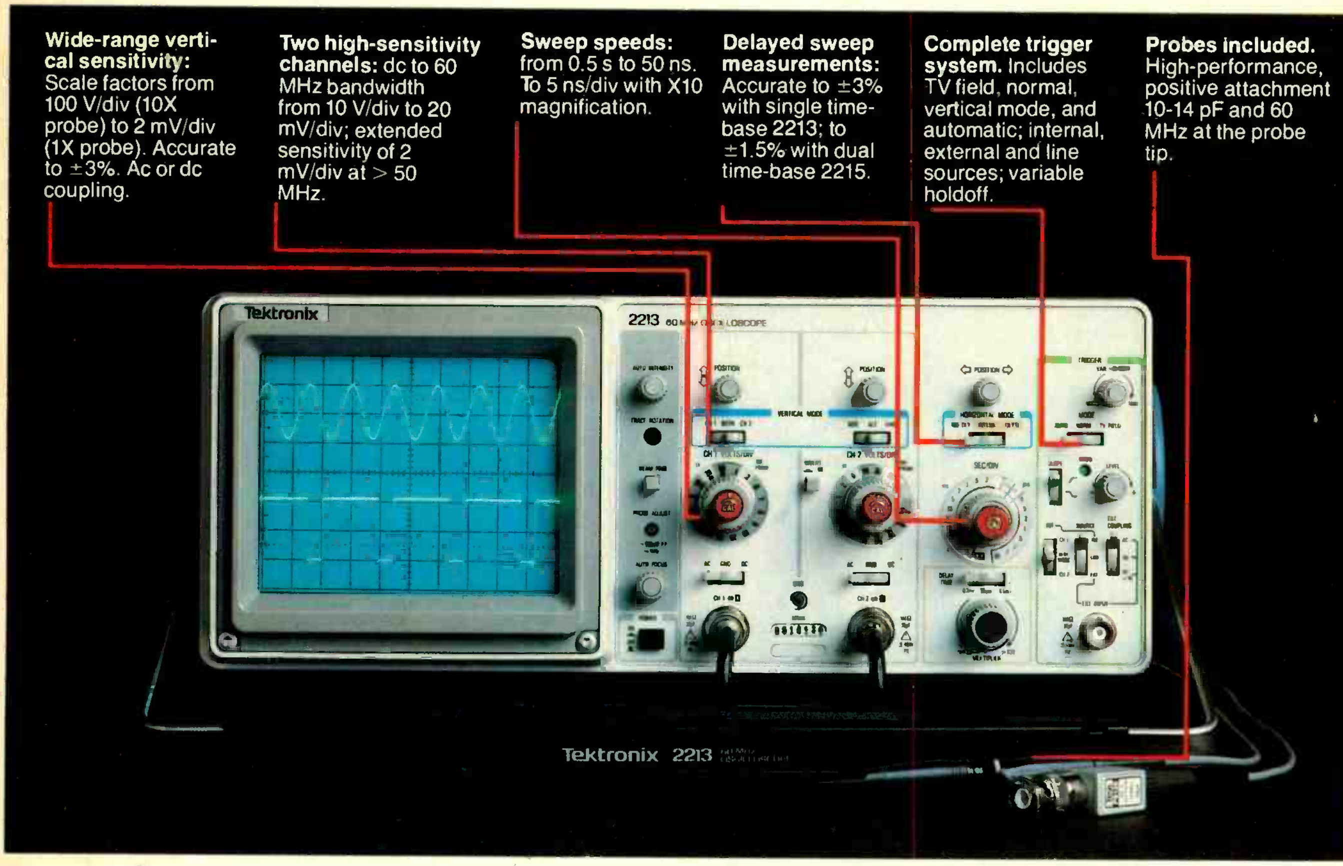

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Popular Electronics Tests

Commodore VIC-20 Low-Cost Computer System

THE Commodore VIC-20 is that company's entry into the Home Computer Sweepstakes. This puts Commodore in competition with Texas Instruments, Atari, and Radio Shack for the growing market for low-cost home computers. The VIC-20 and Atari 400 are running neck-and-neck, with Radio Shack's TRS-80 Color Computer coming up fast. Texas Instruments' TI 99/4 is fourth, but running hard with the stamina for a long race.

All of these machines are now in the price range from $200 to $400 for the basic computer unit. The VIC-20 has a manufacturer's suggested price of $300 for the computer unit, power supply, and r-f modulator, although the selling price in many stores is much less. The VIC-20 was introduced at the 1981 computer shows and has developed a large following of users for a variety of reasons: high-resolution graphics (176 by 184 pixels), color capability (8 border colors and 16 screen colors), sound and music generation, a large supply of software and firmware (cartridges), many peripherals, and relatively low cost for a "real" computer. In addition, it is inexpensive to expand because costs of perhiperals have been kept in proportion to the original cost of the computer.

Commodore has provided a range of peripherals for the VIC-20 that enables the owner to configure several different types of personal system. The owner who wishes to contact one of the Public Information Services, such as CompuServe or The Source, only has to plug in the VICMODEM cartridge, connect a telephone handset cord into the modem, and dial the network access number to be connected to the service. Commodore offers a free one-year subscription to CompuServe and one hour's free time on the network.

In addition, Commodore supplies the VICTERM-1 software, which programs the VIC-20 to act as a "smart terminal." Information on the network can be stored on the Commodore Datasette recorder. If a VIC disk is part of the system, information can be transferred from the network to the VIC disk, or from the VIC disk to the network disk system. To encourage VIC users to use the telecomputing capabilities, Commodore has sponsored the Commodore Information Network, a special-interest group on CompuServe. This provides a "hotline," a public information bulletin board, and an area where computer hobbyists can get programming tips and technical assistance.

The VIC-20 owner who wants to use his computer for home computing, or even simple business applications, can expand the machine's limited memory by plugging in a Memory Expansion Cartridge sold by Commodore in 3K, 8K or 16K sizes. Larger memory expansions are made by several other companies in sizes up to 24K. A 24K memory expansion is the maximum expansion possible since that brings the total RAM to 32K, which is the largest RAM memory this computer can support.

In addition, there are external expansion units that add additional slots to the memory expansion port and permit the simultaneous use of either additional circuit boards or cartridges. Also there are expansion units for the RS-232 interface, and an IEEE Adapter interface that permits the VIC-20 to be connected to standard Commodore CBM computers and to share peripherals with the larger machine. The VIC-20 system also includes a low-cost, 30-cps printer (about $400) which has tractor feed and the ability to print VIC graphics as well as text. For those who want a disk drive, the VIC single-disk drive (170K per drive) is one the lowest-cost units on the market (about $500 for both controller and disk drive). However, for those who require more disk storage, the VIC can be adapted to use standard Commodore CBM dual-disk drives.

When it comes to software, VIC-20 is one of the better-supplied computers on the market. Hundreds of programs of every type are available for the VIC-20 on cassette, disk, and firmware cartridge.

POPULAR ELECTRONICS has tested the basic VIC-20 and some of the software. (We have seen the disk system and modem in operation though we did not test them.)

The VIC-20 Computer is packed in a styrofoam box that contains the power supply, keyboard computer unit, and r-f modulator. Removing the beige-color keyboard unit, you'll find that it's similar to a typewriter with four extra keys down the right side. At the top of the cabinet is a power indicator light. On the right side of the cabinet is a recessed area containing the power cord socket, an on/off switch, and a "D" socket for plugging in a joystick or other game-control device.

At the rear of the unit, are several types of connections. First, there are three card-edge connectors. The largest (on the left) is to plug in VIC Program cartridges or peripheral connectors. Then there are two round DIN connector ports. The 5-pin one is for connecting the video r-f modulator cable. The second one is for connecting special serial devices such as the line printer and the disk drive. Next is a card-edge connector for the cassette recorder. The last card-edge connector is for special accessories that will be developed from time-to-time.

Setting up the VIC-20 is easy enough. To use it with a TV receiver, the r-f modulator has to be set for either channel 3 or 4. (One of these channels is clear in every area of the United States.) On our unit, however, the switch was not marked with the channel position so some experimenting to find the correct channel was necessary. To use a color or black-and-white monitor, the moduator is not used, of course, and the video cable is run directly to the monitor.

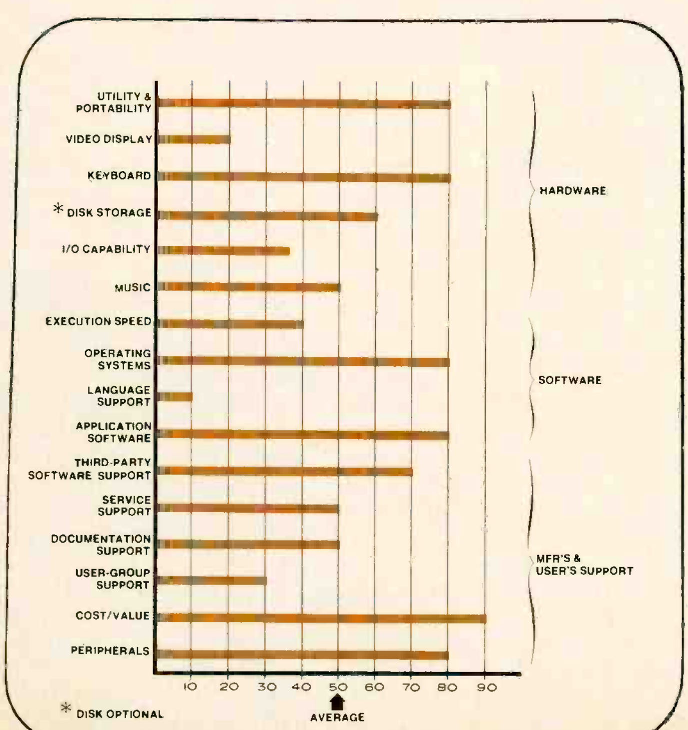
Once the VIC-20 is running, the screen displays the number of bytes of memory that are free for programming. If a cartridge program is to be used, the computer should be switched off at this point and the cartridge plugged in, per directions supplied with the program cartridges. The manual supplied with the computer does not mention this at all.

The VIC-20's keyboard follows the usual Commodore arrangement of using multi-shifts for graphic characters and upper/lower case characters. Looking at the keys, the user finds there are two graphics characters on the front of most of them. When you turn on the VIC-20, the computer is automatically in graphics mode. You can type upper case and the 60 graphics characters shown on the front of the keys. To print the right-hand graphics characters, you hold down the shift key and depress the key with the graphic character you want. To get the left-hand graphic character, you hold down the key with the COMMODORE logo on it. Graphics pictures are created by placing the graphics characters together to create the pattern you want.

To use the VIC-20 in text mode, you press the SHIFT and COMMODORE keys at the same time. You will now be able to type upper- and lower-case letters and the graphics characters on the left side of the keys. These characters are useful for charts and graphs. This multi-shift system permits the VIC-20 to reproduce many more characters than would otherwise be possible. It is not a familar operation for someone who is not used to Commodore keyboards; but after a while, we became proficient in producing interesting graphics designs as well as text on the screen.

The top row of keys has color designations inscribed on their fronts. The colors are red, cyan (light blue), white, black, purple, green, blue, and yellow. With these keys you can change the color of the characters inside or outside a program. Once the color is "set," the display remains in that color until it is changed. The "9" and "0" keys have the letters RVS ON and RVS OFF on the front. They turn on the reverse-color capability so that you can reverse color of the characters and the background. The Commodore color system is very different from that used by other computers with color capabilities, but we found that it was very easy to use and very effective.

The keyboard also contains four function keys on the right side of the console. These are not defined when the VIC-20 is turned on. They are assigned functions or tasks when used with the plug-in cartridges; or they can be assigned functions within a program loaded from a disk or tape, or entered from the keyboard. The existence of user programmable function keys in a low-cost computer is unusual



Comparative analysis of Commodore VIC-20 System.

and indicative of excellent design in the VIC-20.

The VIC-20 has another useful characteristic: the ability to make sounds and music without adding devices. The VIC has four voices enabling it to "sing" simultaneously in four different notes. Using this capability, you can create interesting audio effects and fairly complex music.

One serious drawback of the VIC-20 is its 22-character display. This may not be more than an annoyance to a person who is learning programming on the VIC, but to an experienced person who is used to a display at least twice as great, the 22 characters can be a limiting factor. It is sufficient for the games and simple programs given as examples in the owner's manual; but even for use on the CompuServe network, 22 characters are hardly enough. It sould be noted that there is a Video Combo Cartridge from Quantium Data that extends the screen width to 40 or 80 characters at a cost of $199; the same cartridge can be obtained with 16K of RAM and a PROM socket for $299.

There are several other expansion units made by independent manufacturers, including RAM and ROM Expandors, RS-232 Interfaces, and expansion motherboards. At this year's NCC, a new expansion motherboard unit from Great Britain was previewed that includes six expansion slots for boards or cartridges, and it has its own power supply.

One of the plug-ins for the VIC-20 is the PROM QUEEN cartridge, which turns the VIC-20 into a software development system. This cartridge programs 2732 and 2716 EPROMs or acts as a 4K-byte EPROM emulator. It takes its input from the keyboard, the modem, or another EPROM, thus permitting direct duplication.

When the unit supplied by Commodore was tested, we found considerable r-f interference displayed on the screen. This could not be cleared up with the fine-tuning control on the TV set, but we discovered that, as we moved the keyboard to different positions in the room, we could reduce the pattern on the screen. When we mentioned this to our contact at Commodore, we were told that we had been supplied an early model and that this interference did not exist in present production units. However, examining units on display at several stores, we found that the interference occurred on at least half of them.

The game cartridges tested with the VIC-20 included VIC Avenger, Jupiter Landing, Midnight Drive, and Blackjack. The Arcade-type games were as good as we have seen on much more expensive computers. There are several special features in the VIC cartridge system, one of which enables the user to adjust the image on the screen by pressing the CSR control key. This allows for differences in various TV sets.

The games are set up to permit use of either a joystick or the keyboard as a controller. However we learned that the Aliens had a big advantage over us when we tried to use only the keyboard. We also wrecked more race cars than usual. Conclusion: you really need a joystick control to play the arcade games. The high score indicates the highest total reached, so you have something to shoot for. We did not test the new Bally/Midway series of games that Commodore has just come out with as they had not been released in time for our tests.

User Comments. The Commodore VIC-20 is more computer for the money than we had expected to see. It offers an excellent low-cost way for a person to start computing, yet there is enough programming capability to maintain interest and to learn programming, graphics, and the fundamentals of music. Users can always take a break by plugging in a cartridge to play a wide variety of games. With video and memory expansion units installed, the VIC can also be used as a word processor. Further, it can provide low-cost access to the world of information networks.

The VIC-20 has real computer capability, as well as being a commendable games player and educational tool.

—*Stan Veit*

CIRCLE NO. 102 ON FREE INFORMATION CARD

PHYSICAL CHARACTERISTICS

Housing: Metal with separate power supply and r-f modulator.

Keyboard: Full ASCII (64 characters) with numerals and calculation symbols. Four programmable function keys. Full PET-type graphics character set generated directly from keyboard. Auto-repeat on control keys.

I/O: Centronics-type printer and disk-drive parallel port. Joystick, paddle, and lightpen port. Digital-cassette, composite-video, modem, and bus-expansion ports for plug-in programs and expansion of memory. RS-232C interface capability.

Video Display: 22 characters wide by 23 lines deep.

Program Line Length: 88 characters.

Graphics: High-resolution capability. 176 by 184 pixel (32,384) max. resolution.

Color: Eight border colors, 16 screen colors. Eight screen colors generated directly from keyboard.

Music and Sound: Four tone generators covering five octaves. White-noise generator for special effects.

OPERATIONAL CHARACTERISTICS

Language: BASIC

Assembly Language: Optional

Memory Capacity: 5K expandable to 32K

Disk Storage: 170K

Telecommunications Operation: 300 baud

Some of the peripherals that are available to use with the VIC-20.

COMPUTER SOURCES

By Leslie Solomon, Technical Director, and Stan Veit, Computer Editor

Hardware

IBM Expansion Options. Designed for the IBM Personal Computer, the PC-MATE Winchester/10 is a 10-megabyte hard disk that contains its own power supply and has six additional expansion slots. The PC-MATE CMOS Memory with battery backup is a 32K CMOS memory card. The PC-MATE Speed Disk is a floppy disk simulator using dynamic RAM and is compatible with normal system operation. It provides a speed increase between 5 and 50 depending on the operation being performed. The PC-MATE Base Board parallel digital in-digital out option has a basic set of 96 lines and can be further configured via additional modules. Each Base Board will support up to four "daughter" boards for further expansion. **Address:** Tecmar Inc., Personal Computer Products, 23600 Mercantile Rd., Cleveland, OH 44122 (Tel: 216-464-7410).

Apple III Printing. The PKASO Interface adds text and graphics printing capabilities to the Apple II and III computers. Characteristics include full "snapshot" dump of a screen image, 16 level gray scale printing, user created or software defined characters, and both HIRES and LORES graphics. It supports the Epson, Okidata, Centronics, IDS, NEC, and C. Itoh printers. When used with the Apple III, the interface provides full printing and graphics capability in either the native mode or the Apple II emulation mode. $165. **Address:** Interactive Structures, Inc., 112 Bala Ave., Box 404, Bala Cynwyd, PA 19004 (Tel: 215-667-1713).

Printer Adapter. The ADAX70 allows Commodore/CBM computers to output to the Epson MX-70 parallel printer. It supports upper and lower case, and the Epson MX-70 graphics. Its two-foot cable plugs into the PET IEEE port while another IEEE card edge is provided. A switch selects either upper/lower case, u/l reversed, upper case only and graphics. It works with WordPro, VisiCalc and other software. Power is from the printer or an external supply may be used. BASIC 4.0 is required. $129. **Address:** Connecticut Microcomputers, 36 Del Mar Drive, Brookfield, CT 06804 (Tel: 203-775-4595).

Data Switch. Data-Path Director and Data-Path Protector (key activated) is a high-quality, gold-flashed contacts switch that allows the user to select from any of four terminals tied into its RS232 ports. It is compatible with all 25-line RS232 ports. Models come with 2, 3, and 4 connections. Prices start at $195. **Address:** EMS, 1861 Reynolds Ave., Irvine, CA 92714 (Tel: 714-556-6111).

SS50 CP/M. The Z809 Softboard System enables 6809 SS50 bus computers to run CP/M software. The System will be fully supported with optional copy utility programs that permit the user to transfer any type of file between CP/M and FLEX, CP/M and 0S9 and 0S9 and FLEX. **Address:** Meta Lab, 2888 Bluff St., Suite 106, Box 1559, Boulder, CO 80306 (Tel: 303-499-4236).

Printer Graphics. GRAFTRAX-Plus is an advanced graphics capability for Epson MX Series printers, and is also available as a retrofittable ROM. It offers 66 different type fonts including italics, subscript, superscript, and international symbols for most Western languages. It can also underscore with one pass of the printhead. Other features include programmable form length, horizontal tab and right margin, software printer reset, and true backspace. It can also produce ultra high resolution bit image patterns with up to 120 DPI horizontally and 216 vertically. **Address:** Epson America, 3415 Kashiwa St., Torrance, CA 90505 (Tel: 213-539-9140).

IBM PC Wire-Wrap. The PC-Proto1000 is a wire-wrap/prototype board for the IBM Personal Computer. It takes advantage of the maximum space available within the PC. **Address:** Legend Industries Ltd., POB 112, Pontiac, MI 48056.

Software

Inventory Control. Written for the TRS-80 Model II, INV-X is an inventory control system that features built-in sort/merge, a new hashing algorithm enabling 1.5 I/O's even on a 28,000 standard reports, and a capacity of 6,600 records on the Model II, or 28,000 for unlimited disk storage. It requires a dual-disk system with 64K of RAM and TRSDOS. $299. CP/M and IBM PC versions soon to be available. **Address:** Micro Architect Inc., 96 Dothan St., Arlington, MA, 02174 (Tel: 617-643-4713).

Apple Programs. Apple Alarm monitors on/off alarm switches and can sound an alarm, or keep time when triggered. A 12-page application manual is provided. Requires 32K, disk, DOS 3.2/3.3, and Applesoft. $20. Hypnosis is an aid to suggestive relaxation, behavior modification, and trance induction. It uses photo-optic and acoustic sensory stimulation and is designed for professionals and students of the medical, psychological, and social sciences. Requires disk and integer BASIC. $20. **Address**: Andent, 1000 North Ave., Waukegan, IL 60085 (Tel: 312-244-0292).

VIC-20 Utility. Budget II maintains a full calender years budget data on tape. It requires each month's net income, and 16 budget categories. Data is saved and reloaded at any time. Each month's data is displayed in dollar amounts, percentages, and color bargraphs. In addition to the 12 months, it can display the total year amounts and monthly averages. Requires VIC-1530 Datasette and 8K. $9.95. **Address**: RAK Electronics, POB 1585, Orange Park, FL 32073.

Apple Forth. Forth-79 Version 2 is now available for the Apple. Floating point and HIRES graphics are also available. It meets all the provisions of Forth-79 Standard. The base system includes a screen editor, macro-assembler, string package, 32-bit integer arithmetic, and a 200-page tutorial and reference manual. $99.95. With enhancements $139.95. **Address**: MicroMotion, 12077 Wilshire Blvd., #506, Los Angeles, CA 90025 (Tel: 213-821-4340).

Apple Quick File III. A simple data file system for the Apple III, Quick File III allows for simple arrangement of data into alphabetic, numeric, date, or time order and produces reports in either of two formats—tables (rows and columns); or index card format. Quick File III can calculate totals and subtotals of numeric information, it can also allow for the choice of which rows and columns are to be printed and in what order. This program requires an Apple III system with at least 128K bytes of RAM. $100. Scheduled to be available in August 1982.

Apple LOGO. Requiring an Apple II with a 16K RAM extension, this MIT LOGO package includes the LOGO language system, a unique instant LOGO tutorial program, an introduction to LOGO, a very fascinating teaching program called Alice in Logoland, and a LOGO back-up disk. It also works in color. Materials describing the Young Peoples LOGO Association are also available. $179.95. **Address:** Krell Software, 21 Millbrook Drive, Stony Brook, NY 11790 (Tel: 516-751-5139).

Genealogy Program. Your Family Tree, is a genealogical program that sets up a data base to hold pertinent information about each ancestor including name, date, place of birth, marriage, and death information, plus a comment line. Access is virtually unlimited, with full search capability on any key field using full or partial information. For TRS-80 Model I and III. Cassette or diskette. $29.95. **Address:** Acorn Software Products Inc., 634 North Carolina Ave., S.E. Washington, DC 20003 (Tel: 202-544-4259).

6809 FORTRAN. Running under FLEX and UniFLEX, this compiler complies with ANSI FORTRAN-77 (ANSI X3.9-1978) subset of FORTRAN, with the following exceptions; INTRINSIC and SAVE statements are ignored, EQUIVALENCE is not currently implemented, BACKSPACE is allowed on direct access files, ENDFILE performs no useful function, statement functions are not supported, variable names may be of any length with 7 characters significant, all keywords are reserved names, and direct access files are not available under FLEX. It includes modules for 16.8 digit floating point arithmetic, standard scientific functions, complete file manipulations, runtime traceback features, and a post-mortem dump. Available on 5- or 8-inch diskette. UniFLEX version is $450, FLEX is $375. **Address:** Technical Systems Consultants, Inc., Box 2570, West Lafayette, IN 47906 (Tel: 317-463-2502).

Apple Utility. The Manager contains programs to set up a turnkey memory management system for the Apple making use of either one or two 16K boards. HIDOS loads the DOS onto one 16K card, thus freeing the normally occupied 10.5K space. It will also alter a copy of the System Master so that its utilities make full use of the extra memory. HIDOS then looks for a second 16K card and if found, loads an alternate language. SOLIDOS makes a 16K card into a small (45 sector) disk emulator. $34.95. **Address:** Omega MicroWare, 222 S. Riverside Plaza, Chicago, IL 60606 (Tel: 312-648-4844).

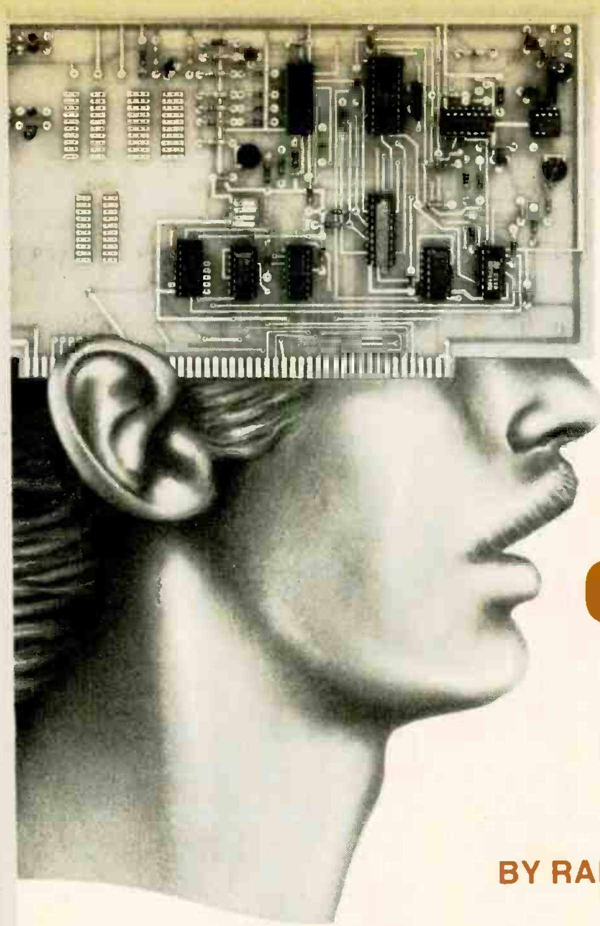
IBM SuperCalc. This spreadsheet takes advantage of the color capability of the IBM Personal Computer. The additional memory allows users to fill in all 16,000 cells with 5-digit numbers, and will allow 10 year projections month by month. Negative values and diagnostic messages are displayed in red, with protected formulas displayed in yellow. **Address:** Sorcim, 405 Aldo Avenue, Santa Clara, CA 95050. (Tel: 408-246-2181).

HP85 Utility. The Professional Organizer is a personal data base management program for the HP-85 that does not have a disk. Data may be manipulated using ADD, DELETE, LIST, CHANGE, INSERT, and TALLY commands. Data files may be saved on and restored from tape cartridges. A linking program enables qualified BASIC programmers to interface with the program. It is supplied on a tape cartridge. $149. **Address:** SCELBI Inc., 35 Old State Road, Oxford, CT 06483. (Tel: 203-888-1946).

VisiCalc Utility. The Consolidator links VisiCalc files and allows manipulation of totals without requiring the user to re-enter information. It will also print out VisiCalc commands, formulas, and locations where they apply. It will handle any matrix size, column widths, rows and columns that can be accomodated on the Apple. $49.95. **Address:** Omega MicroWare Inc., 222 S. Riverside Plaza, Chicago, IL 60606 (Tel: 312-648-4844).

ZX80/ZX81 Stock Programs. These programs help make intelligent decisions on stock market and call option strategies. One program keeps an up-to-date portfolio of up to ten different stocks and calculates accrued dividends, gains, yields, and length of time each stock held. The second program analyzes call option strategy when purchasing a stock and selling a call option against the same stock. Both programs account for broker commission, and have COPY commands for the ZX printer. Both programs require 16K of RAM and are supplied on cassette. $29.95. **Address:** M.H. Marks Ent., 315 Throneberry Court, Pittsburgh, PA 15237 (Tel: 412-486-1694).

Check Accounting. MAXI CRAS is a personal accounting program that can print checks, balance the account, and reconcile it with bank statements. It can handle an almost unlimited number of checks and deposits each month. As many as 223 income and expense accounts are supported. It also interfaces with VisiCalc. Requires a 48K TRS-80 Model I or III with two disk drives and printer, $99.95. **Address:** Adventure International, Dept. G., Box 3435, Longwood, FL 32750 (Tel: 800-327-7172).



Popular Electronics
OCTOBER 1982

A speech synthesizer you can build for use with an S-100 bus computer

THIS IS YOUR COMPUTER SPEAKING

PART 2

BY RANDY CARLSTROM

LAST month, in Part 1 of this article, we discussed some of the principles of speech production and synthesis and developed a circuit for your computer to accomplish such synthesis. Here is a description of the software required and several practical applications for the project.

Software. The 64 phonemes produced by the SC-01 synthesizer chip are given in Table I. Accompanying each hex phoneme code is its symbol, average duration in milliseconds for a 720-kHz clock, and an example word. The italic segments of the example words demonstrate the use of the particular phoneme.

The assembly listing of a vocabulary development program, written in 8080 machine language, and too long to be reproduced here, is available at mailing cost as shown in the Parts List. The operation of the program can be understood from the comments in the source listing.

Five commands are available via the program. The first (XAn; n=0-3) sets the amplitude (audio output power) of the system from zero through two discrete volume settings to full audio output; the second (XFn; n=1-16) adjusts the synthesizer clock frequency in 16 discrete steps to make possible many different intonation variations; the third (XIn; n=1-4) sets the inflection (pitch) of the audio output; the fourth (XE) sets the synthesizer in the sound-effects mode to create all types of human and nonhuman sounds; while the fifth (XS) sets the synthesizer to the normal (speech) mode.

Any of these commands may be used an unlimited number of times in phoneme sequences for dynamic parameter control of the synthesized signal such as intonation and stress pattern variations during the production of words.

There are also two control functions available to the user. Striking the ESC key will cause the current phoneme sequence to be repeated while control-C exits the program and returns to a user-defined memory location (see line 0415 of the program source listing).

Words are programmed into the synthesizer via the system keyboard by entering the appropriate sequences of phoneme symbols from Table I. All phoneme symbols, including any commands used, must be separated by commas. Typing a carriage return (RET) will terminate the current phoneme input sequence and initiate its execution. Commands appearing in a sequence do not go into effect until the next phoneme in the sequence is encountered. Parameter values altered by the various commands remain current until changed otherwise.

As an example of phonetic programming, try entering the following familiar words: "PA1,P,AH1,UH3,P,Y1, IU,L,ER,PA0,EH3,L,EH1,K,T,R, AH1,UH3,N,I2,K,S,PA1 RET;" or this sequence, which uses one of the parameter control commands for a special effect: "PA1,XA3,EH,K,O,XA2,EH, K,O,XA1,EH,K,O,PA1 RET."

Note the PA1 (pause) phoneme appearing at the beginning and ending of both phoneme sequences. This is necessary for proper operation of the SC-01's dynamic articulation controller, to maintain articulation of the first and last sounds in the sequences. The program automatically inserts a PA1 phoneme at the beginning and ending of phoneme sequences, but it is good practice to also explicitly include the PA1 phonemes, should the sequences be later transferred to a ROM (or other type of storage media) for use without the program.

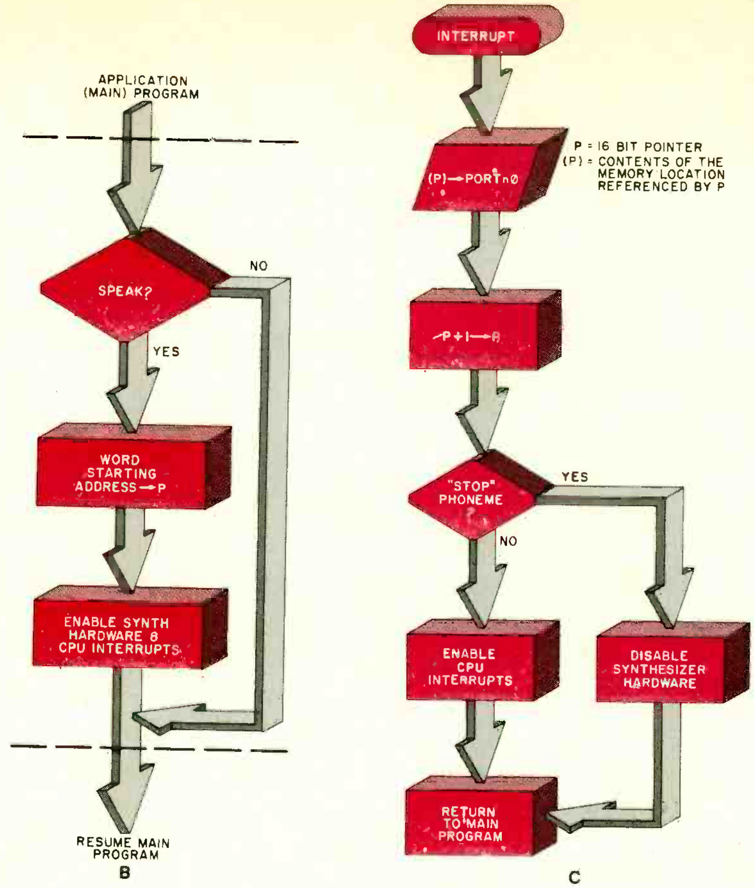
A PA0 (short pause) phoneme may be used between words for rhythm, as was done in the first example. This phoneme is also sometimes used to separate fricative stop sounds (T,DT,K, and P) when they occur consecutively in a phoneme sequence. An example of this usage is in the word *affect* (UH1, F,EH,K,*PA0*,T).

Developing vocabulary words for the synthesizer is basically a trial-and-error method. Slowly pronounce the words to be synthesized out loud several times, noting the different sounds com-

Fig. 8. At (A) is an extract of a typical vocabulary table (numerical values are hexadecimal). (B) A modification of an application program to include vocal output. (C) A speech driver interrupt-servicing routine.

3F	STOP	
3E	PAI	"JUNE"
1E	D	
1A	J	
36	IU	
28	U	
ØD	N	
3E	PAI	
3F	STOP	
3E	PAI	"JULY"
1E	D	
1A	J	
32	UHI	
18	L	
15	AHI	
ØØ	EH3	
29	Y	
3E	PAI	
3F	STOP	
3E	PAI	

A



prising each word. Using Table I, select the phoneme symbols corresponding to each word sound, and enter them into the computer in the order of their occurrences in the words. Carefully listen to the synthesizer's output, paying particular attention to the proper durations of syllables and the rhythm of each word. Adjust the phoneme sequence as many times as necessary to achieve the desired pronunciation. Here are two examples:

Word: intruder
Initial sequence:I,N,T,R,U,D,ER
Refined sequence;
I1,I3,N,T,R,IU,U1,U1,D,ER,R
Word: amplifiers
Initial sequence:
AE,M,P,L,I,F,Y,ER,S
Refined sequence:
AE1,EH3,M,P,L,I3,F,AH1,EH3,AY,ER,Z

Once vocabulary words have been developed, the binary phoneme codes can be transferred to a ROM or look-up table in the computer's RAM for use with other programs. Fig. 8B illustrates a method of using the synthesizer with user-defined application programs, and a vocabulary look-up table (Fig. 8A). When a word is to be synthesized, the main program initializes an index pointer *P* to the beginning address (the first phoneme) of the desired word in the look-up table.

The computer's interrupt system and synthesizer hardware are enabled, and the main program resumes execution. The synthesizer servicing routine of Fig. 8C is called each time the synthesizer hardware interrupts the CPU, i.e., whenever the synthesizer is ready to accept a new phoneme. Each time the routine is entered, the contents of the memory location referenced by the index pointer is sent to the phoneme data port of the synthesizer. The pointer is then incremented to the next location in the table, in anticipation of sending the next phoneme. A STOP phoneme (3FH) signals the end of the phoneme sequence for the particular word, and the CPU's interrupt system is re-enabled or left disabled depending on whether the end of the word has been reached. Note that the two inflection bits (XIn) are included in bits 6 and 7 of the phoneme data byte (bits 0 through 5 are reserved for the actual phoneme code). The parameter control bits can also be updated in a similar manner.

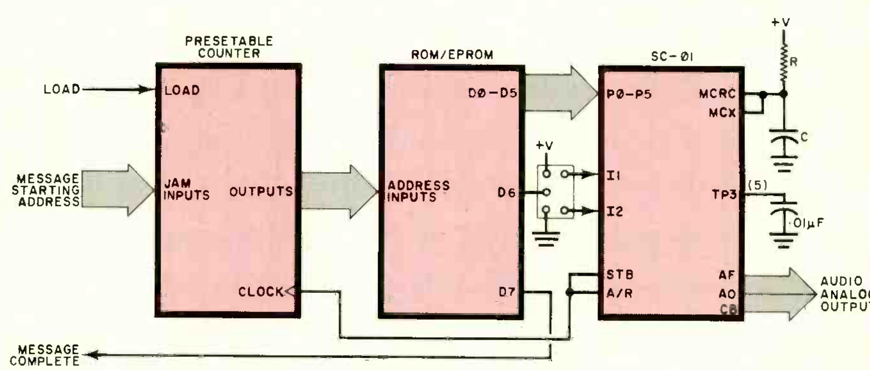


Fig. 9 Block diagram of a stand-alone, multiple-message speech synthesizer.

Applications. Now that we have a means of developing vocabulary words for the synthesizer, let's explore some ways in which the synthesizer can be used. The most obvious is a talking computer terminal. With it, you can finally give your infallible electronic

TABLE I.—PHONEME CHART

Phoneme Code	Phoneme Symbol	Duration (ms)	Example Word	Phoneme Code	Phoneme Symbol	Duration (ms)	Example Word
00	EH3	59	jacket	20	A	185	day
01	EH2	71	enlist	21	AY	65	day
02	EH1	121	heavy	22	Y1	80	yard
03	PA0	47	no sound	23	UH3	47	mission
04	DT	47	butter	24	AH	250	mop
05	A2	71	made	25	P	103	past
06	A1	103	made	26	O	185	cold
07	ZH	90	azure	27	I	185	pin
08	AH2	71	honest	28	U	185	move
09	I3	55	inhibit	29	Y	103	any
0A	I2	80	inhibit	2A	T	71	tap
0B	I1	121	inhibit	2B	R	90	red
0C	M	103	mat	2C	E	185	meet
0D	N	80	sun	2D	W	80	win
0E	B	71	bag	2E	AE	185	dad
0F	V	71	van	2F	AE1	103	after
10	CH*	71	chip	30	AW2	90	salty
11	SH	121	shop	31	UH2	71	about
12	Z	71	zoo	32	UH1	103	uncle
13	AW1	146	lawful	33	UH	185	cup
14	NG	121	thing	34	O2	80	for
15	AH1	146	father	35	O3	121	aboard
16	OO1	103	looking	36	IU	59	you
17	OO	185	book	37	U1	90	you
18	L	103	land	38	THV	80	the
19	K	80	trick	39	TH	71	thin
1A	J*	47	judge	3A	ER	146	bird
1B	H	71	hello	3B	EH	185	get
1C	G	71	get	3C	E1	121	be
1D	F	103	fast	3D	AW	250	call
1E	D	55	paid	3E	PA1	185	no sound
1F	S	90	pass	3F	STOP	47	no sound

/T/ must precede /CH/ to produce CH sound.
/D/ must precede /J/ to produce J sound.

chess companion a personality with a voice. You can warp around an uncharted region of space as captain of the USS Enterprise as you receive verbal status reports from your crew. Realistic, simulated sounds of phaser fire, explosions, red alerts, etc. are also possible with the sound effect abilities of the synthesizer.

There are also many practical applications of the speech synthesizer. How about using its multilingual ability in a translation application, or giving a verbally impaired person a voice? There are many areas of education where a speech synthesizer might also be employed.

The SC-01 chip can be used in a stand-alone voice system by supplying it with phoneme-select code sequences from an address counter/ROM circuit, as shown in Fig. 9. Typical applications of such a system would be a talking clock or in robotics, where fixed vocabularies are acceptable.

As a final application example, let's see how a speech synthesizer can be used in the home.

Using an 8080-based CPU module (See "Designing with the 8080 Microprocessor, Part 2," POPULAR ELECTRONICS, October 1981, p.80) an "electronic helpmate" can be constructed. The operating program, speech recognition word templates, and speech synthesizer vocabulary (look-up) tables are stored in the CPU module's EPROM memory. Lights and appliances can be controlled from a remote control system (such as Radio Shack's *Plug'n Power* control center), which is interfaced to an output port of the CPU module. A 12-V battery back-up circuit powers the critical security portion of the system in the event of a power failure as shown in Fig. 10.

In this approach, the primary inputs to the system are verbal commands via

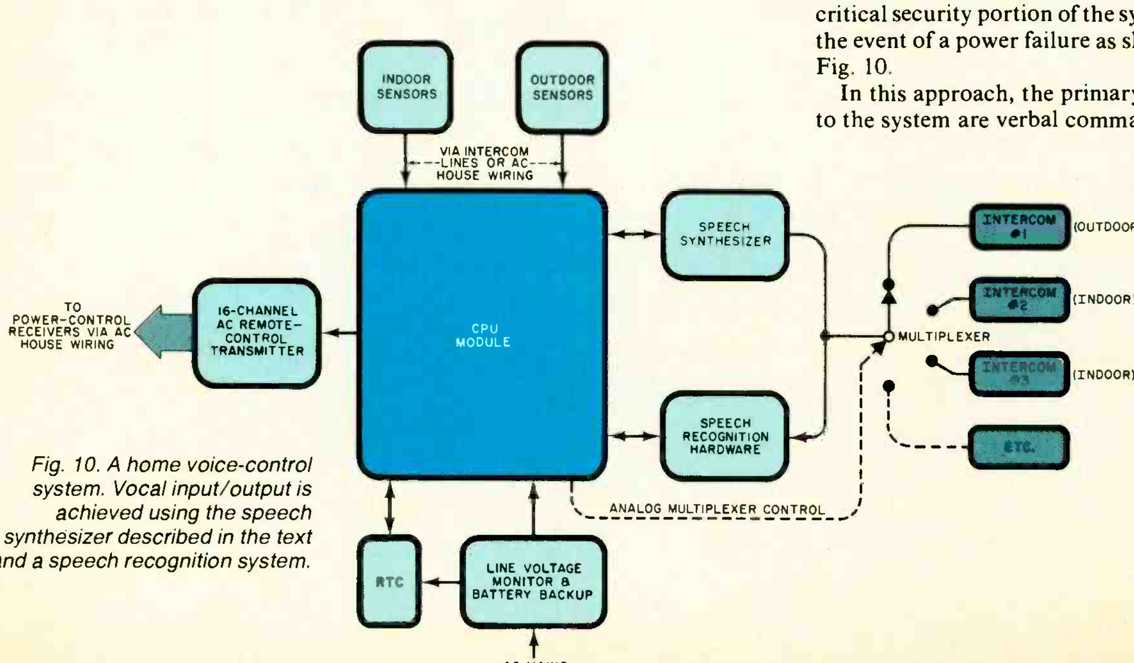
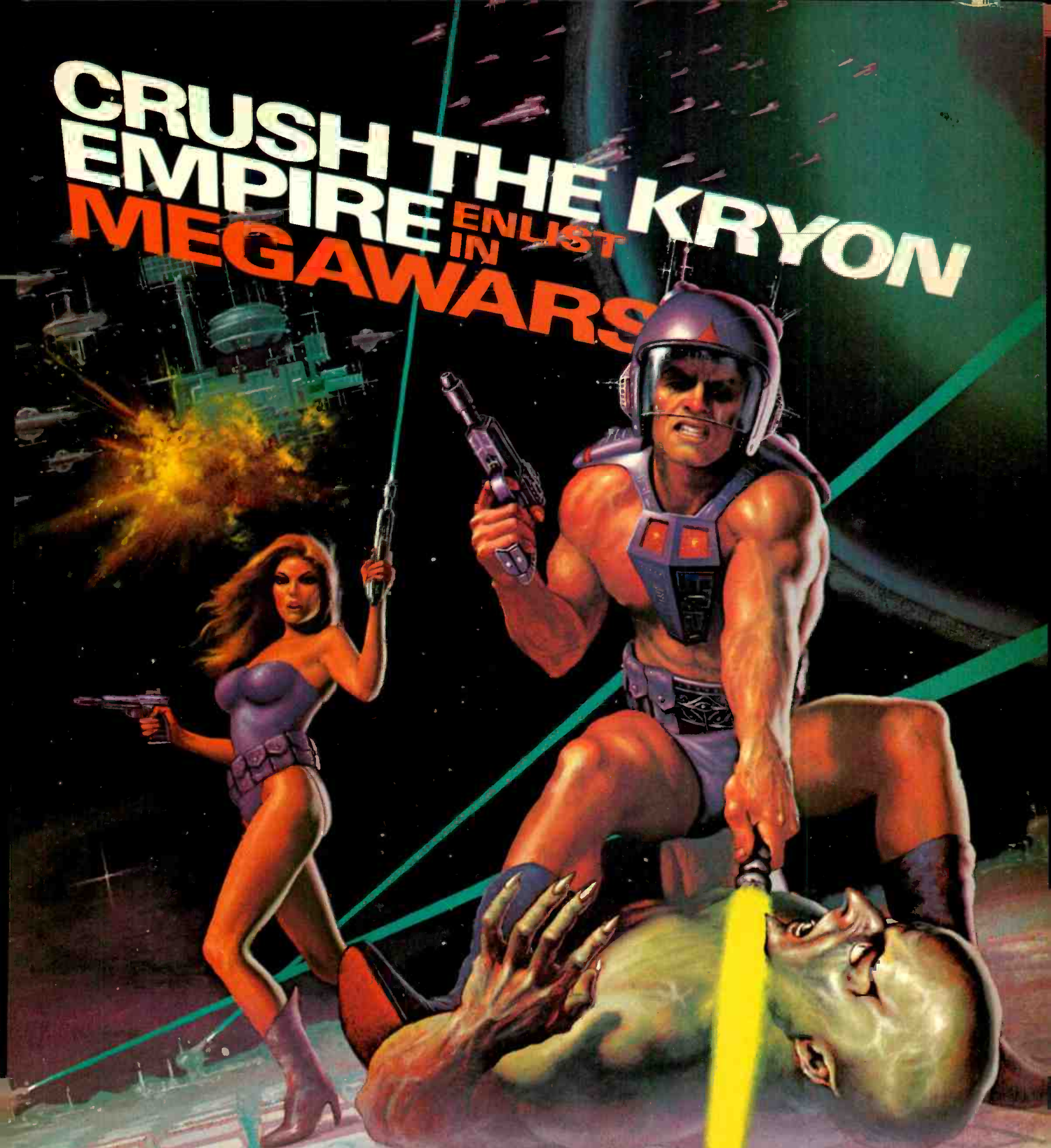
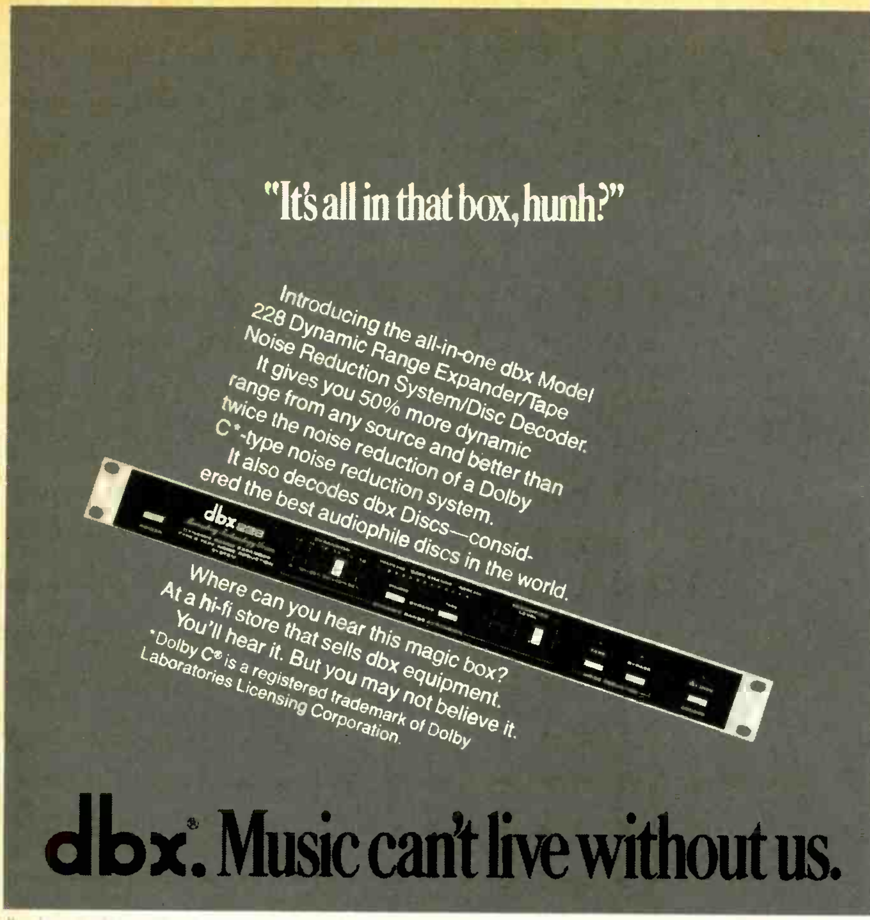


Fig. 10. A home voice-control system. Vocal input/output is achieved using the speech synthesizer described in the text and a speech recognition system.


CRUSH THE KRYON
EMPIRE
ENLIST IN
MEGAWARS



speech synthesizer

intercoms located in strategic locations of the house. The CPU module "decodes" the verbal commands using an integrated speech-recognition system and processes them accordingly. The speech synthesizer's output is also piped throughout the house using the intercom system. If but even one *wireless* intercom is used, adding a "terminal" at any location is as easy as plugging the intercom into the nearest outlet. This technique may be carried a step further to even include two-way radio links to the CPU module. Thus, there are many applications possible with this type of I/O.

A real-time clock (RTC) can be employed to facilitate time and date-related functions of the system. These functions may include remembering an appointment, pseudo-randomly turning house lights on and off as a security measure, turning an electric blanket or coffee pot on or off, or announcing the time. These functions can be invoked by verbal commands from any intercom location in the house.

Various sensors installed around the house and premises communicate with the CPU module via the intercom system or via simple remote transmitters installed in the vicinity of each group of sensors. Each sensor generates a unique frequency (in the ultrasonic range) when triggered, thereby enabling the CPU module to identify the triggered sensor(s) and take appropriate action.

To eliminate much of the unsightly wiring, each sensor may utilize an infrared emitter, which is driven at the sensor's unique assigned frequency. An infrared detector in each remote transmitter (or intercom) receives this infrared energy, and relays the sensor's frequency ("device code") to the CPU module via the house wiring (or intercom system) for detection. The detection circuitry basically consists of a frequency-to-voltage converter connected to the input of a dot/bar display driver IC operating in the "dot" mode. The outputs of the display driver are connected to an input port of the CPU module for sampling. LEDs connected to these outputs also provide a visual indication of the sensors' status.

Besides the types of sensors depicted in Fig. 10, the sensors may also include dual infrared beams across doorways, allowing the CPU module to keep track of the number of people in each room of the house. The CPU module may use this data to turn lights off automatically when the last person has left the room, or to "talk" a burglar out of the house (such as after a pre-specified time of night or whenever the house is supposed to be unoccupied). ◇

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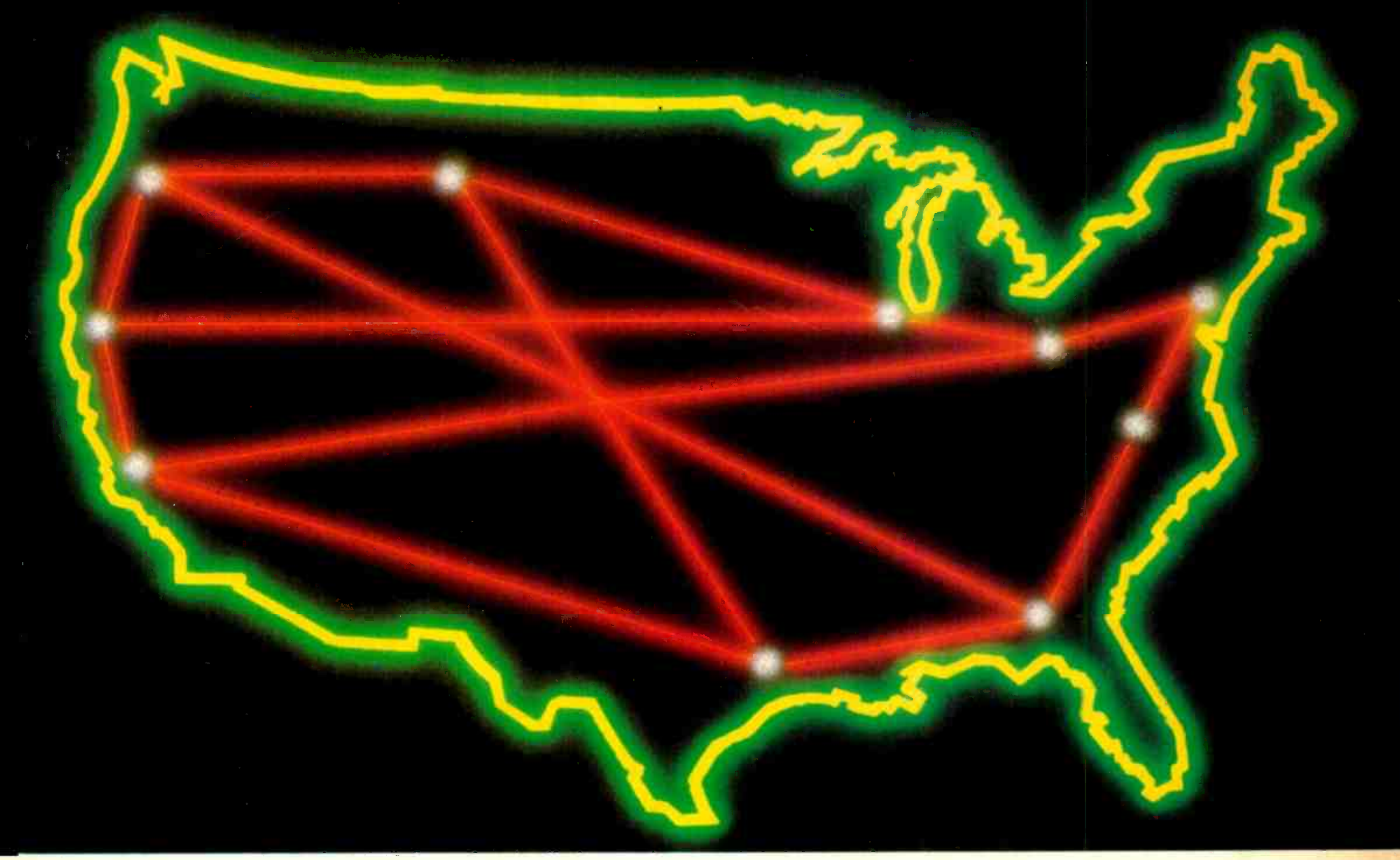

Communications Networks for Computers

BY STAN VEIT

THE American telephone system spans the nation and reaches into almost every home, store, factory and office. It's also connected by cable and satellite into an international network that enables us to talk with people all over the world just by dialing a number. This familiar communications network was originally designed for voice transmission, but nowadays it's also used to transmit digital data.

In this article we'll explore the communication networks that use telephone lines to transmit digital information. We'll take a look at the companies that provide the information, learn how to use their services, find out what they cost, and how to access them. Finally, we'll investigate other avenues of communications like television cable and local computer networks.

Data-Communication Networks. There are many data-communication networks that transmit digital data across the country. They receive the data from local sources and compress it into "packets" that are sent in a continuous stream from point to point. At the destination, the data is routed over local lines to receiving terminals. As a result of this efficient utilization of transmission time, the data networks can charge much less than if an individual leased a line from AT&T for computer-to-computer communication.

The principal companies in this business are Tymnet, which is part of a computer time-sharing company called Tymshare, and G.T.E. Telenet. It's expected that American Bell, the new data-communications subsidiary of AT&T,

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Nippon Electric Co., Ltd., Tokyo, Japan

and IBM will become very active in this field. Telenet and Tymnet are providing most of the data-communication services for the computer information networks.

Computer Networks. In general, computer networks are groups of computers connected by wires, sharing large resources such as printers and data storage devices. However, the term "networks" has become one of the buzzwords of the decade and has been used to describe several very different operations. For example, computer networks are quite different from time-sharing systems. A time-sharing system has one or more large computers at a central location. Clients use remote terminals to access the computers and then use them as if they were in the same office. The computer network also has one or more large computers accessed by remote terminals. However, the large computers provide predetermined information services and some computing services. Typical of the information services they provide are newspapers and magazines, electronic mail, banking and purchasing, reservations and travel, games and personal communications.

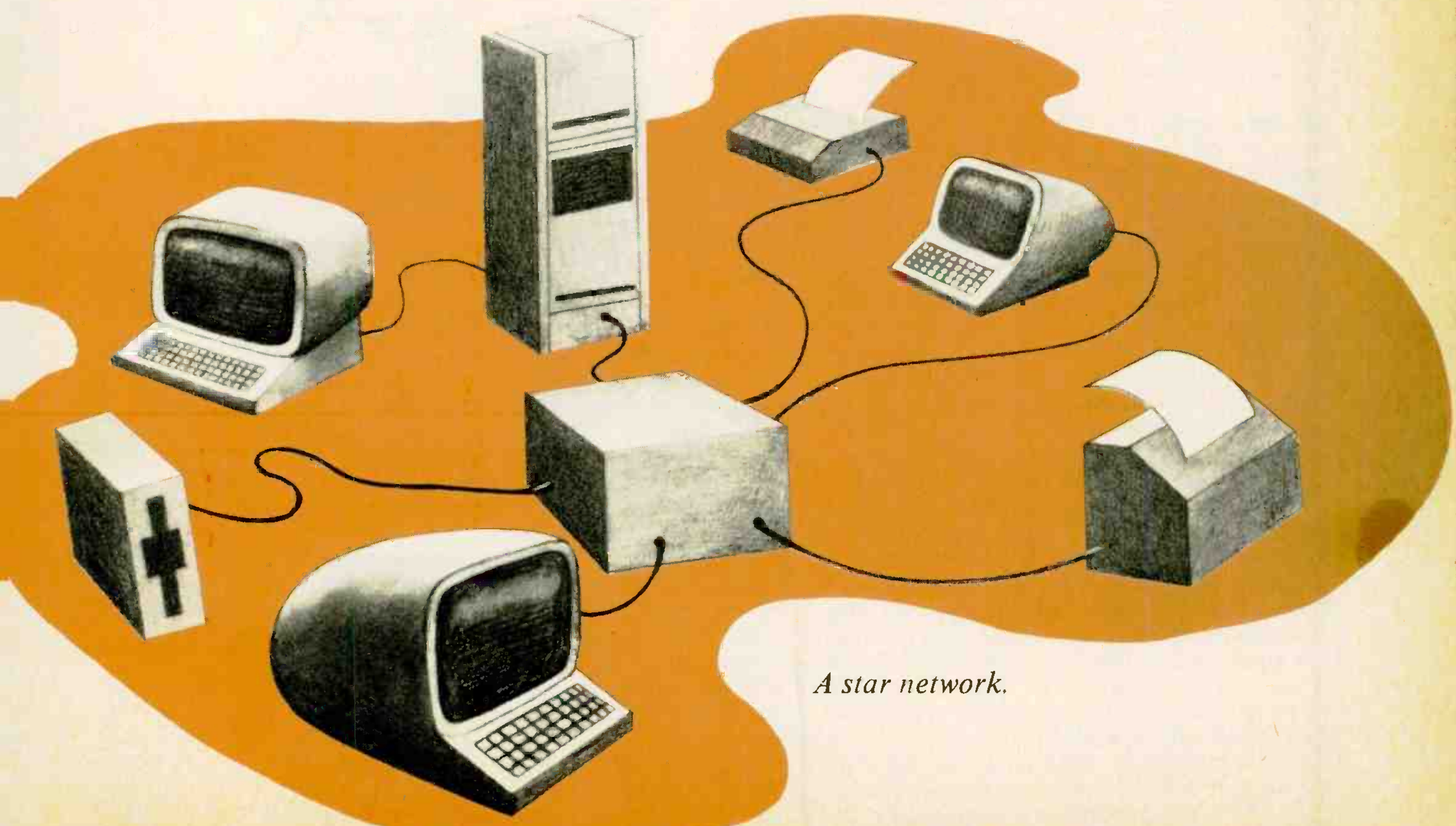
Two of the largest networks were started several years ago by time-sharing services as a method of using their large computer and communications resources during the hours when businesses were closed. The Source (1616 Anderson Road, McLean, VA 22102) and CompuServe (5000 Arlington Centre Blvd., Columbus, OH 43220) were the first of the public computer information networks and are still the most prominent.

On a smaller scale, Dow Jones Electronic News Service, once a local service for Wall Street users, is now a national information network providing a variety of financial services.

Lockheed Information Services, Palo Alto, CA, started a "data base of data bases" and it has grown to be the largest source of research information in the world. Called Dialog, it provides index information on the contents of thousands of data bases.

There are many other specialized networks, some of which are described later in this article. Furthermore, new companies are entering the field every month. American Bell says it will provide services that are extensions of the business of moving data. It is thought that they may offer information services.

Another new company has been started by Kemmons Wilson, the founder of Holiday Inn. He will franchise local outlets for a new computer information utility called INC Telecommunications, which will use the satellite facilities of National Public Radio. Steven G. Wozniak, one of the founders of Apple Computer, has been engaged to write the software needed for the new system.



A star network.

Network Costs. Naturally, these computer services all cost money. The subscriber pays an initial fee when he joins the network. An ID number is assigned and the subscriber chooses a secret password for his account. The charges for use of the network are calculated by the length of time that the subscriber is connected and for any extra services he orders. There are higher charges for service during "prime time" business hours.

In addition, when special commercial and financial services are accessed, extra charges are common. For example, Dow Jones may be accessed from CompuServe at an extra charge. Other special services are extra, too. For instance, most of the computer language manuals are charged to the subscriber's account, as are special printing services and diskette copies of software. Payment for the network service is charged to the subscriber's credit card. Moreover, the initial registration fee covers only a minimum amount of disk storage, with extra storage available at additional cost. Also remember that, in addition to the network's fees, the user must pay for telephone service.

Network Operation

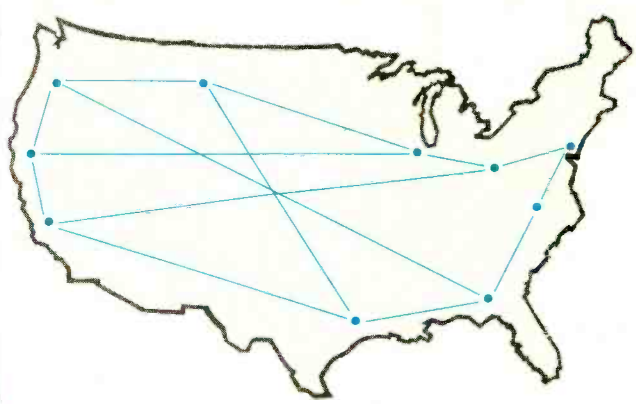
THE Source and CompuServe operate similarly, but there are differences that make the use of each a separate experience. To illustrate this, we will discuss the operation of each system.

CompuServe. This is a network service operating out of Columbus, Ohio. It is a subsidiary of the H&R Block company. A CompuServe subscriber joins the system after paying a modest fee of about $20, which includes an hour of use. Usage time is $5 per hour except for "prime time" hours when it is higher. The new subscriber is given a questionnaire, an I.D. number, and a password.

The user dials a local-access number and waits for a high-pitched tone. Then he places the telephone handset into the rubber cups of an acoustic-coupler (or similar type) modem. If a direct-connect modem is used, the procedure is slightly different. You call the local number using the phone or the computer keyboard (depending on the modem) and the connection is made automatically. At this point, the system begins communication with the caller. The system prompts the caller to identify himself as a subscriber; and the caller responds by entering an identification number and password. This is called the system sign-on (or log-on). It not only identifies the caller, but adjusts the system output to the precise equipment he is using. The subscriber is now confronted with the top level of the system menus. He then makes a selection from one of the following broad subject areas: Business And Financial Services, Personal Computing Services, or Home Services.

The business services include stock and commodity data bases and quotation services. Electronic mail service is also provided. The home services provide computerized banking, buying and selling of merchandise, local and national news, and schedules for airlines, trains, buses and theaters. You can make reservations and purchase tickets through this service. A subscriber can also contact other subscribers all over the country in a simulation of CB radio. He can use the free noncommercial classified ads on the system. In addition, there are bulletin boards maintained by publications or by the various computer manufacturers. They use this service to inform owners of the latest fixes and modifications to their equipment, and sometimes provide software support.

This magazine, as a pioneer in electronic publishing, maintains an edition of POPULAR ELECTRONICS on CompuServe. To access it, enter GO PEM-1. Besides columns by the staff editors and



writers, it also has a SIG (Special Interest Group) where people can request information or help from the magazine's staff. The advantages of this "quick reaction" service over normal mail are obvious.

Electronic communications, news, and data bases are not the only attractions of CompuServe. There are computer games available, too, including nationwide contests that test your computer gaming skills.

Personal computing services involve the interactive use of the large computing facilities by subscribers. To a user connected to the network computer, it seems as if he were using his own machine. Many different computer languages are offered and the user can store his work and data on the system disks. Computer printout services are also available at network headquarters, with the results delivered to customers by mail or UPS.

The public access area is another personal computing service that can be utilized by subscribers. It features a user-donated software exchange where programs in the public domain can be downloaded from the CompuServe data storage to the subscriber's own disk system. However, not all of the software is free. There are companies that sell programs over the net-

work. The advantage to buying software this way is that you can try a demo program before you buy, and you can get delivery at once.

There is a feeling of excitement that you get when using CompuServe because there's so much to try and to learn. Some of this enthusiasm is generated by personal messages from the "sysops" (system operators). These are volunteers who run the various bulletin boards. They act as moderators, instructing newcomers and helping them become part of the group. Sysops develop a following who may "tune-in" to listen and talk with them just as people follow talk shows on radio and TV. In any event, the sysops are an attraction on CompuServe because they humanize an otherwise regimented process of menu selection from one level to another.

To heighten subscriber's interest, CompuServe publishes a monthly magazine, *Today*, that all members receive at no additional cost along with a newsletter called *Update*. These publications generate interest in using the network and the many services that are available.

The Source. This is a public information utility operated by The Source Telecomputing Corporation, a subsidiary of The Readers Digest Association. It operates from a bank of large Prime computers in McLean, VA, and it is accessed over the facilities of Telenet and Tymnet in much the same way as CompuServe. The initial fee to join the Source is $100. The evening, weekend, and holiday hourly rate is $7.75 while after midnight the rate drops to $5.75. Prime time hourly rates are significantly higher.

The sign-on procedures for The Source are almost identical to those on CompuServe, except that the subscriber always uses either Telenet or Tymnet to access the system. The only direct access is in the area around Washington, D.C. and Northern Virginia, where the main computer is located.

The Source offers the same type of services as CompuServe but there is less variety. For example, the only local newspaper on The Source is the N.Y. Times. The Source is a network of data bases that are accessible in two ways. You can call a database after obtaining its address from The Source index; or you can find information through a command level from which other levels are connected through a hierarchy of menus.

The Source features communications, information, and computer services. In the communications area they offer electronic mail, "Chat," and "Post." The electronic mail service allows you to send messages to any other subscriber, while Chat allows you to have an interactive dialog with another subscriber who is on line the same time you are. Post is a free classified ad bulletin board. Information abounds on The Source. It features 36 categories of news and commentary on business and financial markets, plus abstracts from leading financial publications. Prices on stocks, bonds, commodities, metals, money-market certificates, federal notes, and bills are given from all the major markets and from the over-the-counter market. Compu-U-Star is a discount shopping service that is accessed on The Source and offers savings to members on high-ticket items such as

cars, appliances, furniture, and electronic equipment.

Through the The Source you can get airline schedules, travel tips, and reservations for airlines, hotels, and tours. They also have restaurant reviews that can be a big help to a business person who wants to know where to eat and entertain while traveling. The Source also offers subscribers games, bulletin boards, and personal computing services. An unusual service is called the User Publishing section. In this area, users are encouraged to publish anything they want, provided they do not exceed the standards of decency or violate the rights of others.

If you access The Source through the index, it's like being all by yourself in a big library where you can use the card catalog to find out where the book you need is located. You can then go to the correct stack where you locate the right shelf and find the book you want.

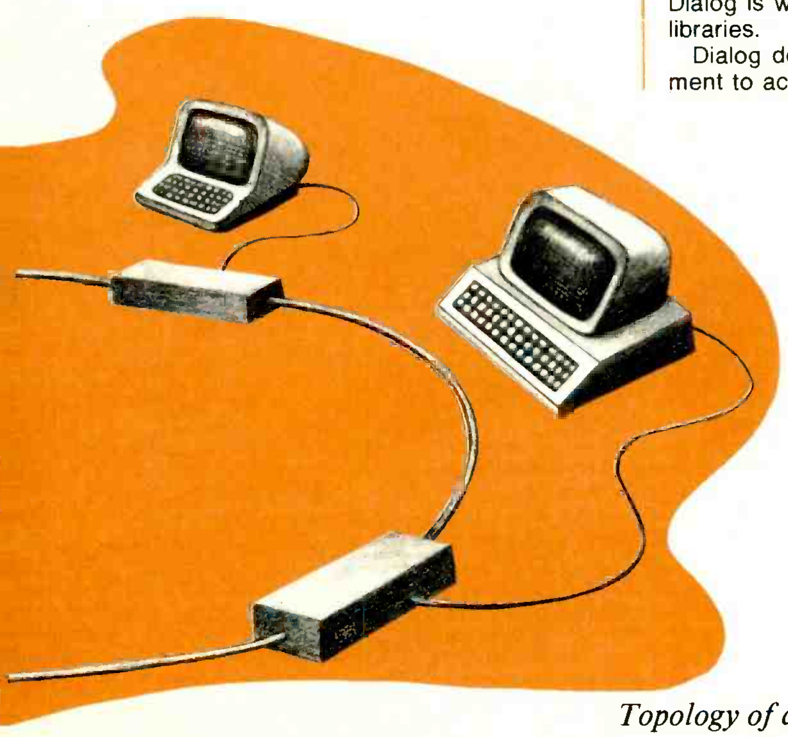
The Source doesn't seem to be as interactive as CompuServe. True, The Source has the Chat area where you can talk to others, but I have never found anyone home to talk to! When you want specific information such as airline schedules, The Source may be quicker to use, and it has been said that the data bases available on The Source are more complete and thorough. But CompuServe seems to be a bit more friendly, a place where you not only can find information but also interact with others.

Dow Jones News/Retrieval. This service offers subscribers prices, news, and analysis of all major security and commodity markets. It provides in-depth information on all factors that affect the financial community and enables subscribers to evaluate the performance of their own portfolio against that of the leading money managers. Many subscribers prefer the expertise that Dow Jones is known for. The Dow Jones service not only provides the market activity of a company, but gives all the news about that company. Stock prices are maintained on a current basis, and past performance information is available, too. The Dow Jones service is available through Apple dealers, Commodore dealers, and Radio Shack stores.

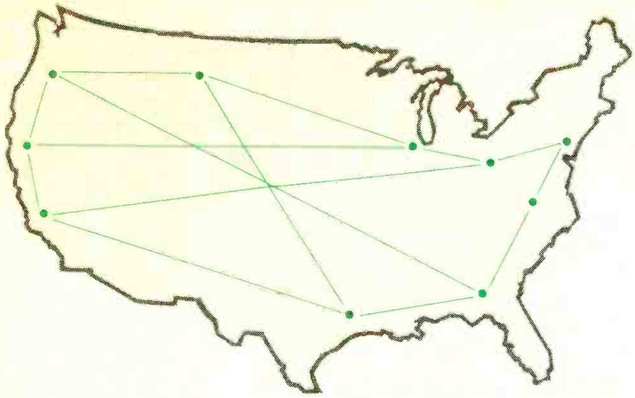
Lockheed's Dialog. Many of the largest information networks are devoted to the retrieval of scientific, medical, and legal information. The largest and oldest of these is Lockheed's Dialog (3460 Hillview Ave., Palo Alto, CA 94304). It is the key to hundreds of data bases on every subject from agriculture to zoology. These data bases contain information concerning business/economics, government and foundation grants, current research, research papers, humanities, arts, law, medicine, science, technology, engineering, and just about every other subject known to mankind.

A researcher skilled in the use of Dialog can find bibliographical references and abstracts on any subject. Actually, these references to database information are all that the system contains, but normally that's all that is needed. The actual documents can be ordered once the researcher knows where they are. A minute with Dialog is worth hours, or days, of research in libraries.

Dialog does not require complicated equipment to access it. Simple personal computers



Topology of a loop network.



or dumb terminals can be used. However, the researcher must know how to use the system, and that is not simple. In fact, there are people who research Dialog for others for a fee. There is a database of databases, called Dialindex, used in Dialog to find the proper data base to conduct a search for a subject. In addition there is a related service called Dialorder used to order the documents you find with Dialog.

Other Networks. Mead's Lexus is a law database which requires a special terminal to access it. A database in a much different subject area is Aero Net of Titusville, FL, which connects aircraft dealers all over the United States in a trading and multi-listing nework. The development of business information and sales networks like these may become the most important marketing concept of the 1980's.

The *New York Times* owns The Information Bank which provides on-line information derived from the newspapers. This information bank is now available on The Source.

Graphnet (329 Alfred Ave., Teaneck, NJ 07666), although not an information bank, is a service that provides electronic teletype interface to subscribers. A personal computer can be used to access the major teletype systems and to send and receive messages.

EIES (Electronic Information Exchange System) is a nationwide independent computerized network originally funded by the National Science Foundation. It is now operated on a membership basis. Users sign in through Telenet.

The Plato network was originally developed at the University of Illinois. Now owned and operated by The Control Data Corp. (P.O. Box O, Minneapolis, MN 55440), it is an interactive learning system that has courses on many subjects. Plato produces its lessons on "pages" with which the student interacts by means of a keyboard. Each page asks questions and produces new pages as the result of the student's answers. Because of the high cost of a Plato terminal (around $5000), it is used at Control Data Learning Centers throughout the United States.

The networks mentioned here are just a sampling of those that are available; and new ones are added every month. Since some are devoted to one industry, one profession, or one scientific discipline, they rarely come to our attention. However, we will become more aware of them in the future as colleges and public libraries make their services available to the general public.

Computer Bulletin Boards. Some computer hobbyists are also radio amateurs who have a tradition of regular interactive communication. Because of an FCC ban on the transmission of ASCII code by ham radio, these hobbyists established computer bulletin boards. The development of the TRS-80, Apple II, and PET personal computers provided the other necessary element for the spread of computer bulletin boards. Here for the first time were large groups of identical computers. This meant that standard bulletin board programs could be used and anyone with the proper equipment could call in and use the service.

The software to operate these bulletin boards was developed by a number of individuals. Ward Christensen and Randy Seuss were the original developers of the Computerized Bulletin Board™ software. Their concepts were extended in the formation of ABBS (Apple Bulletin Board System) for Apple, Forum-80 for Radio Shack TRS-80 computers, PAN for PET computers, and RBBS (Remote Bulletin Board System) for CP/M-based computers. The services provided by these computer bulletin boards, in addition to message transmission, include the distribution of public-domain software collected by Apple, TRS-80, and CP/M user groups.

Most of the computer bulletin boards are sponsored by computer clubs and user groups. The management of the computerized bulletin board is done by a system operator who often owns the equipment. The system consists of communications software, the computer, disk drives, and a modem.

The bulletin board program starts the computer when a call is received. The caller can then "sign-on" and receive the information on the bulletin board. In some cases, the caller can leave a message of his own. When the caller disconnects, the software system detects the disconnect, "hangs up the phone," and awaits the next call. Some of these bulletin boards have enough capacity to transmit a complete club newsletter.

Telephone numbers and time of operation for many club bulletin boards are listed in magazines covering club activites. AMRAD (Amateur Radio Research Corp., 1524 Springdale Ave., McLean, VA 22101) has a list they will send for $1.00. The Source and CompuServe also list locations and information regarding the CBBS as part of their services to clubs.

Accessing Networks

A NETWORK subscriber need not own a computer to use the services of the networks.

All that's necessary is a "dumb" terminal and a communication interface. Several advertisers in this magazine offer low-cost terminals capable of connecting to the various services.

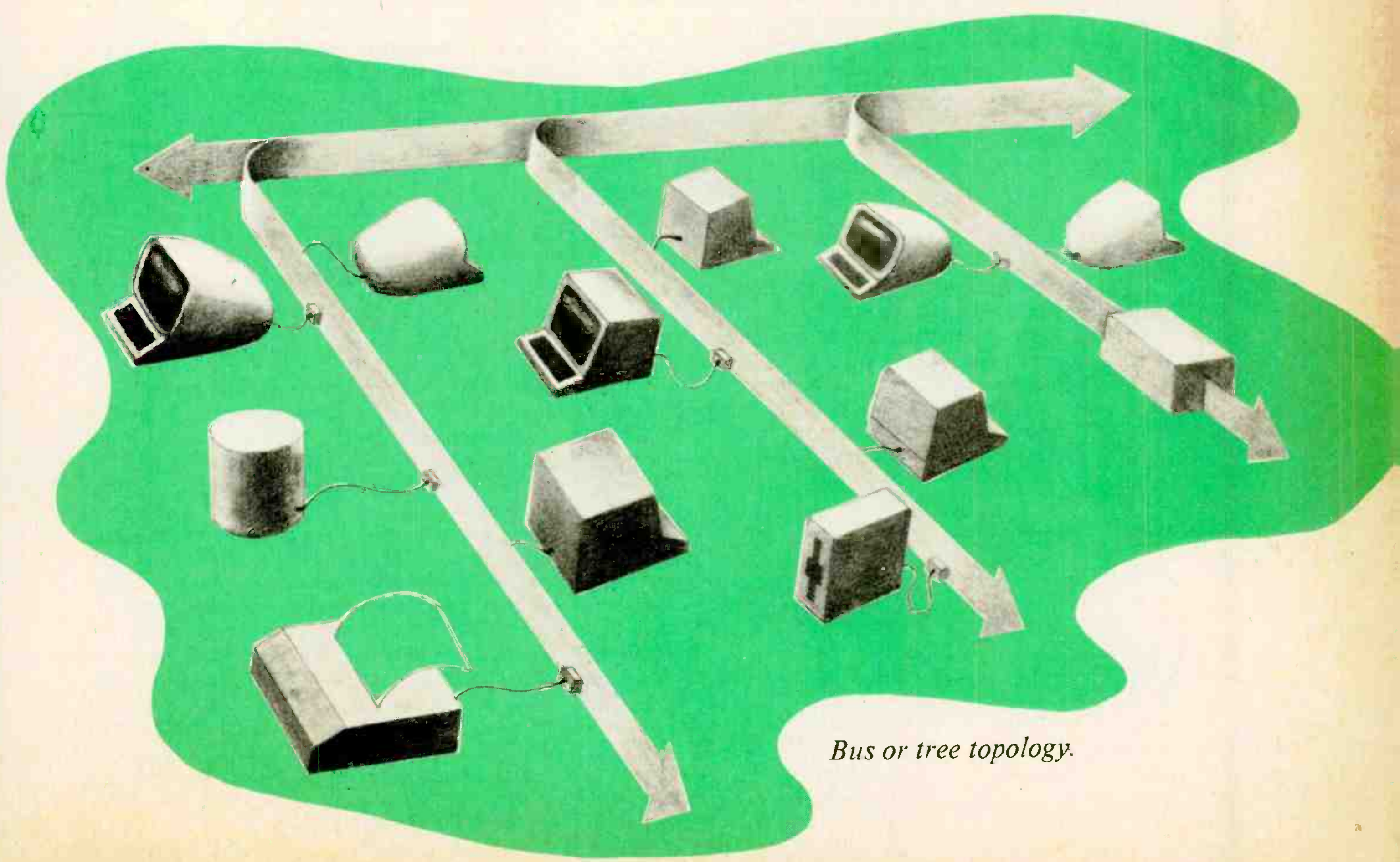
In addition, low-cost computers such as the Radio Shack Color Computer, the Commodore VIC-20, and TI-99/4A can be used with communications peripherals. Timex/Sinclair plans to offer a modem for its Model 1000/ZX81 $99.95 computer. The Panasonic/Quasar hand-held computer has a communication interface and other pocket models like those from Casio, Epson, Radio Shack/Sharp, and others are expected to follow suit. A pocket terminal was recently introduced by IXO. A network subscriber can now carry the terminal, or computer, in an attache case and communicate with the network from a telephone booth anywhere in the country.

The small computer owner can use his equipment without a disk drive, using the mass storage of the network, or he can obtain software that will permit loading of data from the network onto his own disk. This is called downloading. Data stored on the local computer disk can also be transmitted to the network. This is called uploading. Both techniques extend the capabilities of the subscriber's computer. A typical application might consist of transmitting programs or data from a subscriber in New York to one in Los Angeles. The NY subscriber would upload the data to the network and give permission for the LA user to access it. The LA user can then download the information or program. It is that simple.

Modems. Modems are the connecting link for all of the services we have discussed in this article. A modem is the translating element between the computer and the telephone system. It would be very convenient to be able to directly transmit or receive information on our computers (or terminals) via the telephone. The trouble is that the output from computers or terminals is a series of digital pulses. Our telephone system was only designed to transmit human speech.

This problem is solved by converting the digital output into a series of audio tones that can be transmitted over the telephone line. The same thing is done to record computer data on an audio cassette. Converting the data from digital pulses into audio tones is called modulation. Going from audio tones back to digital pulses is called demodulation. The device that does this is called a "modulator/demodulator" or modem for short. This is the device we need to communicate digital data over the standard telephone lines.

In most systems, we use tones of one frequency to signify a logic "one" and tones of a



Bus or tree topology.

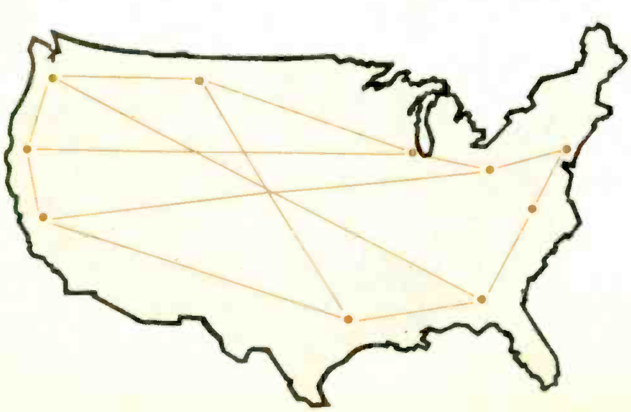
different frequency to signify a logic "zero." When we change or shift the tones to correspond to the ones and zeros in the data stream, it is called frequency-shift-keyed modulation (FSK).

With an audio-cassette system, data travels in only one direction at a time and, therefore, only one set of tones is required. However, in a bi-directional telephone transmission there would be a problem with only one set of tones. Data can be sent both ways over the same set of wires (called full-duplex) but it wouldn't work if the same set of tones were used to transmit data in both directions. Therefore a modem uses two sets of tones. One set of tones (1070 Hz for zero and 1270 Hz for one) is used for originating data. Another set of tones (2025 Hz and 2225 Hz) is used for receiving data. If your computer were connected to The Source, for example, you would be the originating system and your data would be sent with tones of 1070 Hz for zeros and 1270 Hz for ones. The Source computer would answer you with tones of 2025 Hz for zeros and 2225 Hz for ones.

If you use your modem to call up network systems you need an "Originate Only Modem" which has a 1070/1270-Hz modulator, and a 2025/2225-Hz demodulator. If you also receive calls, you might need an answer modem with a modulator using 2025/2225 Hz and a demodulator using 1070/1270 Hz. It really doesn't matter which set of frequencies is used as long as there is agreement between both ends.

When the data is transmitted over the telephone system, noise on the line is likely to interfere with the communication if the data is transmitted too fast. Therefore, most data transmissions are done at 300 bits per second maximum. This rate is also called 300 baud, and it results in a transfer speed of about 30 characters per second. But there are special modems that can transmit at 1200 baud. For really high-speed data communications, data is transmitted over specially conditioned low-noise lines at a rate up to 9600 baud.

To simplify the connection between the computer and the telephone system, there are modems that use the transmitter and receiver of an ordinary telephone handset to make the connection. The telephone instrument is placed into rubber cups to minimize the noise. This type is called an acoustic-coupler modem. The other type of modem connects directly into the telephone line and is called a direct-connect modem. The acoustic couplers are cheaper but are more likely to pick up noise interference.



Cable Networks

TODAY, many homes have a second set of communication wires coming into the house—the TV cable. Cable services provide many more channels than vhf and uhf stations make available. Since at least one-half of a terminal exists in the TV set, it isn't difficult to provide the keyboard and additional parts to make one or more cable channels interactive computer networks. This has already been tried on an experimental basis and it is just a matter of time before television and home computers will merge. Cable companies charge a flat rate for a month's service, which is an incentive to use the TV cable instead of the telephone system.

The Warner Communications Corp. and American Express have been experimenting with a prototype two-way, interactive cable TV network in Columbus, OH. The QUBE system uses simple pushbutton terminals to provide yes/no/multiple choices to televised questions and offers to sell products. This service has proven to be very popular. Other attempts to offer an interactive game-playing service via two-way cable TV will soon be underway in major cities in the United States. If these are successful, it is predicted that fully interactive personal-computing and information-utility services will move to the TV cable within five years.

Local Networks

SEVERAL computers, or computers and terminals, can be connected within a local area to share common peripherals and/or software. Such a local network can be as simple as several small computers in a classroom, connected to share a disk and printer. It can also be as complex as all the computers, terminals, and other business machines in a large office connected together to provide the interactive services needed by a large business organization.

The Xerox Corp. and other major manufacturers such as Digital Equipment Corp. and Intel have proposed a system called Ethernet that uses coaxial cable to connect computers, word processors, copiers, fax, and other machines into an automated office. This system uses a transmission scheme which is called a *baseband system* because it operates at low voltage and frequency.

In local networks each station (called a "node") can communicate with every other node without requiring a special management node (or processor). The signals are broadcast along the wire in the same way that a radio broadcasts—every other station can listen—but a reply is expected only from the node addressed. Each node can detect when another node is "talking" so that it refrains from sending and thus avoids collisions that would lose data. There are various methods of designing the network, as shown in the accompanying diagrams.

The most common design (or topology) is the *star*, where the branches radiate from a central node. This is the design of the telephone switchboard and, since many offices have PBXs, they can be used for wiring. The trouble with the star design is that if the central node goes down, the net is no longer connected.

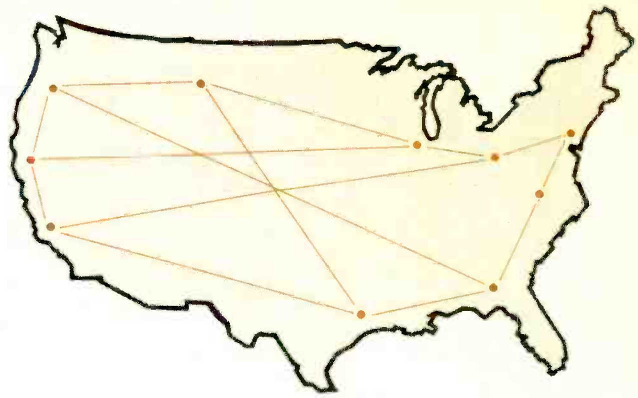
Another design is the *ring* or *loop*. Here the nodes are connected to each other through repeaters. When a signal is received, it is amplified and passed to the next node. If a node fails, it opens the loop and the net fails.

The third topology is the *bus*, which is simply a long piece of cable that runs past the node locations. When a device is to be added, it is merely tapped in through a plug-in socket. If a node fails, it does not bring down the entire net, and additional nodes can be added without reconfiguring the system. This is why Xerox advertises Ethernet with a picture of a wall socket ready for you to plug-in your electronic staple machine.

The expression *baseband* has to do with the frequency of the data transmission. If the center conductor is referenced to zero volts, and then raised to some non-zero value, another node can detect the change in voltage condition and decode the information. These changes occur at relatively low frequencies used by microcomputers.

Another type of local network called a *broadband system* also uses a coaxial cable but transmits at very high frequencies. A typical example is the television cable, which uses frequencies of 50 MHz to 100 MHz. At these frequencies, signal losses due to the cable almost disappear and the signal can be sent for miles rather than a few thousand feet. Wang and other companies have developed broadband network systems for connecting computers. However, the argument between baseband and broadband systems continues and there is no sign of agreement. Since the outcome is uncertain, it has limited the growth of local network systems. IBM and AT&T have yet to be heard from and the method they choose will greatly influence the outcome. The use of the telephone system and its requirement for simple, low-cost wiring seems to favor the baseband systems. However, if the primary connecting medium becomes TV cable and/or satellites, then local broadband systems seem to make more sense.

Personal Computer Networks. At the low end of the computer business there is no such confusion. Several systems have been suc-



cessfully sold. These are all slow-speed baseband networks. Some of them use twisted-pair wires rather than coaxial cable.

The Clustar One system from Nestar ties groups of Apple computers together to provide complex financial-information networks. The Omninet from Corvus also works with Apple. Commodore and Radio Shack each have a network system and there are several for CP/M-based computers. North Star Computer has announced a new network system which is the first to permit different types of computers to operate on the same network.

Schools, as well as automated offices, seem to be the targets of microcomputer networking. Here the network offers the use of many computers sharing expensive peripherals such as hard disks, printers, plotters, and analog-data-collecting equipment. The network offers system control while providing the flexibility to add equipment as the system grows.

We have just begun to see the growth of local networks. As long as small 8-bit computers were limited to 64K of memory and small, low-cost floppy disks, it didn't make much sense to connect them. In fact, the very concept of the personal computer called for a cheap stand-alone unit operated by one user. We are now entering into the period of 16- and 32-bit microprocessors with megabytes of memory and large hard-disk data storage.

We are also developing single-chip video and communications circuits. These can be used to build very cheap terminals. All the elements are in place for local networks of powerful microcomputers, sharing large disk drives and peripherals such as printers, plotters, and data-collection equipment. Perhaps we will see a computer network in each classroom, or in each department of a school. In this case, each student would have an individual terminal and could access the computer for information, or submit work for review by the instructor (or the instructor's program!).

The ultimate will be the interface of the local network with the world-wide public information networks beaming their data from satellites. Of course, it won't stop there. Next, the satellites will be collecting additional information from our space probes throughout the solar system and beyond. ◇

SWD-1 VIDEO CONVERTER

FOR CABLE TV

The SWD-1 Video Converter is utilized on cable TV systems to remove the KHz's signal from a distorted video (channel 3 in/out) and also pass thru the normal undistorted/detected audio signal. Rocker switch selects operating mode to remove KHz's distortion from the video or pass all other channels normally. Simple to assemble—less than 30 minutes. Pre-tuned. Input/output Channel 3. Impedance 75 ohms. 117VAC.

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The Affordable Video Control Center

Excellent in isolation and no loss routing system. Simple Simons VSB-300 Video Switching Box enables* you to bring a variety of video components together for easy viewing/dubbing. Also you gain the ability to record one channel while viewing another. Unit includes two F-type quick connector ended cables.

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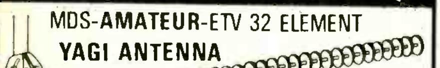
MDS-AMATEUR-ETV 32 ELEMENT YAGI ANTENNA



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MAE-2 32 Element YAGI Antenna **$23.95**

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For use with KSDC-KIT 1.9 - 2.5GHz Down Converter. Completely assembled with Attractive Cabinet, TV/Converter Mode Switch, Frequency Control and LED Indicator.

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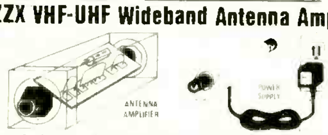

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Our New STVA 14.5dB GAIN, 14 ELEMENT CORNER REFLECTOR YAGI ANTENNA

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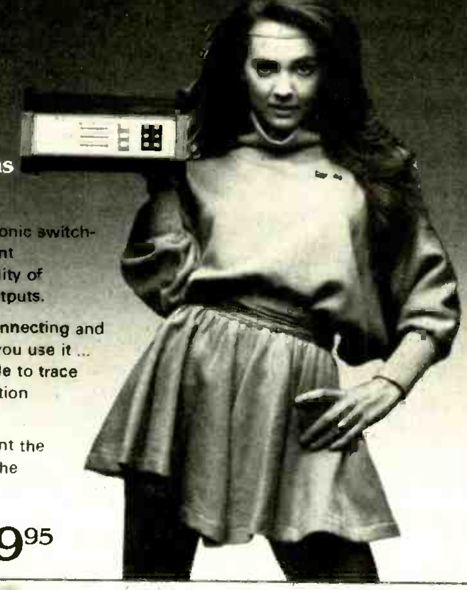

Bambi Electronic Video Switch ... makes switching of your VCR/VTR, Pay TV Decoders, Cable TV, Video Discs, Video Games, Closed Circuit TV, Antennae and Microcomputer as easy as pushing buttons.

The Bambi Electronic Video Switch is an electronic switching network which can accept up to six different sources of video signals and provide the flexibility of directing the inputs to any or all of the three outputs.

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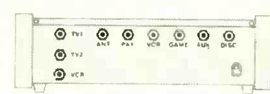

Bambi's Specifications:

- Input/Output Impedance — 75 ohm
- Signal Loss — 3dB ±1dB
- Noise — 4dB ±1dB
- Input Return Loss — 12dB min.
- Isolation — 65dB min.
- Power Req. — 117VAC 60 Hz, 2W
- Dimensions — 10¼ W x 6⅜ D x 3⅛ H
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Model UES-A56F

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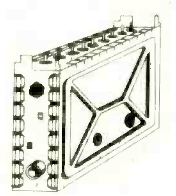

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Antenna Input 75 ohms
Channels 14-83 Output Channel 3

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5	PT1-SW	Power Transformer, PRI-117VAC, SEC-24VAC, 250ma	6.95
6	PP2-SW	Panel Mount Potentiometers and Knobs, 1-1KBT and 1-5KAT w/Switch	5.95
7	SS14-SW	IC's 7-pcs, Diodes 4-pcs, Regulators 2-pcs Heat Sink 1-piece	29.95
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11	11L5-PWD	Coil Kit, 18mhs 3-pcs, .22µhs 1-piece (prewound inductors) and 2 T37-12 Ferrite Toroid cores with 6 ft. #26 wire.	6.00
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Video Accessories

What's available, what they do, and when to use them

BY IVAN BERGER AND LANCELOT BRAITHWAITE

ALONG with the current boom in home video has come a proliferation of video accessories: video stabilizers, image enhancers, distribution amplifiers, switchers, channel converters, commercial killers, and color processors. Many of these devices are familiar to broadcasters and other professionals; but they're new to home users, who wonder just what they do, how they do it, and how to know when it needs to be done.

Some of these accessories have been around for years but they are just now being used at home. This is because they have to do with video signals—such as those from TV cameras—rather than r-f signals such as those that go to TV antenna terminals. Until cameras, VCRs, video disc players, and TV sets with direct audio and video (monitor) inputs became common in the home, there was no way to use most video accessories.

Stabilizers. Video stabilizers restore vertical sync pulses that have been weakened, deleted, misshaped or otherwise modified to the point where the hold controls (especially automatic vertical-hold circuits) on a receiver or monitor can't keep the picture from rolling. Some home stabilizers also clamp horizontal sync pulses to the proper level; but only professional stabilizers can fix errant or damaged horizontal sync.

The problem can occur with misaligned VCRs. But it occurs most often when a TV set with no manual vertical hold is used to view prerecorded video cassettes made with copy-guarding schemes that modify the vertical sync pulses. The object of such schemes is to misshape or weaken the pulses just enough so that any further change (as would occur when illicitly copying the tape) would alter the sync so that it no longer prevents rolling, though the original tape could play normally. Considering the wide variations between VCRs and TVs, the scheme provides a very fine line to tread, which is why some combinations can't make the grade without a little help from a stabilizer.

Figure 1 shows the block diagram of a fairly elaborate stabilizer. There are low-cost stabilizers that work without some of the stages shown here. The one shown has a buffered input (sometimes not used) to prevent interactions between the stabilizer and the equipment feeding it and between the stabilizer's own two signal paths. The buffer may also, in some units, amplify the input signal a bit.

The lower signal path is fairly straightforward. The input signal is amplified and then clamped to ensure that it doesn't get too high. Refurbished sync is added to it by the sync inserter; and then the signal is fed to the output amplifier where it is buffered.

The upper signal path of Fig. 1 is where the actual processing is done and where that refurbished sync signal comes from. The video signal is first inverted, to cancel crosstalk and to make signal comparisons easier. (This is another circuit often omitted.)

The signal is then fed through a sync separator, which strips off the picture information, leaving only sync. (The process is actually quite simple, since sync pulses in a standard, 1.0-volt video signal are always between 0 and $\frac{1}{3}$ volt, while picture information is between $\frac{1}{3}$ and $\frac{2}{3}$ of a volt.)

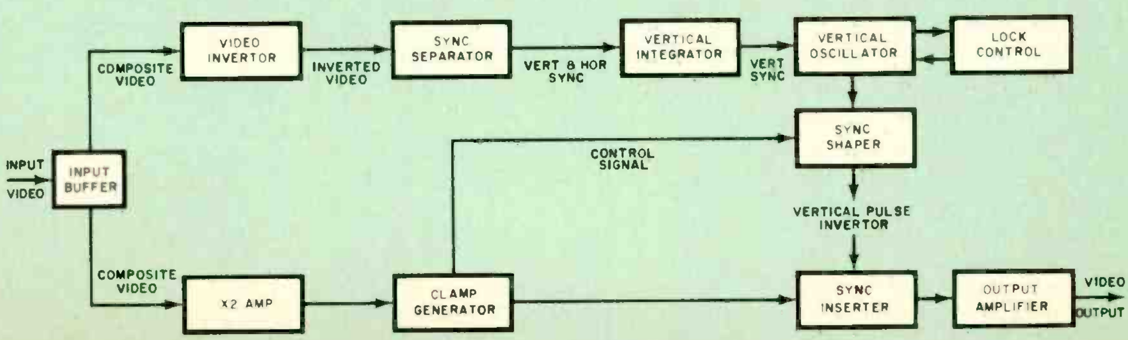


Fig. 1. In a video stabilizer, video and sync are separated and mishapen sync is restored.

Because both horizontal and vertical sync pulses fall into that voltage range, the vertical integrator must screen out the horizontal component. It works on a time, not a voltage, basis. Since horizontal pulses (which occur 262.5 times per field or once per line) are much briefer than vertical ones (which occur only between fields), the integrator assumes that any pulse too long to be a horizontal one is vertical.

The vertical sync output from the integrator is then used to trigger the vertical oscillator, because it's often better to regenerate sync pulses than to fix them. The vertical lock control trims the oscillator to match its output frequency to that of the TV set. This is the equivalent of a receiver's vertical hold control.

The sync pulses are then shaped, and a control signal from the clamp generator makes sure they have the correct amplitude (approximately 0.3 volt). The vertical pulse inverter is usually combined with the sync shaper, and is only needed when the signal from which the new sync was derived has already gone through an inverter stage.

At the sync inserter stage, the new sync is combined with the picture information of the original signal, which is then fed to the output amplifier/buffer stage.

While all home-video stabilizers have video inputs, there are a few whose outputs are r-f, for use in systems consisting of a single VCR and a TV set with no monitor inputs.

Image Enhancers. Image enhancers are used to make pictures look crisper, sharper, and more detailed. Details, in video, correspond to transients in audio. The scanning beam must make fast voltage transitions as it encounters each new detail, while it should make no transitions at all when traversing a perfectly smooth expanse of a single color. The higher the frequency response, the more crisply such transients come across. (That's why bandwidth and horizontal resolution can be equated when discussing video systems.)

The obvious way to sharpen picture details is to extend or boost video high-frequency response. Though the solution is obvious, however, the complexity of the video signal makes the solution difficult to accomplish as shown in Fig. 2.

One reason for the complexity is shown in Fig. 3. This shows the chrominance (color) and luminance (object shape and size) information in a video signal. The signals occur at discrete frequencies separated by 15,750 Hz, the horizontal scanning rate. By offsetting the chroma frequencies so that they fall between those used by the luminance signals, the two can be kept from interfering with each other. (This is the main reason for a comb filter in a color TV set.)

But though their individual frequencies are interleaved, their frequency ranges overlap. Thus, though boosting the higher frequencies in the video signal enhances sharpness, it boosts chroma level, which oversaturates the colors.

The chroma trap is designed to deal with this problem, usually by the simple process of stripping off the 3.58-MHz colorburst signal and chroma information, giving the enhancement circuits only luminance to work on.

The next stage actually performs two functions. It amplifies the luminance signal to make sure its level will be high enough. Of its three outputs, the one feeding the phase shifter/delay buffer is "differentiated" to emphasize its higher frequencies. The delay in the next stage shifts the phase of this differentiated signal so that it and the undifferentiated signal can be compared more readily by the stage that follows.

This stage, the transient magnitude discriminator, derives a primitive correction signal based on the difference between the two versions of the luminance signal. The more detail there is in the picture, the more high frequencies there are in the luminance signal, and the greater the enhancement signal the discriminator puts out. The enhancement signal includes lower picture frequencies, too, since some picture details also show up there. But since the signal has been differentiated, the high frequencies, which are most in need of enhancement, will predominate.

The next stage is primarily a buffer, but with a filter circuit attached. Since noise rises with frequency in video just as it does in audio, the discriminator's high-frequency-enhanced output will contain more noise than the normal luminance signal does. A variable high-cut filter is therefore added to reduce that noise. Use of the noise filter invariably cuts back some of the gains in sharpness and detail. But if the filter and boost characteristics are properly chosen, this cutback can be minimized. The enhance control simply regulates how much of the enhancement signal is fed to the summing amplifier.

This amplifier has three inputs, one each for chroma (from which the luminance was stripped by the composite color processor stage), luminance (from the luminance amplifier) and the enhancement signal itself. The output amplifier stage is for buffering and gain adjustment.

Enhancers can be used in one of two ways: to enhance details in signals being viewed or to pre-enhance already-sharp signals before recording. The latter reduces the loss of detail usual in home taping. Either way, the enhancer can only help to bring out details already present, not re-create details which have already been lost.

Distribution Amplifiers. Video distribution amplifiers need very little description. Basically, they are amplifiers whose input buffer circuits feed several independent outputs rather than a single one. This serves two purposes that a simple, resistive splitter would not: it buffers the outputs, preventing electrical interaction between them and it prevents unintentional reduction in video signal level.

A distribution amplifier, however, can be equipped to do more. Give it enough gain, and its output signal can be stronger than its input, reducing generation loss in taping and even brightening dark scenes in the signals fed through it. In such a case, it will often have both a level control and an output level meter to assure correct video output. The level control adjusts the brightness of the signal, and helps control the buzz that sometimes leaks into the audio from high-contrast program material. One model (the Showtime Video Ventures VV-70P) has an indicator which lights when the output is at the standard, 1-volt level. Some noise filtration may be built into distribution amplifiers, too.

Audio distribution amplifiers are even more likely to have level controls and noise filters. Some may also have tone controls and mixing inputs for microphones.

Switchers. Switchers come in three varieties: audio, video and r-f. They differ mainly in the types of jack used for input and output connections, the amount of capacitance that can be permitted in the circuits, and the amount and type of shielding used. (Stray capacitance is never desirable, but more can be tolerated in audio than in video switchers, which in turn can tolerate more than r-f switchers can.)

Most such switchers are matrix types, with multiple outputs as well as inputs. This allows devices to be interconnected at will, without plugging and unplugging cables, so that one could (for example) dub from a Beta to a VHS deck while feeding the output from a video disc player to the monitor screen, but switch the monitor occasionally to look in on the progress of the dub. Usually, each input circuit feeds a signal bus, and each output circuit has a switch that can be connected to any of these busses.

Some switchers are mechanical, while others are all-electronic. In electronic switchers, contact resistance is lower and capacitance and crosstalk are easier to control. Electronic switchers (especially video switchers) are also more likely to contain some amplification to compen-

Shown here (top to bottom) are: MFJ's Enhancer/Stabilizer; ColorMax VTS-157 Splitter; Cable Works Switcher; Showtime Video Ventures Color Processor; Vidicraft VCR Image Enhancer.

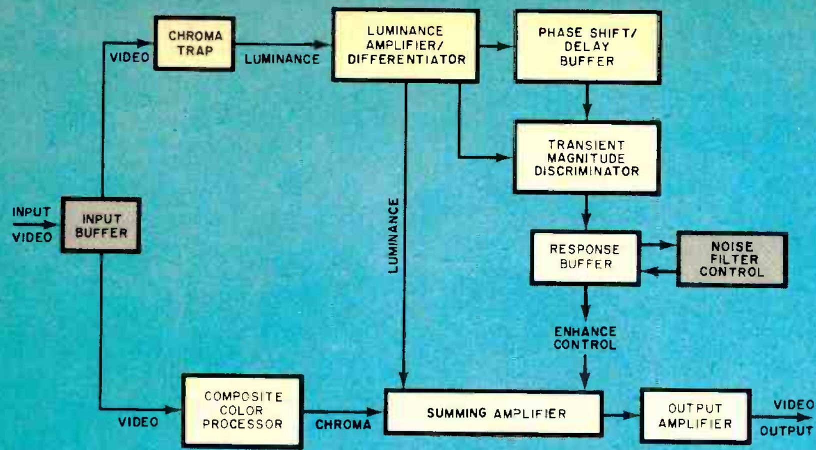


Fig. 2. Luminance information is enhanced without oversaturating colors.

sate for signal losses in the switching circuits, and to buffer the outputs.

Some switchers link audio and video, so that when dubbing from one device to another, the audio and video are dubbed together. Others switch the two independently, and may even be independent devices. R-f switchers, of course, switch video and audio together, as both are part of the r-f signal.

Patch bays are an alternative to switchers. They have two sets of jacks, one each in the front and rear. All devices in the system are connected to the rear jack, and any two devices can then be interconnected by plugging short patch cables between their corresponding jacks in the front. Some patch bays are "normalled." That is, the connections most commonly used are automatically made when no patch cables are plugged in but are broken when patches are made. This is more common in audio than in video or r-f patch bays, though.

Patch bays designed for stereo sound use may sometimes be used for audio and video, if the capacitance is carefully controlled. In such a setup, one of the original stereo channels would carry audio and the other video, and a patch cord would connect them together. At least one manufacturer of audio patch bays, Audio Visual Systems of Los Angeles, recommends its product for such use.

Channel Converters. Channel converters are among the few video accessories that operate on r-f rather than video and audio signals. There are two types.

One is the type most cable companies provide, which transposes any selected channel to a specific channel such as 3, 4 or 12, with channel selection done by a switch on the converter or a remote control attached to it. The main advantage to using them is to save the cost of renting one from the cable company or to get cable service without paying a fee—which is strictly illegal, of course.

The other type is the "up-converter," which raises midband and superband cable channels to uhf frequencies, where TV receivers and VCR tuners that are not "cable-ready" can tune them in without cable-company converter boxes. (Cable-ready sets, of course, can tune them in directly.) Transposed to standard broadcast frequencies, the cable channels can be tuned in with a TV receiver's remote channel selector, or programmed into a VCR's tuner/timer. There's also a saving offered by many cable companies to users who do not need to rent converter boxes.

Since the spacing between cable channels is the same as that between normal broadcast channels (6 MHz), conversion is easy. By beating all cable signals against an r-f oscillator, the converter can raise all signals to the uhf band. A 584-MHz shift (as on the Marshall VR-533 converter) would put channels 2 through 6 (54-88 MHz) onto uhf channels 42-46, channels A-I (120-174 MHz) onto uhf channels 52-60, vhf channels 7-13 (174-216 MHz) onto uhf channels 61-67, and cable channels J-X (216-312 MHz) onto uhf channels 68-82.

Channel converters differ in the number of channels they can convert. A "35-channel" converter in addition to the uhf band, will handle the 12 vhf channels plus 23 cable ones (A-W), giving the same channel capacity as a "105-channel" cable-ready TV receiver. Since cable channel frequencies are not completely standardized, up-converted cable channels may not always fall within the tuning range of some receivers. The problem is probably uncommon, but one should ask for a guarantee when purchasing a converter, just in case.

Channel converters leave one problem unsolved: how to handle pay cable channels, which must be decoded before use by the cable system's converter. One solution is Energy Video's "Channelizer." (Other companies have similar products.) It has two inputs: one for the decoder's output, and another for the r-f signal from a cable or a vhf/uhf antenna. It also has an output to feed the TV's antenna input. The Channelizer converts the decoder's channel-3 signal onto any other vhf channel. It can also be used with outputs from other devices using channel 3, such as VCR's, video disc players, video games or home computers.

A simpler solution is to combine a splitter with a switch, as in Fig. 4A. In one switch position, the TV or VCR receives the cable signal; in the other, it receives the output from the cable company's converter. Figure 4B shows a more complex configuration, with extra switching to enable the VCR and the TV to receive either decoded or undecoded signals independently.

Commercial Killers. It's bad enough to have commercial interruptions when you're watching a show, but it's even worse to see the same commercials over and over when you re-play your off-the-air tapes. It costs more to tape commercials, too—a movie scheduled to run 2½ hours on television can often fit into two

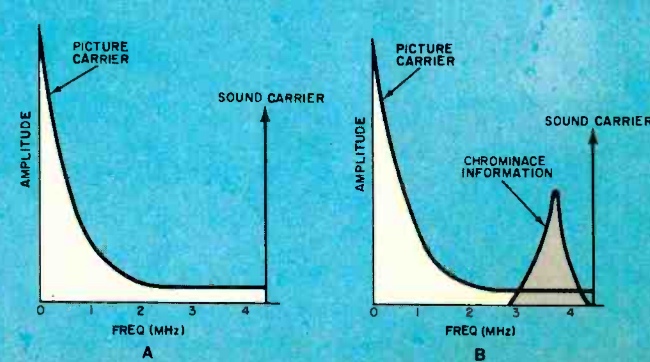


Fig. 3. Envelopes of (A) monochrome signal and (B) with chrominance added. Energy is actually bunched at intervals of horizontal scanning rate of 15,750 Hz to give an interleaving effect and avoid interference.

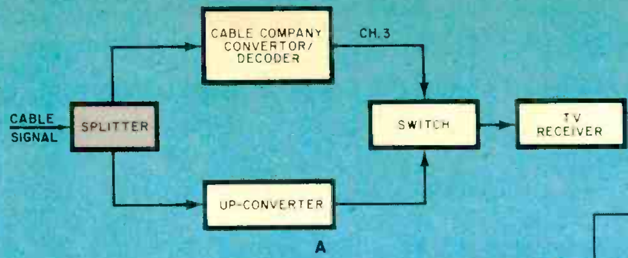
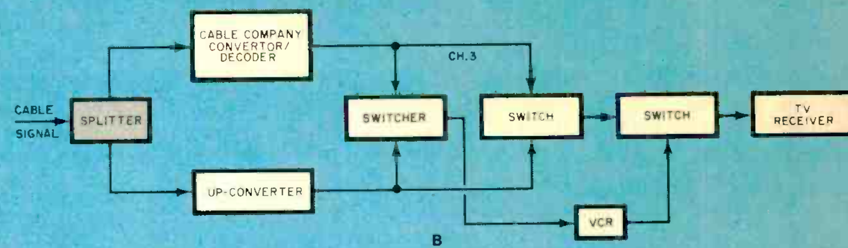


Fig. 4. An up-converter (A) allows you to tape mid- and superband (cable) channels via a VCR's uhf input. A channel splitter lets you watch one cable channel while taping another.



hours of tape if all its commercials and announcements are eliminated. What's needed is a way of catching commercials and editing them out. Several accessories are available to help with this.

The simplest is the tone alert, such as the Vidicraft Commercial Alert. It beeps when it detects the brief flash of black which, by FCC regulations, must precede and follow each commercial. When you hear the warning beep, you can either hit your VCR's pause control, or rewind the tape to the start of the commercial break, then put the deck into record-pause mode until the break is over.

The latter method eliminates all traces of commercials, though it may, on older VCR designs, cause some picture breakup at the transition between old and new recordings. It also takes more time, but have you ever seen a commercial break which didn't leave you enough time to go through all these manipulations and still dash out to the kitchen for a soda or beer? A good partner for Commercial Alert would be the Videomega Adzap, a wireless remote control which can mute the TV or make the VCR pause for a preset time.

The Killer, from Video Services, is more automated, but more specialized, too. Its specialty is eliminating commercials and announcements from black-and-white movies. Since all commercials and announcements are in color these days, it operates by sensing when the TV station turns its colorburst on, and triggering the VCR's pause control till the color goes away. The Killer will not work, however, if the station leaves its colorburst on while transmitting black and white material (when a station does this, you will sometimes notice color casts on black-and-white film).

Like the Commercial Alert, the Shelton Editor works by detecting the momentary shift to black which accompanies transitions into or out of commercial breaks, but also checks for the interruption in the sound which occurs between commercials and other blocks of material.

The new, 300-series Editor models do even more. Instead of pausing the recorder at the start of the first commercial, they wait till that commercial ends, then rewind the tape back to the point where they sensed the first break to black. They can then resume taping. They continue rewinding each time they sense a break to black within 2 minutes of the last one. Anything lasting longer than two minutes is presumed to be program, and not rewound. This system only works, of course, with VCR's offering remote-controlled rewinding, but it does eliminate all but a few seconds of program loss.

Color Processors. If you're critical about video color, then you're probably dissatisfied with much of the color you see on you TV screen. Variations in reception, camera adjustment, VCR response, and even picture-tube phosphors can all lead to unsatisfactory color: colors so hot they practically fluoresce or so pallid they turn the world into pastel.

You can correct these problems, to some extent, with the tint and color controls on your set, but that can mean recorrecting for each channel you receive and each tape you play. With a color processor, though, you can correct off-color signals before taping them, and never have to touch the set's controls—at least not while playing back your tapes.

Color processors vary in the degree and type of color correction they provide. Most have chroma gain and phase and video level controls. Chroma gain, like a receiver's color control, adjusts color saturation (intensity) over the range from mild black and white to hot, sizzling color. Chroma phase, like a receiver's tint or hue control, adjusts the picture hue from an overall green cast at one end of the scale to purple at the other. Since tint is a function of chroma phase (which can rotate 360 degrees at most), color shifts actually chase themselves around a circle. When the control is set to its maximum green position, the shift of reds toward green also causes greens to shift toward blue and blues toward red; set to maximum blue position, colors shift the other way. Since color perception is also affected by screen brightness, there's usually a luminance control, too.

The Showtime Video Ventures VV-777P adds yet another control, burst amplitude, which changes the relative levels of the burst and chrominance signals. In practical terms, its major effect is to give some additional control of flesh tones with relatively little effect on other colors. Since burst amplitude and chroma gain both affect color saturation, it will usually be necessary to re-adjust one control after adjusting the other. Burst amp setting may also affect high-frequency video rolloff, which controls sharpness and detail. This should be watched for when setting the control.

Combinations. Since each of these devices does a different job, you may want to use several of them in combination. In that case, you should look into components that combine a number of functions. If such an accessory exists, has all the functions you need, costs no more (and preferably less) than the equivalent separate components, and performs at least as well as they do, then you would probably be well-advised to buy it. It will also save space and create less of a rats' nest of cables.

However, individual components let you pick and choose the functions you like, and shop for the best or most cost-effective component in each category. They also let you buy the most important functions first, then add the others as your budget permits.

The order in which these components are connected can make a difference in how they perform. Combination units automatically connect things in the proper sequence. If you do have individual units, we suggest connecting them as follows:

- VCR out
- Stabilizer
- Enhancer
- Color Processor
- Input to second VCR, monitor, or r-f converter. ◇

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INCREASE YOUR ANALOG METER'S RANGE

Adding the right shunt to your meter's circuit will extend its measuring range

BY JOHN BAILEY

IN AN analog meter, dc current flowing through a meter coil creates a magnetic field that works against the field of a fixed magnet. The resulting force causes the meter coil to rotate, moving the meter needle, which is attached to the coil, upscale. If too much current flows through the meter coil, the magnetic field may be so strong that the meter needle actually wraps itself around the upper limit stop. Thus, each meter has a built-in upper current limit (its range) to prevent such accidental damage. If you want to use a meter at a current value that is higher than its limit, you must use a meter shunt.

A meter shunt is actually a resistor that "shunts" excessive current around the meter movement. As the higher current flows through the shunt, the voltage drop across it ($E = IR$) is applied to the meter coil. The resistive shunt must be designed so that, at the maximum desired current flow, the voltage generated across the shunt will cause a current flow ($I = E/R$) within the meter coil to allow its pointer to just reach the top of its scale. Thus, by proper selection of the shunt resistance, a meter with almost any current rating can be used to measure almost any desired current. All that has to be changed is the meter scale.

The range of a milliammeter can be increased to almost any value by using a shunt whose resistance is calculated from $R_s = R_m/[(\text{new range}/\text{meter range})-1]$ where R_s is the shunt resistance and R_m is the meter resistance. For example, to increase the range of a 1-mA, 50-ohm meter to measure 20 mA, $R_s = 50/[(20/1)-1] = 50/19 = 2.6316$ ohms.

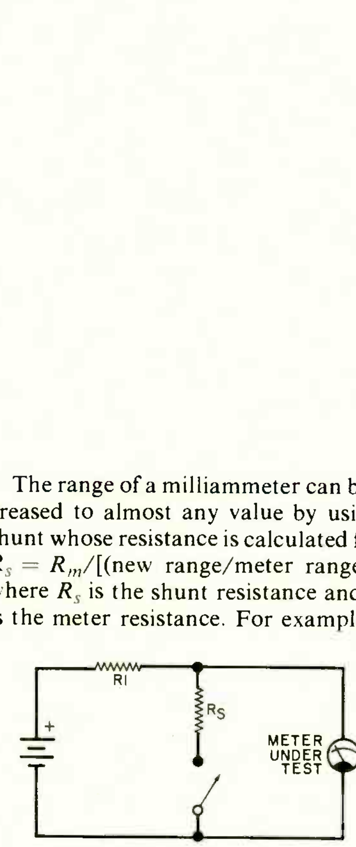


Fig. 1. Circuit for determining meter resistance using two precision resistors.

Determining Meter Resistance. If the meter resistance is not known, you may be able to measure it using the resistance function of a DMM. However, the measuring voltage of most DMMs may be high enough to drive a sensitive analog meter off scale. *Do not* use a VOM because there is normally too much voltage across their probe tips. Besides, the accuracy of a typical VOM is not good enough for this type of measurement.

The well-known procedure of shunting the meter being measured with a resistor of such value that a normal full-scale deflection is reduced to half-scale deflection (thus making the meter resistance equal to the shunting value) is basically sound; but it requires an adjustable constant-current source. Even if such a source were available, the value of the shunting resistor would have to be measured with a bridge.

Fortunately, there is a relatively simple and easy way to determine the resistance of a meter. All you need is a low-voltage battery and two precision resistors. The circuit required is shown in Fig. 1. Precision (1%) resistor $R1$ is selected to produce a little less than full-scale deflection (battery voltage is not important). Note this deflection and call it "A." The meter is then shunted with another precision resistor R_s selected to produce a deflection of approximately half scale. This deflection is noted as "B." Solve for R' using $R' = R_s[(A-B)/B]$. Enter R' into $R_m = (R1 \times R')/(R1-R')$ to determine meter resistance. For example, assume a 1-mA meter and a 1.5-V dry cell. Then $R1$ was

selected as 1580 ohms and it produced a deflection of 0.92 mA ("A"). Similarly, R_s was selected as 51.1 ohms and it produced a deflection of 0.47 mA ("B").

Thus, $R' = [51.1(0.92-0.47)]/0.47 =$ 48.93 ohms. The meter resistance is determined by calculating $R_m = (1580 \times 48.93)/(1580 - 48.93) = 50.49$ ohms.

Making a Shunt. For noncritical applications, a shunt is formed by scramble winding a length of enameled copper wire on a high-value resistor body which serves as a form with axial leads. The wire gauge and length are found from a Wire Table that covers gauge and resistance/foot.

It has been customary to wind on slightly more wire than was needed according to calculations and then to remove turns until the exact value was reached. However, there is a slight problem in this approach.

When the shunt wire is soldered to the resistor leads, the temperature of the wire, and the associated resistor body/leads may increase the total resistance due to the positive temperature coefficient of the wire. In conjunction with this, usually insufficient time was allowed for the wire and resistor to cool down to room temperature before removing any turns. This resulted in the shunt appearing to have too much resistance, so more turns than necessary were removed. Then, when the shunt had cooled, it was found to have too low a value.

However, there is a way to "tweak" the shunt resistance to the correct value while it is connected to the meter with which it will be used.

Start by using the wire table to determine the gauge and length of wire whose resistance is slightly *less* than that required for the shunt. This is found using the first equation in this article. Do not wind this wire on the resistor body at this time. Instead, use the setup shown in Fig. 2. Solder a heavy-gauge wire (large enough so that its resistance will be negligible) to each end of the length of magnet wire, and connect the other ends across the meter to be shunted.

Adjust the current calibration potentiometer until the desired current flows through the series circuit as indicated on the calibration meter. The meter to be shunted should display a slightly lower indication due to the slightly smaller shunt.

Grip one end of the heavy-gauge shunt lead in a bench vise, and the other soldered end in a pliers. Make sure that there are no kinks in the shunt wire as it may break in the next step.

While observing the meter-to-be-shunted indications, gently pull the wire using the pliers. The wire will stretch with a soft "give" feeling and its resistance will increase. Keep stretching the shunt wire until the meter to be shunted produces the desired indication (via the calibration meter). It may be necessary to readjust the calibration meter depending on how much disparity there was between the two meter deflections when the process was started.

To illustrate stretching versus resistance, a 5-foot length of #34 gauge wire was stretched 18" as its resistance increased 40% approximately linearly. This amount of stretch should not be used, but it does show what happens during a wire stretch.

Shunt Example. Assume a 1-mA meter is to be shunted so that its new full-scale value will be 20 mA. The meter resistance (using the equations in this article) was found to be 50.49 ohms. The value of the shunt was found to be 2.657 ohms. A wire table showed that #36-gauge wire has 423 ohms per 1000 feet (0.423 ohms/foot). Therefore, 6.31 feet produces 2.67 ohms. Six feet was selected to produce 2.538 ohms, slightly less than the calculated value.

Using the circuit of Fig. 2, the wire was stretched until the shunted meter indicated exactly full scale when the calibration meter indicated 20 mA.

The wire was then scramble wound on a 1000-ohm (any high value will do), half-watt resistor body with the ends of the shunt wire soldered to the resistor body axial leads. The completed shunt was then installed on the meter, and the meter scale re-calibrated. ◇

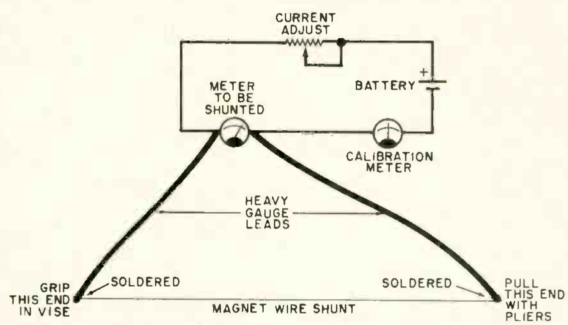


Fig. 2. Heavy-gauge leads are used to reduce any resistance between the meter and the shunt to be stretched. Do not stretch the magnet wire shunt to the breaking point.

PLUG-IN ACCESSORY UPGRADES POCKET SCANNERS

A simple circuit provides power-supply protection, backup power, trickle charging, and other features without modifying your portable

BY PAT JOHNSTONE

THE pocket scanner is a popular item among reporters, radio enthusiasts, volunteer workers, and others who want to monitor public-service broadcasts. However, its small size usually means a sacrifice in features. For example, most pocket scanners have a poorly protected power supply, short battery life, and little flexibility. The circuit described provides pocket scanners with features found on bulkier base units.

Before we discuss the circuit, let's examine the pocket scanner in more detail. Pocket scanners usually have a jack for external power. When the scanner is powered from this jack, an internal switch disconnects the scanner's batteries from the circuit, isolating them from the external power. In this mode the batteries are not charged by the external source. To recharge the nickle-cadmium batteries, a second jack is provided to isolate the scanner circuit from the battery eliminator/charger. This provides recharging power to the NiCad batteries but makes the scanner inoperative. Thus, the user must choose between operating the radio or charging its batteries. The only way to get around this is to purchase separate charger/eliminators for each function. However, if you did use a separate charger and eliminator, you would still have the problem of an unprotected power source. The scanner is committed to the ac power as long as the battery eliminator is in use; and if it should fail, the scanner goes dead. An unnoticed blown fuse can mean lost communication.

An inexpensive solution to these problems and more can be found in the simple circuit shown in Figure 1. The entire assembly can be point-to-point wired to work on any scanner that has separate "charge" and "power" jacks.

Circuit Operation. The parts specified in the list are for Bearcat Thin-Scan® models. The same circuit can be used for Realistic or similar scanners by substituting coaxial power plugs for the ones specified here.

A 1/8" mini plug, *P1*, for external power and a 3/32" submini plug, *P2*, for charge are soldered to a stiff piece of copper wire to hold them at the proper spacing so they will fit their respective jacks without bending. Join only the ground (negative) bases of these. External power from a car battery or eliminator/charger is applied to the circuit via *J1* (a submini jack here, but it can be coaxial if needed). Reverse-polarity protection, another feature not found on many small units, is provided by diode *D1*. At this point a bridge rectifier could be substituted for *D1* if you are unsure of the polarity of the external supply. In either case, a negative-ground supply should be present after rectification.

Electrolytic capacitor *C1* acts to remove the ripple (buzz) from the ac-powered battery eliminator. Both eliminators and scanners provide some filtering, but their small size only allows for small filter capacitors so hum or buzz is often a problem. Furthermore, a polarized capacitor across power supply leads is good practice even if the ac adaptor is not used.

After filtering, power enters the scanner via *P1*, acting as a battery eliminator. Simultaneously, power is applied across the poles of the NiCad batteries via *P2*, acting as a charger. The charge rate is limited by resistor *R1*, which can be altered to suit the users needs and the charge-current demand of the NiCads. In the event of a power failure or removal of the external supply, power from the batteries is allowed to pass back through diode *D2* and operate the scanner (and any accessory plugged into *P3*, mentioned later) without interruption of service. Diode *D1* also prevents back drainage through the external supply.

As an option, subminiature plug *P3* can be added across the leads of *C1* (observing polarity) to power other outboard accessories, such as tone-activated relays or the plug-in descrambler module made by Paralin, 2511 E. 25th St., Tulsa, OK 74114. (This module is made especially for pocket scanners.) Since accessories connected through *P3* use the scanner's batteries, descramblers or other devices may be used with the same portability as the pocket scanner. For neatness and physical protection, the completed and tested assembly can be cast in a mold of epoxy or polyester resin, available at most hobby shops. The resin can be molded and dyed black to match the color and contour of the scanner. ◇

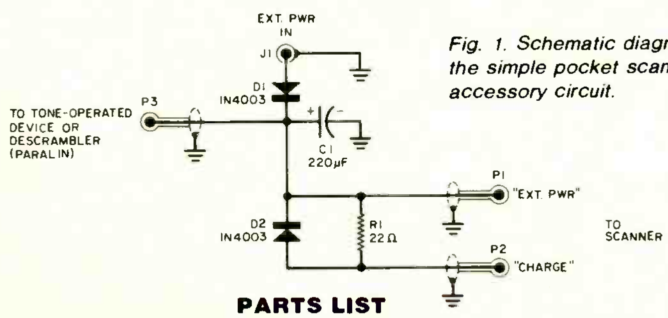


Fig. 1. Schematic diagram of the simple pocket scanner accessory circuit.

PARTS LIST

C1—220-µF electrolytic
D1,D2—Diode (1N4003)
J1—Submini jack (see text)
P1—Mini plug (see text)
P2,P3—Submini plug (see text)
R1—22-Ω, 1/2-W resistor

Circuit Analysis with your TRS-80 Computer

Here are five programs to simplify electronic design work.

BY ROY BABYLON

AC Formulas

1.

THE first program in this group deals with six areas of general interest in ac circuit design. The first three have to do with the relationship among peak voltage, instantaneous voltage, and the angle of the sine wave. The next two involve the relationship between frequency and wavelength. Anyone working with tuned circuits or antennas will find these sections useful. A unique feature of the program is that it gives answers in both feet and meters. This part is also helpful in converting scope readings. Normally measured in time (period), these readings are converted into the more familiar and useful frequency equivalents. The final part of the program handles conversion between the various relationships of rms, peak, peak-to-peak, and average amplitude values.

The program was converted from a Level I to a Level II format (which explains its layout), and it is directly compatible with either one. The main difference between the two formats is that Level II has subroutines such as square root, angle functions, etc., built in. This is why all the subroutines were placed at the end of the program. For a Level I machine, enter the program as written. It must be modified accordingly for a Level II machine. ◇

```
3 CLS
20  PRINTTAB(15);"VARIOUS A C  FORMULAS":PRINT
35 PRINT "ENTER NUMBER NEXT TO UNKNOWN:":PRINT
40 PRINT "PEAK VOLTS=1",,"PERIOD-FREQUENCY=4"
41 PRINT "INSTANTANEOUS VOLTAGE=2","WAVELENGTH (METERS OR FEET)=5"
43 PRINT "ANGLE POINT ON WAVE=3","RMS-PEAK-AVERAGE CONVERSIONS=6":PRINT
50  INPUT"REQUESTED FORMULA IS ";U
60   IF U=1 GOTO90
65   IF U=2 GOTO140
70   IF U=3 GOTO410
75   IF U=4 GOTO460
80   IF U=5 GOTO560
85    IF U=6 GOTO190
90  INPUT"ENTER INSTANTANEOUS VOLTAGE";I
100 INPUT"ENTER ANGLE IN DEGREES";X
110  GOSUB 30376
120 PRINT"PEAK VOLTAGE EQUALS ";I/V;"VOLTS"
130  END
140 INPUT"ENTER PEAK VOLTAGE IN VOLTS";E
150 INPUT"ENTER ANGLE IN DEGREES";X
160  GOSUB30376
170 PRINT"THE INSTANTANEOUS VOLTAGE IS";E*V;"VOLTS"
180 END
190 PRINT"ENTER THE NUMBER NEXT TO THE KNOWN VOLTAGE"
200 PRINT"RMS (EFFECTIVE) VOLTAGE 1"
210 PRINT"PEAK VOLTAGE            2"
220 PRINT"AVERAGE VOLTAGE         3"
230 INPUT"THE KNOWN VOLTAGE IS";U
240 IF U=1 GOTO270
250 IF U=2 GOTO310
260 IF U=3 GOTO360
270 INPUT"ENTER THE RMS VOLTAGE";X
280 PRINT"THE PEAK TO PEAK VOLTAGE IS";2.828*X;"VOLTS"
290 PRINT"THE PEAK VOLTAGE IS";1.414*X;"VOLTS"
300 PRINT"THE AVERAGE VOLTAGE IS";.9*X;"VOLTS"
305 END
310 INPUT"ENTER PEAK VOLTS";P
320 PRINT"THE PEAK TO PEAK VOLTAGE IS";2*P;"VOLTS"
330 PRINT"THE RMS VOLTAGE IS";.707*P;"VOLTS"
340 PRINT"THE AVERAGE VALUE IS";.636*P;"VOLTS"
345 END
360 INPUT"ENTER AVERAGE VOLTAGE";A
370 PRINT"THE PEAK VOLTAGE IS";1.57*A;"VOLTS"
380 PRINT"THE PEAK TO PEAK VOLTAGE IS";3.14*A;"VOLTS"
390 PRINT"THE RMS VOLTAGE IS";1.11*A;"VOLTS"
400 END
410 INPUT"ENTER PEAK VOLTAGE";P
420 INPUT"ENTER INSTANTANEOUS VOLTAGE";I
430  S=I/P
435  GOSUB 30550
440 PRINT"THE ANGLE ON THE SINE WAVE IS";V;"DEGREES"
442 END
444 INPUT"ENTER PEAK VOLTAGE";P
445 INPUT"ENTER PHASE ANGLE IN DEGREES";X
446  GOSUB 30376
448 PRINT"THE INSTANTANEOUS VOLTAGE IS";P*V;"VOLTS"
```

```
450 END
460 PRINT" PERIOD=1 , FREQUENCY=2 "
470 INPUT"FORMULA DESIRED IS";X
480 IF X=1 GOTO 500
490 IF X=2 GOTO 530
500 INPUT"ENTER FREQUENCY IN HERTZ";F
510 PRINT"THE PERIOD OF";F,"HERTZ IS";1/F;"SECONDS"
520 END
530  INPUT"ENTER PERIOD IN SECONDS";T
540 PRINT"THE FREQUENCY IS";1/T;"HERTZ"
550 END
560 PRINT" WAVELENGTH=1 , FREQUENCY=2 "
570 INPUT"DESIRED FUNCTION ?";X
580 IF X=1 GOTO 600
590 IF X=2 GOTO 650
600 INPUT"ENTER F IN HERTZ";F
610  V=3E8/F
620   X=984E8/F
630 PRINT"THE WAVELENGTH(LAMBDA)IS EQUAL TO";V;"METERS OR";X;"FEET"
640 END
650 INPUT"ENTER WAVELENGTH";W
660 INPUT" METERS=1 , FEET=2 ";C
670 IF C=1 GOTO 690
680 IF C=2 GOTO 700
690 PRINT"FREQUENCY=";3E8/W;"HERTZ"
695 END
700 PRINT"THE FREQUENCY OF";W;"FEET IS";984E8/W;"HERTZ"
710 END
30376  Z=ABS(X)/X:X=Z*X
30380  IF X>360 THEN X=X/360 : X*(X-INT(X))*360
30390  IFX>90THENX=X/90:Y=INT(X):X=(X-Y)*90-ONYGOTO30410,30420,30430
30400  X=X/57.29578 :IF ABS(X)<2.48616E-4 Y=0:RETURN
30405  GOTO30440
30410  X=90-X : GOTO 30400
30420  X=-X : GOTO 30400
30430  X=X-90 : GOTO 30400
30440  Y=X-X*X*X/6+X*X*X*X*X/120-X*X*X*X*X*X*X/5040
30455  RETURN
30500  REM *ARCCOS* INPUT S, OUTPUT Y,W
30510  REM Y IS IN DEGREES, W IS IN RADIANS
30520  GOSUB 30550 : Y=90-Y : W= 1.570796-W : RETURN
30550  X=S : IF ABS(S)<=.707107 THEN 30610
30560  X=1-S*S : IF X<0 THEN PRINT S; "IS OUT OF RANGE" : STOP
30570  W=X/2 : Z=0
30580   Y=(X/W-W)/2 : IF (Y=0)+(Y=Z) THEN X=W : GOTO 30610
30600  W=W+Y : Z=Y : GOTO30580
30610  Y=X+X*X*X/6+X*X*X*X*X*.075+X*X*X*X*X*X*X*4.464286E-2
30620  W=Y+X*X*X*X*X*X*X*X*X*3.038194E-2
30625   IF ABS(S)>.707107 THEN W=1.570796E-2
30630  Y=W*57.29578 : RETURN
```

Impedance Matching

2.

THIS short program for the TRS-80 Level II was designed to furnish the proper values of resistors for an L-type impedance-matching network and also draws the circuit diagram and figures out the system loss in decibels.

The program is self-prompting and uses no subroutines. Lines 20 and 30 ask the designer for the two impedances to be matched. Lines 40 through 70 are the "working" lines and operate on the data supplied in lines 20 and 30. The working lines are self-explanatory. Lines 90 through 130 print component identification and values for the circuit drawn by lines 140 and 150. Line 140 draws all the horizontal lines, and line 150 takes care of the vertical. Line 160 is a simple clock, which keeps the drawing on the screen for a predetermined amount of time. With the value used, the drawing remains for about 35 seconds. (To increase this time, increase the value of "N.") After the clock in line 160 times out, the computer goes to line 170 which returns it to line 10 to await the next problem. ◇

```
10 CLS
15 PRINTTAB(15)"L TYPE IMPEDANCE MATCHING NETWORK"
20 INPUT"ENTER INPUT IMPEDANCE";Z1
30 INPUT"ENTER OUTPUT IMPEDANCE";Z2
40 R1=Z1*SQR(1-(Z2/Z1))
50 R2=Z2/SQR(1-(Z2/Z1))
60 M=SQR(Z1/Z2)+SQR((Z1/Z2)-1)
70 L=20*(LOG(M)/LOG(10))
80 CLS
90 PRINT@520,"Z IN >>>"
100 PRINT@205,"R1=";R1,"OHMS"
110 PRINT@560,"Z OUT <<<"
120 PRINT@920,"LOSS IN DBS IS";L
130 PRINT@595,"R2=";R2;"OHMS"
140 Y=15:FORX=10TO30:SET(X,Y):NEXTX:Y=12:FORX=30TO58:SET(X,Y):NEXTX:Y=18:FORX=30TO58:SET(X,Y):NEXTX:Y=15:FORX=58TO100:SET(X,Y):NEXTX
 :Y=21:FORX=74TO87:SET(X,Y):NEXTX:Y=32:FORX=74TO87:SET(X,Y):NEXTX:Y=36:FORX=10TO100:SET(X,Y):NEXTX:
150 X=30:FORY=12TO18:SET(X,Y):NEXTY:X=58:FORY=12TO18:SET(X,Y):NEXTY:X=80:FORY=15TO21:SET(X,Y):NEXTY:X=74:FORY=21TO32:SET(X,Y):NEXTY:
X=87:FORY=21TO32:SET(X,Y):NEXTY:X=80:FORY=32TO36:SET(X,Y):NEXTY:
160 FORN=1TO10000:NEXTN
170 GOTO 10
```

Capacitance Networks

HERE is a Level II program covering eight different areas in the design of capacitance networks. The first three areas are of primary interest to students taking a course in electronics and will probably be of little use to experimenters. The other five areas, however, will be useful for both groups.

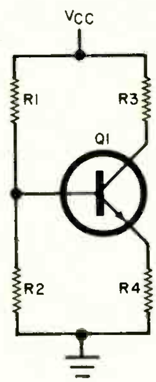
The program is self-explanatory and self-prompting when run. One unique feature of the program (section 8) allows you to change the total capacitance of a network by a specific amount. This section of the program not only tells you what value to add, but also tells whether to put the added capacitance in series or parallel. ◇

```
10 CLS
20 PRINTTAB(15)"VARIOUS CAPACITIVE FORMULAE"
30 PRINT"CHARGE ON A CAPACITOR                          #1"
40 PRINT"VALUE OF A CAPACITOR (PHYSICAL FACTORS)        #2"
50 PRINT"ENERGY IN AN ELECTROSTATIC FIELD               #3"
60 PRINT"RESISTOR & CAPACITOR TIME CONSTANTS            #4"
70 PRINT"SERIES & PARALLEL REACTANCES                   #5"
80 PRINT"CAPACITIVE REACTANCE                           #6"
90 PRINT"IMPEDANCE                                      #7"
100 PRINT"SERIES/PARALLEL CAPACITORS                    #8"
120 INPUT U
130 ON U GOTO 135,290,335,375,515,565,605,645
135 CLS
140 INPUT"ENTER UNKNOWN Q=1 , C=2 , E=3";X
150 ON X GOTO 160,210,250
160 INPUT"ENTER CAPACITOR VALUE IN U-FARADS";C
170 INPUT"ENTER VOLTAGE";V
180 PRINT"THE CHARGE IS";(C*V)/(1E6);"COULOMBS OF ELECTRONS "
190 END
210 INPUT"ENTER VOLTAGE",V
220 INPUT"ENTER CHARGE IN COULOMBS";Q
230 PRINT"THE CAPACITANCE IS";(Q/V)*(1E6),"MICROFARADS"
240 END
250 INPUT"ENTER CAPACITANCE IN U-FARADS",C
260 INPUT"ENTER CHARGE (Q) IN COULOMBS";Q
270 PRINT"THE VOLTAGE IS";(Q/C)*1E6,"VOLTS"
280 END
290 INPUT"ENTER AREA OF PLATES IN SQ  METERS";A
300 INPUT"ENTER DISTANCE BETWEEN PLATES IN METERS";D
310 INPUT"ENTER DIELECTRIC CONSTANT (FROM TABLE)",K
320 PRINT"THE CAPACITOR VALUE IS";K*(A/D)*8.85;"U-U FARADS"
330 END
335 CLS
340 INPUT"ENTER THE VOLTAGE VALUE";V
350 INPUT"ENTER CAPACITOR VALUE IN U-FARADS";C
360 PRINT"THE ENERGY IN THE ELECTROSTATIC FIELD IS":1/(2*C)*(V[2)*(1E6),"JOULES"
370 END
375 CLS
380 INPUT"ENTER UNKNOWN , TIME=1 , RESISTOR=2 , CAPACITOR=3";X
390 ON X GOTO 400,440,480
400 INPUT"ENTER RESISTOR VALUE IN OHMS";R
410 INPUT"ENTER CAPACITOR VALUE IN U-FARADS";C
420 PRINT"THE TIME CONSTANT IS";R*C*1E-6,"SECONDS"
430 END
435 CLS
440 INPUT"ENTER TIME IN SECONDS";T
450 INPUT"ENTER CAPACITOR IN U-FARADS";C
460 PRINT"THE RESISTOR VALUE IS";T/C*1E6,"OHMS"
470 END
475 CLS
480 INPUT"ENTER TIME IN SECONDS";T
490 INPUT"ENTER RESISTANCE IN OHMS";R
500 PRINT"THE CAPACITOR VALUE IS";T/R*1E6,"U-FARADS"
510 END
515 CLS
520 INPUT"ENTER CAPACITIVE REACTANCE (XC1)";A
530 INPUT"ENTER (XC2)";B
540 PRINT"THE SERIES REACTANCE IS",A+B;"OHMS CAPACITIVE"
550 PRINT"THE PARALLEL REACTANCE IS";(A*B)/(A+B);"OHMS"
560 END
565 CLS
570 INPUT"ENTER CAPACITOR VALUE IN U-FARADS";C
580 INPUT"ENTER FREQUENCY IN HERTZ";F
590 PRINT"THE REACTANCE IS",(1/(6.28*F*C*1E-6)),"OHMS OF XC"
600 END
605 CLS
610 INPUT"ENTER REACTANCE (XC) IN OHMS";B
620 INPUT"ENTER RESISTANCE IN OHMS";R
630 PRINT"IMPEDANCE (Z) EQUALS";SQR((B[2)+(R[2));"OHMS"
640 END
645 CLS
650 INPUT"ENTER 1 FOR TOTAL VALUE , 2 FOR CHANGING TOTAL VALUE";Q
660 ON Q GOTO 670,840
665 CLS
670 INPUT"ENTER NUMBER OF CAPACITORS USED,    2 , 3 , OR 4";X
680 ON X GOTO,685,725,775
685 CLS
690 INPUT"ENTER VALUE OF C1";A
700 INPUT"ENTER VALUE OF C2";B
710 PRINT"THE SERIES VALUE IS";(A*B)/(A+B);"AND THE PARALLEL VALUE IS",A+B,"U-FARADS"
720 END
725 CLS
730 INPUT"ENTER VALUE OF C1";A
740 INPUT"ENTER VALUE OF C2";B
750 INPUT"ENTER VALUE OF C3",C
760 PRINT"THE SERIES VALUE IS";1/(1/A+1/B+1/C);"AND THE PARALLEL VALUE IS";A+B+C;"U-FARADS"
770 END
775 CLS
780 INPUT"ENTER VALUE OF C1",A
790 INPUT"ENTER VALUE OF C2";B
800 INPUT"ENTER VALUE OF C3";C
810 INPUT"ENTER VALUE OF C4";D
820 PRINT"THE SERIES VALUE IS";1/(1/A+1/B+1/C+1/D);"AND THE PARALLEL VALUE IS";A+B+C+D;"U-FARADS"
830 END
835 CLS
840 INPUT"ENTER PRESENT TOTAL VALUE OF CAPACITANCE";T
850 INPUT"ENTER DESIRED VALUE";D
860 IF T>D GOTO 870 ELSE 880
870 PRINT"TO OBTAIN";D;"AS A FINAL VALUE , ADD";((T*D)/(T-D));"IN SERIES WITH  YOUR PRESENT CIRCUIT"
875 END
880 PRINT"TO OBTAIN";D;"AS A FINAL VALUE  ADD";D-T;"IN PARALLEL WITH YOUR PRESENT CIRCUIT."
890 END
```

Common-Emitter Amp Design

4.

IF YOU are designing a common-emitter amplifier such as that shown in the diagram and have only minimum information about the transistor, this is a useful program to have. The only data needed is the maximum collector current, maximum collector voltage, beta, and type of transistor (silicon or germanium). The layout of the program is straightforward and it is self-prompting when run.



Lines 30 through 70 ask for information needed for the calculations in lines 80 through 140. Lines 150 through 190 print out the results of the calculations and label what they are. These values are the "ideal" and it is up to the designer to pick the closest standard values available.

The remainder of the program draws a schematic of the circuit and labels all parts values. Line 200 begins by asking if a schematic is necessary. If not, the program jumps to line 220 which ends it. If a schematic is desired, the program jumps to line 230, which begins the graphics by clearing the screen and then printing the parts values and labels. Lines 250 through 310 draw the rest of the schematic.

Line 320 is a simple clock. With the value of "N" used, the graphics remain on the screen for about 20 seconds. To increase this time, make "N" a larger number. After the clock times out, the screen is cleared and the program is sent back to line 20 to await the next problem. ◇

```
20 PRINT"COMMON EMITTER AMPLIFIER"
30 INPUT"ENTER MAX. COLLECTOR CURRENT";A
40 INPUT"ENTER BETA";B
50 INPUT"ENTER VCC VOLTAGE";C
60 INPUT"ENTER TYPE: SILICON=1 , GERMANIUM=2";D
70 INPUT"ENTER LOWEST FREQUENCY TO BE AMPLIFIED";K
80 E=.5*A'IC
90 F=.45*C'VC
100 G=.1*C'VE
110 I=E/B'IB
120 IF D=1 H=G+.6 ELSE H=G+.3'VB
130 J=(C-F)/I 'R1
140 L=.1*(G/E):M=(1/(6.28*K*L))*1E6
150 PRINT"R1=";J;"OHMS"
160 PRINT"R2=";(G/C)*J;"OHMS"
170 PRINT"R3=";(C-F)/E;"OHMS
180 PRINT"R4=";G/E;"OHMS"
190 PRINT"CI=";M;"MICRO FARADS"
200 INPUT"IS A SCHEMATIC DESIRED ? YES=1 , NO=2";R
210 IF R=1 GOTO230ELSE 220
220 END
230 CLS
240 PRINT@204,"R1":PRINT@218,"R3":PRINT@19,"VCC":PRINT@349,"C":PRINT@469,"B":PRINT@540,"E":PRINT@716,"R2":PRINT@730,"R4":PRINT@743,"
C1 =":PRINT@914,"GROUND":PRINT@192,;J;:PRINT@210,;(C-F)/E;:PRINT@705,;.25*J;:PRINT@723,;G/E;:PRINT@747,;M;" MICRO FARADS"
250 X=40:FORY=17TO26:SET(X,Y):NEXTY:
260 X=40:Y=20:SET(X,Y):X=40:Y=20:FORN=1TO10:SET(X,Y):X=X+1.5:Y=Y-.5:NEXTN:X=53:FORY=14TO16:SET(X,Y):NEXTY:X=53:FORY=28TO30:SET(X,Y):
NEXTY:X=40:Y=24:SET(X,Y):X=40:Y=24:FORN=1TO10:SET(X,Y):X=X+1.5:Y=Y+.5:NEXTN:
270 Y=4:FORX=26TO53:SET(X,Y):NEXTX:Y=6:FORX=22TO30:SET(X,Y):NEXTX:Y=6:FORX=49TO57:SET(X,Y):NEXTX:Y=14:FORX=22TO30:SET(X,Y):NEXTX:Y=1
4:FORX=49TO57:SET(X,Y):NEXTX:Y=22:FORX=26TO40:SET(X,Y):NEXTX:Y=30:FORX=22TO30:SET(X,Y):NEXTX:
280 Y=30:FORX=49TO57:SET(X,Y):NEXTX:Y=28:FORX=53TO69:SET(X,Y):NEXTX:Y=33:FORX=64TO74:SET(X,Y):NEXTX:Y=35:FORX=64TO74:SET(X,Y):NEXTX:
Y=30:FORX=49TO57:SET(X,Y):NEXTX:Y=38:FORX=22TO30:SET(X,Y):NEXTX:Y=38:FORX=49TO57:SET(X,Y):NEXTX:
290 Y=40:FORX=26TO69:SET(X,Y):NEXTX:Y=6:FORX=22TO30:SET(X,Y):NEXTX:Y=6:FORX=49TO57:SET(X,Y):NEXTX:X=39:FORY=3TO4:SET(X,Y):NEXTY:X=22
:FORY=6TO14:SET(X,Y):NEXTY:X=26:FORY=4TO6:SET(X,Y):NEXTY:X=26:FORY=14TO30:SET(X,Y):NEXTY:
300 X=26:FORY=38TO40:SET(X,Y):NEXTY:X=49:FORY=6TO14:SET(X,Y):NEXTY:X=49:FORY=30TO38:SET(X,Y):NEXTY:X=53:FORY=4TO6:SET(X,Y):NEXTY:X=5
3:FORY=38TO40:SET(X,Y):NEXTY:X=57:FORY=6TO14:SET(X,Y):NEXTY:X=57:FORY=30TO38:SET(X,Y):NEXTY:
310 X=69:FORY=28TO33:SET(X,Y):NEXTY:X=69:FORY=35TO40:SET(X,Y):NEXTY:X=40:FORY=40TO42:SET(X,Y):NEXTY:X=30:FORY=6TO14:SET(X,Y):NEXTY:X
=22:FORY=30TO38:SET(X,Y):NEXTY:X=30:FORY=30TO38:SET(X,Y):NEXTY:
320 FORN=1TO10000:NEXTN:CLS
330 GOTO20
```

Voltage-Regulator Design

5.

THIS final program can be used in the design of three different types of zener-diode voltage-regulator circuits. It was designed and tested with TRS-80 Level II, but is directly compatible with TRS-80 Level I.

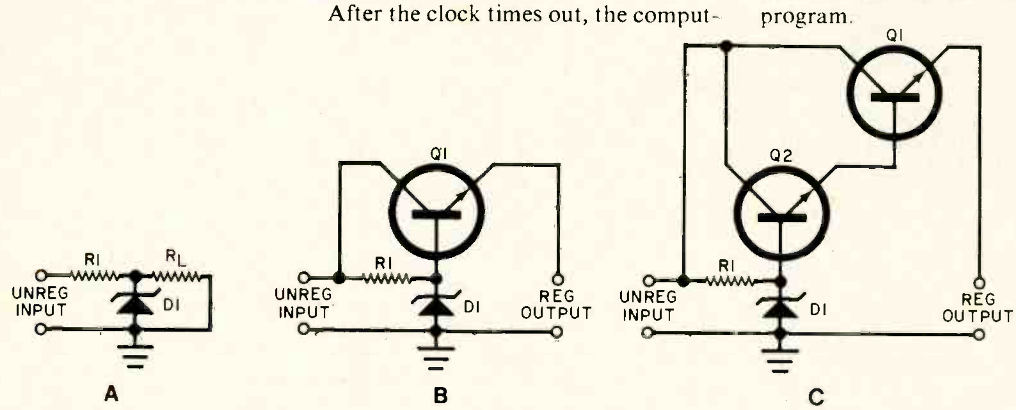
The program is applicable to all three of the circuits shown in the diagram. Lines 30 through 70 ask for information common to all three. Lines 100 through 110 are used only in the first circuit. (We really don't care about the diode's impedance in the other circuits since it isn't seen by the load.)

Line 120 asks which circuit is of interest and lines 130 to 150 branch to the respective graphic "subroutines," which draw the circuits. Lines 860, 1060, and 1250 are simple timing clocks to hold the schematic of the regulator on the screen for a specified amount of time. With the value shown, the display remains for about 20 seconds.

After the clock times out, the computer goes to the next line which directs the computer to the proper line number for the start of that particular part of the program. The first few lines of each individual circuit program query the designer for any additional data that is needed. Following these query lines are a number of data-operation or formula lines.

Following these calculations, the computer prints the results. Unfortunately these results are "ideal" values, and it is up to the designer to pick the nearest standard value. Another set of values is calculated with a 50% safety factor.

One change you may want to make in the program is in lines 60 and 70. Instead of entering power in these two lines, you may want to enter the maximum and minimum current. By doing this, you can eliminate lines 80 and 90. (However, use "J" as the variable in line 60 and "K" in line 70 so that you don't have to rewrite these factors in the remainder of the program. ◇



The program here is applicable to any one of these circuits.

```
10 CLS
20 PRINT@16,"VOLTAGE REGULATOR CIRCUITS"
30 INPUT"ENTER REGULATED OUTPUT VOLTAGE DESIRED";A
40 INPUT"ENTER MINIMUM VOLTAGE FROM POWER SUPPLY FILTER";B
50 INPUT"ENTER MAXIMUM VOLTAGE FROM POWER SUPPLY FILTER";C
60 INPUT"ENTER MAXIMUM POWER OF LOAD";D
70 INPUT"ENTER MINIMUM POWER OF LOAD";E
80 J=D/A
90 K=E/A
100 L=A/.1*J
110 F=A/.1*K
120 INPUT"ENTER CIRCUIT DESIRED 1 , 2 OR 3";M
130 IF M=1 THEN 720
140 IF M=2 THEN 880
150 IF M=3 THEN 1080
160 CLS
170 PRINT"THE CIRCUIT YOU HAVE PICKED WILL REQUIRE ONE ZENER DIODE AND ONE SERIES RESISTOR. REFER TO CIRCUIT #1."
180 G=(C-A)/(1.1*J)
190 I=(C-A)*(1.1*J)
200 H=A*(J-K)
210 PRINT"CALCULATED VALUE OF R1 IS";G;"OHMS (PICK NEXT STANDARD LOWER VALUE)"
220 PRINT"CALC. WATTAGE OF R1 IS";I;"WATTS"
230 PRINT"CALC. VALUE OF D1 IS";A;"VOLTS @";H;"WATTS"
240 PRINT"MAX. LOAD CURRENT IS";J;"AMPS."
250 PRINT"MIN. LOAD CURRENT IS";K;"AMPS."
260 PRINT"MIN. DIODE IMPEDANCE IS";F;"OHMS"
270 PRINT"MAX. DIODE IMPEDANCE IS";F;"OHMS"
275 PRINT"      <>        <>        <>        <>   "
280 PRINT"FOR A SAFETY FACTOR OF 50%:"
290 PRINT"R1 SHOULD EQUAL ";G;"OHMS AT";1.5*I;"WATTS"
300 PRINT"ZENER DIODE D1 SHOULD EQUAL";A;"VOLTS AT";1.5*H;"WATTS"
310 END
320 PRINT"THE CIRCUIT YOU HAVE CHOSEN WILL REQUIRE 1 ZENER DIODE, 1 SERIES RESISTOR , AND 1 TRANSISTOR. REFER TO CIRCUIT #2."
330 INPUT"ENTER BETA OF Q1";N
340 INPUT"ENTER IF Q1 IS SILICON=1, GERMANIUM=2";L
350 I=J/N
360 IF L=1 THEN H=A+.6 ELSE H=A+.3
```

```
370 G=(B-H)/I
380 O=(B-H)*I[2
390 P=(C-H)/G
400 Q=H*P
410 R=C-A
420 S=J*R
421 PRINT"RESISTOR R1 CALCULATES TO";G;"OHMS (PICK NEXT LOWEST STANDARD VALUE),AT";O;"WATTS"
422 PRINT"ZENER DIODE D1 CALCULATES TO";H;"VOLTS AT";Q;"WATTS"
423 PRINT"TRANSISTOR Q1 CALCULATES TO";R;"VOLTS (VCE),AT";S;"WATTS"
430 PRINT"  <>          <>          <>     "
440 PRINT"FOR A SAFETY FACTOR OF 50%:"
450 PRINT"R1 SHOULD BE";1.5*O;"WATTS ~ ";G;"OHMS"
460 PRINT"ZENER D1 SHOULD BE";1.5*Q;"WATTS @ ";H;"VOLTS"
470 PRINT"Q1 SHOULD BE";1.5*S;"WATTS @ ";1.5*R;"VOLTS"
480 END
490 CLS
500 PRINT"THE CIRCUIT YOU HAVE CHOSEN WILL REQUIRE 1 ZENER DIODE , 1 RESISTOR , AND TWO TRANSISTORS. REFER TO CIRCUIT # 3"
510 INPUT"ENTER THE BETA OF Q1";N
520 INPUT"ENTER THE BETA OF Q2";T
530 INPUT"ENTER IF Q1 & Q2 ARE SILICON=1 , GERMANIUM=2";L
540 IF L=1 H=A+1.2 ELSE H=A+.6
550 U=N*T
560 I=J/N
570 V=C-A
580 S=I/T
590 G=(C-H)/S
600 W=(C-H)/G
610 Q=H*W
620 O=(C-H)*I[2
630 P=C-A
640 R=(C-A)*J
650 X=(C-A)*I
661 PRINT"THE CALC. VALUE OF R1 IS";G;"OHMS (PICK THE NEXT STANDARD LOWER VALUE)"
662 PRINT"THE CALC. POWER OF R1 IS";O;"WATTS"
663 PRINT"THE CALC. VALUE OF D1 IS";H;"VOLTS @";Q;"WATTS"
664 PRINT"THE CALC. VALUE OF Q1 IS";R;"WATTS @ A VCE OF";P;"VOLTS"
665 PRINT"THE CALC. VALUE OF Q2 IS";X;"WATTS @ A VCE OF";(C-A);"VOLTS"
667 PRINT"   <>          <>          <>          <>     "
668 PRINT"FOR A SAFETY FACTOR OF 50%:"
670 PRINT"R1 SHOULD BE";1.5*O;"WATTS @ ";G;"OHMS"
680 PRINT"Z1 SHOULD BE";1.5*Q;"WATTS @ ";H;"VOLTS"
690 PRINT"Q1 SHOULD BE";1.5*R;"WATTS @ A VCE OF";1.5*P;"VOLTS"
700 PRINT"Q2 SHOULD BE";1.5*X;"WATTS @ A VCE OF";1.5*(C-A);"VOLTS"
710 END
720 CLS
730 PRINT@135,"RESISTOR"
740 PRINT@12,"COPY THIS CIRCUIT DOWN"
750 PRINT@67,"R1"
760 PRINT@454,"ZENER DIODE D1"
770 PRINT@490,"LOAD"
780 PRINT@320,"UNREGULATED INPUT VOLTAGE"
790 PRINT@499,"REGULATED"
800 PRINT@564,"OUTPUT"
810 Y=7:FORX=6TO12:SET(X,Y):NEXTX:Y=5:FORX=12TO32:SET(X,Y):NEXTX:Y=9:FORX=12TO32:SET(X,Y):NEXTX:Y=7:FORX=32TO88:SET(X,Y):NEXTX:Y=37:
FORX=7TO88:SET(X,Y):NEXTX:Y=32:FORX=80TO98:SET(X,Y):NEXTX:Y=15:FORX=80TO98:SET(X,Y):NEXTX:
820 Y=26:FORX=44TO64:SET(X,Y):NEXTX:Y=21:FORX=44TO64:SET(X,Y):NEXTX:
830 X=12:FORY=5TO9:SET(X,Y):NEXTY:X=32:FORY=5TO9:SET(X,Y):NEXTY:X=88:FORY=7TO15:SET(X,Y):NEXTY:X=80:FORY=15TO32:SET(X,Y):NEXTY:X=54:
FORY=7TO20:SET(X,Y):NEXTY:X=54:FORY=26TO37:SET(X,Y):NEXTY:X=98:FORY=15TO32:SET(X,Y):NEXTY:
840 X=43:FORY=21TO26:SET(X,Y):NEXTY:X=88:FORY=33TO37:SET(X,Y):NEXTY:X=64:FORY=21TO26:SET(X,Y):NEXTY:
850 PRINT@826,"CRKT#1"
860 FORN=1TO10000;NEXTN
870 GOTO160
880 CLS
885 PRINT @ 12, "COPY THIS CIRCUIT DOWN"
890 PRINT@80,"TRANSISTOR Q1"
900 PRINT@390,"RESISTOR R1"
910 PRINT@462,"ZENER D1"
920 PRINT@200,"COLLECTOR"
930 PRINT@285,"BASE"
940 PRINT@226,"EMITTER"
950 PRINT@512,"UNREGULATED INPUT"
960 PRINT@542,"REGULATED OUTPUT VOLTAGE"
970 Y=8:FORX=6TO35:SET(X,Y):NEXTX:Y=6:FORX=35TO65:SET(X,Y):NEXTX:Y=10:FORX=35TO65:SET(X,Y):NEXTX:Y=8:FORX=65TO88:SET(X,Y):NEXTX:Y=15
:FORX=10TO16:SET(X,Y):NEXTX:
980 Y=32:FORX=6TO88:SET(X,Y):NEXTX:X=35:FORY=6TO10:SET(X,Y):NEXTY:X=65:FORY=6TO10:SET(X,Y):NEXTY:X=10:FORY=8TO15:SET(X,Y):NEXTY:X=16
:FORY=13TO17:SET(X,Y):NEXTY:X=32:FORY=13TO17:SET(X,Y):NEXTY:
990 X=50:FORY=10TO18:SET(X,Y):NEXTY:X=46:FORY=18TO26:SET(X,Y):NEXTY:X=55:FORY=18TO26:SET(X,Y):NEXTY:X=50:FORY=26TO32:SET(X,Y):NEXTY:
1000 Y=13:FORX=16TO31:SET(X,Y):NEXTX:
1010 Y=17:FORX=16TO31:SET(X,Y):NEXTX:
1020 Y=18:FORX=46TO55:SET(X,Y):NEXTX:
1030 Y=26:FORX=47TO55:SET(X,Y):NEXTX:
1040 Y=15:FORX=32TO50:SET(X,Y):NEXTX:
1050 PRINT@824,"CRKT#2"
1060 FORN=1TO10000:NEXTN:
1065 CLS
1070 GOTO320
1080 CLS
1085 PRINT @ 5, "COPY THIS CIRCUIT DOWN"
1090 PRINT@396,"R1"
1100 PRINT@620,"REGULATED OUTPUT"
1110 PRINT@36,"TRANSISTOR Q1"
1120 PRINT@640,"UNREGULATED INPUT"
1130 PRINT@180,"EMITTER"
1140 PRINT@222,"Q2"
1150 PRINT@237,"BASE"
1160 PRINT@279,"C"
1170 PRINT@416,"BASE"
1180 PRINT@590,"ZENER DIODE D1"
1190 Y=5:FORX=6TO72:SET(X,Y):NEXTX:Y=3:FORX=73TO100:SET(X,Y):NEXTX:Y=5:FORX=101TO111:SET(X,Y):NEXTX:Y=7:FORX=73TO100:SET(X,Y):NEXTX:
Y=20:FORX=29TO47:SET(X,Y):NEXTX:Y=24:FORX=29TO47:SET(X,Y):NEXTX:Y=17:FORX=50TO75:SET(X,Y):NEXTX:Y=22:FORX=20TO27:SET(X,Y):NEXTX:
1200 Y=13:FORX=50TO75:SET(X,Y):NEXTX:Y=15:FORX=76TO87:SET(X,Y):NEXTX:Y=15:FORX=40TO49:SET(X,Y):NEXTX:Y=26:FORX=58TO67:SET(X,Y):NEXTX
:Y=34:FORX=58TO67:SET(X,Y):NEXTX:Y=40:FORX=6TO111:SET(X,Y):NEXTX:Y=22:FORX=20TO28:SET(X,Y):NEXTX:
1210 X=20:FORY=5TO22:SET(X,Y):NEXTY:X=29:FORY=20TO24:SET(X,Y):NEXTY:X=40:FORY=6TO15:SET(X,Y):NEXTY:X=47:FORY=20TO24:SET(X,Y):NEXTY:X
=50:FORY=13TO17:SET(X,Y):NEXTY:X=58:FORY=26TO34:SET(X,Y):NEXTY:X=67:FORY=26TO34:SET(X,Y):NEXTY:
1220 X=62:FORY=18TO25:SET(X,Y):NEXTY:X=75:FORY=13TO17:SET(X,Y):NEXTY:X=87:FORY=8TO15:SET(X,Y):NEXTY:X=73:FORY=3TO7:SET(X,Y):NEXTY:X=
100:FORY=3TO7:SET(X,Y):NEXTY:
1230 Y=22:FORX=48TO62:SET(X,Y):NEXTX:X=62:FORY=35TO40:SET(X,Y):NEXTY:
1240 PRINT@930,"CRKT#3"
1250 FORN=1TO10000:NEXTN:
1260 GOTO490
```

Popular Electronics Tests

BBC-Metrawatt/Goerz Model MA 3D Digital Multimeter

THE BBC-Metrawatt/Goerz Model MA 3D Digital Multimeter is a general-purpose 3½-digit LCD multimeter of unique physical design—it folds down on itself to protect its display and switches. When closed, it looks like a transistor radio in a black plastic case, with very little indication that it is a DMM.

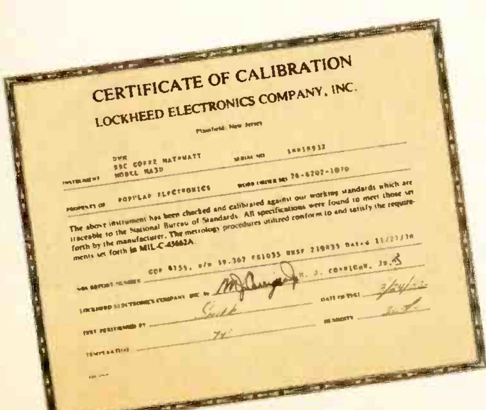
When the case is open, the "cover" exposes a 3 ½-digit, 0.72" high, seven-segment, high-contrast LCD readout, with only a function rotary switch and a power on-off switch on the other half. The LCD display cover can be positioned at any of 8 selectable (detent) angles from closed to flat open. Thus, there is no need for a tilt stand since the display can be positioned as desired. The color-coded test leads are plugged into submerged safety connectors on one side as is the external power connector.

The protective safety leads and connectors comply with the safety rules set down by VDE 0411/DIN 57 411, assuring safety fo the instrument and the user.

The power switch is automatically placed in the off position when the case is closed, while a carrying strap enables the meter to be slung from the neck, leaving the hands free to use the test leads.

The 25 ranges include five each for ac and dc voltages from 200 mV to 650 volts full scale, five each for ac and dc current from 2 mA to 10 A full scale, and five for resistance measurement from 2 kilohms to 20 megohms full scale. Accuracy is ±0.25% on the dc ranges. (Complete specifications are shown in the accompanying Table).

The shock-resistant case is 5¾" wide, 4¾" deep, 2" thick (case closed), and it weighs slightly under one pound. Suggested retail price is $199.



CERTIFICATE OF CALIBRATION

LOCKHEED ELECTRONICS COMPANY, INC.

The above instrument has been checked and calibrated against our working standards which are traceable to the National Bureau of Standards. All specifications were found to meet those set forth by the manufacturer. The metrology procedures utilized conform to and satisfy the requirements set forth in MIL-C-45662A.

TECHNICAL SPECIFICATIONS BBC-METRAWATT/GOERZ DMM

AC/DC Voltage Ranges:
Accuracy: DC ±0.25% of rdg + 1 dig
AC ±0.75% of rdg + 2 dig
Input Resistance: 10 megohms, 40 pF
Resolution: 0.1 mV on 200 mV
1 mV on 2 V
10 mV on 20 V
100 mV on 200 V
1 V on 650 V
Overload Protection: 250 V on 200 mV
780 V on 2 to 650 V

AC/DC Current Ranges:
Accuracy: DC ±1% of rdg + 1 dig
AC ±1.5% of rdg + 2 dig
Resolution: 1 μA on 2 mA
10 μA on 20 mA
100 μA on 200 mA
1 mA on 2 A
Voltage Drop: 200 mV on 2 and 20 mA
240 mV on 200 mA
650 mV on 2 A
Overload Protection: 250 V

Resistance Ranges:
Accuracy: ±0.5% of rdg + 1 dig on
2, 20, 200 ±2% of rdg + 1 dig
on 2, 20 megohms
Resolution: 1 ohm on 2 kilohms
10 ohms on 20 kilohms
100 ohms on 200 kilohms
1 kilohm on 2 megohms
10 kilohm on 20 megohms
Full-Range Voltage: 0.5 V on 2 kilohms
0.78 V on 20 kilohms
0.83 V on others
Open-Circuit Voltage: 1.23 V
Overload Protection: 250 V

Frequency Range:
AC Voltage:
200 mV to 200 V:
30-400 Hz, ±1% of rdg + 4 dig
15 Hz-4 kHz, ±3% of rdg + 8 dig
650 V:
30-200 Hz, ±1% of rdg + 4 dig
15-600 Hz, ±3% of rdg + 8 dig
AC Current:
30-400 Hz, ±2% of rdg + 4 dig
15 Hz-4 kHz, ±3% of rdg + 8 dig

Display: 7-segment LCD, 18 mm 3½ dig
Full-Scale Value: 1999
Overrange: Left digit remains on
Polarity: No sign is positive.
Minus sign is negative.
Decimal Point: Automatic.

Power Supply: 9-V battery
Life: 100 hr with manganese-dioxide
200 hr with alkaline-manganese
Arrow appears if below limit.
Power Line: NA 2-9/20 adapter (7-13 V dc)

Case:
Class: II, VDE 0411/DIN 57 411
Type: IP50-DIN 40 050, IP20 at connectors
Dimensions: 146 × 118 × 44 mm
Weight: 0.45 kg less battery

General Description. The model MA 3D has only one operational control—an indented function/range switch used to select the desired function and any of its five ranges. Each function and its associated five ranges are clearly identified so that there is no possibility of error. The base section top cover carries the identification of the three input connectors (+, common, 10A) and the fuse data. The 9-volt transistor radio battery is concealed within the large "hinge" section with access via a snap on/off panel.

The meter is entirely black plastic with sharp white engraved identifications. The only touch of color is the bright red power on/off switch in the lower right corner. When the cover is swung to the closed position, this switch is mechanically coupled to a detent in the cover that automatically turns the power off.

User Comments. The Model MA 3D was checked by the Lockheed Instrumentation Measurement Laboratory (Plainfield, NJ) against standards traceable to the Nation Bureau of Standards, and the instrument was found to meet or exceed its claimed specifications in all respects.

We put the Model MA 3D to work on our bench, where it made a big hit due to its rather large (¾") high-contrast LCD readout and the tiltable cover that contains the display. Four small rubber "feet" make the instrument skid-proof on the benchtop.

By connecting the slender three-foot braided strap to its support pins on the case, and tilting the meter "face" at 90° to the instrument base, the instrument can be carried while keeping the display clearly visible. This leaves both hands free to manipulate the test leads. This is ideal for those who must make measurements when standing up or in cramped quarters.

We found the function/range switch easy to use, the legends clear and easy to read, and the LCD readout one of the best we have seen. We appreciate the thought given to the safety test leads, with their large protective rim to keep fingers from contacting the metal probe tips where dangerous voltages might exist. At the other end of the test leads, the covered ends fit into submerged connectors, removing these from any finger contact.

Besides being an excellent bench instrument, when closed the Model MA 3D easily fits within a pocket. (Its rounded edges avoid tearing of pocket linings.) We can highly recommend this uniquely packaged, modestly priced digital multimeter. *—Leslie Solomon*

CIRCLE NO. 104 ON FREE INFORMATION CARD

COMPUTER BITS

By Stan Veit
Computer Editor

News from the Computer Shows

SOME major computer shows are over, everybody has gone home, and it is time to evaluate the wonders exhibited there. Houston, Texas hosted the National Computer Conference (NCC) and it was a "Texas-size" event indeed with over 90,000 people attending. Atlantic City, NJ, the former home of the eastern computer shows returned as an exhibit site for COMDEX and attracted Independent Sales Organizations from all over the world. Both shows were a success as showcases for a new generation of small desktop and portable computers.

At the NCC, it seemed every manufacturer had a new personal computer. Similarly, companies that had previously produced only mainframe computers or large minis introduced microcomputers and those that had been in the personal-computer business were showing portable machines. Many of the new offerings were built around 8/16-bit processors or 16/32-bit processors. However, some of the large mainframe manufacturers showing personal computers gave the impression that they just had a toe in the water and they might not really produce the machines they were showing.

The 8086/8088 family from Intel and the M68000 family from Motorola have won the competition to become the dominant microprocessor chips of the eighties. This fact was obvious from the number of computers using one or the other of these sixteen-bit microprocessor chips. In spite of this, the Z80 has won a new lease on life because many of the new computers support the older processor as a "slave" or secondary processor. The TRS-80 Mod 16 is a typical example. It uses the 68000 as the main processor, but also has a Z80 to run the existing Mod II software. Even the IBM PC, which uses the 8088, operates with a plug-in Z80.

The "Battle of the Operating Systems" was not much in evidence at either NCC or COMDEX. CP/M was the main operating system for 8-bit systems, while MDOS (PC DOS) was the main system shown for 8088/8086 computers. The competing system from Digital Research, CP/M-86, did not seem to be used as the primary operating system for many of the new offerings although it is offered as an alternate on almost all of the 8088/8086-based systems. UNIX™ was much talked about as a future 16/32-bit operating system, but few new computers are using it at this time. Fortune Computer's 16:32 Computer, with the M68000, was one of the new computers now using Unix. The Charles River Data System's Universe 68 series of 68000 computers and the 16-bit Onyx Computers are others.

As more 68000 systems come into use, UNIX will likely become a stronger competitor. A lot will depend upon Radio Shack's choice of a M68000 Operating System for the Mod 16. If Radio Shack adopts UNIX, it will be the most used 16-bit microcomputer operating system. If Radio Shack decides on a system unique to TRS-80 Mod 16, UNIX will still be a strong contender and the Mod 16 might suffer from lack of software. The UCSD P-System (UCSD Pascal) grew in strength as it was adopted as a secondary operating system for more computers. It stands today as the only transportable microcomputer operating system. It is already so well established that it is number two among software operating systems. However it is number two on almost all the computers where something else is number one! Not a bad position to be in for any product, though.

Portables were the main hardware innovation at both NCC and COMDEX. They come in three sizes. The first is the suitcase size represented by the Osborne 1 and similar machines. The next size is the briefcase size such as the Epson HX-20, the Compass, the Sony Typecorder, and the Teleram, all of which fit in a briefcase or attache case. The smallest size is the hand-held computers.

The Osborne 1 has a new front panel that makes the unit physically more attractive. There is also a double-density version and a modification kit that retrofits this needed improvment to all previous units. The addition of double density permits the release of a large body of CP/M software in Osborne format. This makes the Osborne 1 a much more useful computer. As a bonus, the Osborne Computer Co. is giving users the UCSD run-time package for its machines. While this alone does not permit the running of Pascal on the Osborne, it does allow many application programs written in UCSD Pascal to be run on the machine.

The success of the Osborne 1 has apparently impressed others as some computer companies have rushed their versions of a portable computer into prototype production. The Kaycomp II from Non-Linear Systems, for example, offers most of the Osborne 1 features at the same price, but it includes a 9" CRT instead of the 5" CRT used in the Osborne. Since this is one of the shortcomings of the Osborne 1, the Kaycomp II could be a strong competitor.

The Fox from Digital Microsystems is another portable from one of the established manufacturers. It offers the advantage of being compatable with a broad library of CP/M software that can run on larger machines.

Morrow Design's Micro Decision is another portable offering all of the features of the Osborne 1, including either one 200K drive or two drives that store 400K. The Morrow computers only cost $1195 for the single-drive model or $1545 for the double-drive computer. Neither model comes with a video monitor, but for the difference in price, the user can select any size or quality monochrome monitor desired.

A new company, Janos Ltd., of Anaheim, CA, offers some innovative portable computer designs. The Courier Portable features a 9" CRT, a Z80A CPU with 64K of memory, and a serial interface. The computer uses the Standard Bus and provides five card slots for system expansion. The disk drive is the new Sony $3^1/_2$" system that stores 322K bytes per disk. The Janos Courier is priced at $3995, twice the cost of the Osborne 1, but it offers many additional features. Janos has another model with two removable 5-megabyte hard-disk cartridges in place of the floppy disks. This is the ultimate in portable computer data storage: 10 megabytes of data storage in a package you carry like a suitcase!

From Canada comes the Hyperion Portable Computer made by Dynalogic Infotech of Ottawa. This was easily the most attractive design at both of the shows. It is a portable compatable with the IBM PC computer, running the Microsoft MS DOS Operating System with advanced disk BASIC. It has both serial and parallel I/O ports and is compatable with the IBM PC printer, or other Epson or Centronics-type printers. It includes a built-in 300-baud modem for data communications and a time and date clock with battery back-up.

The Hyperion weighs 20 lb and measures only 18" W by 10" D by 8½ "H. The keyboard stores in the case and the entire assembly fits into a vinyl carrying case. The Hyperion costs $4999 but its IBM compatability and design features will make it attractive to many users.

Another portable that attacted a lot of attention at both the NCC and the COMDEX shows was the Otrona which was the subject of an article in the June issue of this magazine.

The briefcase class of computers and terminals also aroused much interest. The Compass computer by Grid Systems features a fold-down, flat electroluminescent screen with a 24- line by 53-character display with horizontal scrolling. All of the other briefcase-size units either show a single line or, in the case of the Epson HX-80 and the Teleram T-3000, a four-line display. The Compass is still in the early production stage. It is priced at over $8000, but it represents the logical future of portable computers.

The Epson HX-20 is a more affordable briefcase system, packing a powerful computer into an 11″ × 8½″ × 1¾″ package. It contains two CMOS 6301 CPUs, 16K of RAM memory (expandable to 32K) and 32K of ROM memory (expandable to 64K), a 24-character by 4-line display with horizontal scrolling to 255 characters. A dot-matrix printer is included as well as an RS-232C port. Parallel interfaces are provided for connection to a standard Epson printer, a bar-code reader, the cassette, and an extension of the system bus. An optional microcassette is available too. This is mounted in the front panel and makes the HX-20 a complete self-contained computer system.

The Teleram-3000 features bubble memory data storage and the ability to run the popular CP/M operating system. This is made possible by a low-power version of the Z80 CPU, 64K of RAM, and 4K of ROM. The bubble memory simulates the Drive A required by CP/M and the display is 80 characters by 4 lines. Provision is made to add an expansion unit for office use. This permits the installation of up to four external disk drives, a video monitor, and other perhiperals. At the less that $3000 price quoted, the Teleram will find many users who want more portability than is offered by the suitcase-size machines.

Handheld computers were represented by the Sharp 1500 which also is sold under the Radio Shack label and the Matsushita brand which is sold by Panasonic, Quasar, and Olympic, as well by the designers, Friends Amis. The Sharp 1500 features increased memory over its previous version and an interface to a four color printer/plotter. This is one of the most ingenious peripherals ever developed for a small computer. It produces printing in several sizes and colors and can plot histograms, line graphs, and even pie charts.

The Panasonic (Quasar, et al) unit has an interconnecting bus unit with peripherals that plug-in producing an attache-case computer system composed of the computer, a small printer, a modem with communications software in ROM, and a video unit with both a color graphics display and a black and white display. There is also a bus extension and an RS-232C interface. Memory expansion units can be plugged in to expand the memory up to 56K. In addition, there is a plastic connector unit that permits any two units to be connected without the main interconnecting unit. The computer uses both Microsoft BASIC and a Forth-like language called Snap. The CPU is a 6502 and the Apple II+ can be used as a development system to develop Snap programs. All of the versions of the system are identical, except that Friends Amis have developed their own expansion capability using a holding device called the "Datashuttle." This holds the basic HHC and adds up to 40K of nonvolatitle RAM. It has interfaces for a modem, a tape casette, an RS-232C interface, an ac adapter, and battery charger. It retains the standard parallel connector for peripherals and the bus expander. →

computers

In spite of the emphasis on portable computers, many companies introduced standard desktop and rack-mounted machines. Digital Equipment Corporation entered the personal computer field with four new computers. The first of these, the Rainbow, marked the first time that DEC has ever used an outside CPU and operating system. The Rainbow features a Z80 processor and uses the CP/M operating system and software. The other new DEC computers use a new LSI version of the PDP-11/23 and the standard DEC operating systems. One new machine is an updated word processor based on the PDP8 series.

Zenith has also departed from its usual bus and operating system by introducing the Z100 series of desktop computers. The Z100 represents Zenith's 8088/8086 16-bit generation. The series consists of two types of computers. The Series 110 is a low-profile color computer with no monitor. The Z120 is a one-piece cabinet with a built-in monitor. Both have 128 bytes of dynamic RAM, expandable to 196K on the main board. Both also have dual 5¼" drives with 48 tracks and use double-density, double-sided media. Optional 8" drives are available and a Winchester technology hard-disk drive will be available soon. I/O consists of both serial RS-232C ports and a Centronics-compatable parallel port. In one of its most important departures from the past, Zenith has adopted the S-100 bus for memory expansion and peripheral interface. The memory can be expanded up to 768K bytes using S-100 memory boards. The color unit offers eight colors with color memory standard in the Z120 and optional in the Z110. The dispay format is 24 lines of 80 characters, with 225 lines of 640 dots available for graphics. Video output for the Z120 is RGB and either monochrome or RGB for the Z110. Zenith also introduced its new terminal for use with Videotext services.

By far the most innovative thing at the NCC was not at the Astrodome. We were taken to a distant hotel and shown a new approach to computing. However, we were requested to sign a nondisclosure agreement before we were shown this wonder. We can say this much, however. It is a computer system and it operates in the same manner as a human mind. It can stop one operation and do another, then go back to the first, without missing anything. It is super "user friendly" and will work for the new user as well as the most experienced computer operator. This is no "blue sky" operation. It is the joint effort of some of America's most talented designers and Japan's precision manufacturers. It will be on the market in the last quarter of 1982. We predict that it will change the way people think about "personal computers." ◇

PROGRAMMER'S NOTEBOOK

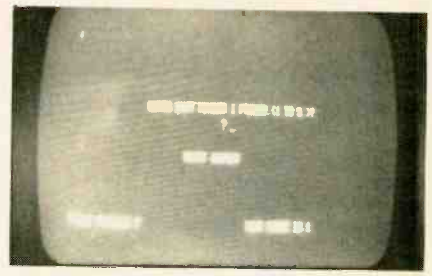
By Jim Keogh

Keeping Score

THERE are many times when you want your computer to keep track of one or more events. The most common occasion is probably when you want to keep score during a computer game. In this month's column, we will discuss how you can use your microcomputer to keep score during a game or count events.

For a computer to keep score, the programmer must include, in the program, one or more registers. These are similar in function to the cash registers used in retail stores. In the store, every transaction is recorded. For instance, the clerk reads the price tag on the merchandise and records the amount on the cash register.

The register then adds the amount of the transaction to the previous transactions. Many times there are two or more registers (counters) within the equipment. These include registers for taxes and departments. At the end of



How a score appears on screen.

PROGRAMS FOR KEEPING SCORE OR COUNTING EVENTS

TRS-80

```
5 REM CLEAR SCREEN
10 CLS
15 REM SET REGISTERS TO ZERO
20 C = 0
30 X = 0
35 REM RANDOM NUMBER
   GENERATOR
40 A = RND (5)
45 REM REGISTER STATEMENT
50 X = X + 1
55 REM GAME INSTRUCTIONS
60 PRINT @ 400, "GUESS WHAT
   NUMBER I PICKED (1 TO 5)?"
70 REM INPUT STATEMENT
80 INPUT "                    "; F
85 REM DISPLAY OF REGISTER
   COUNTER
90 PRINT @ 832, "TIMES
   GUESSED";X
95 REM COMPUTER DECIDES IF AN-
   SWER IS CORRECT
100 IF F = A THEN GOTO 160 ELSE
    110
105 REM COMPUTER TELLS IF AN-
    SWER IS WRONG
110 PRINT @ 600, "WRONG ANSWER"
115 REM TIMING LOOP
120 FOR EE = 1 TO 75
130 DD = EE + 1
140 NEXT EE
145 REM LOOP TO BEGINNING OF AN-
    OTHER CHANCE
150 GOTO 40
155 REM COMPUTER TELLS IF AN-
    SWER IS RIGHT
160 PRINT @ 600, "RIGHT"
165 REM REGISTER STATEMENT
170 C = C + 1
175 REM COMPUTER TELLS
    OPERATOR HIS OR HER SCORE
180 PRINT @ 870, "YOUR SCORE IS";C
185 REM TIMING LOOP
190 FOR EE = 1 TO 75
200 SS = EE + 1
210 NEXT EE
215 REM LOOP TO BEGINNING OF AN-
    OTHER CHANCE
220 GOTO 40
```

APPLE II

```
5 REM CLEAR SCREEN
10 CALL - 936
15 REM SET REGISTERS TO ZERO
20 C = 0
30 X = 0
35 REM RANDOM NUMBER
   GENERATOR
40 A = RND (5)
45 REM REGISTER STATEMENT
50 X = X + 1
55 REM GAME INSTRUCTIONS
60 HTAB (15)
61 VTAB (20)
63 PRINT "GUESS WHAT NUMBER I
   PICKED (1 TO 5)?"
70 REM INPUT STATEMENT
80 INPUT "                    ";F
85 REM DISPLAY OF REGISTER
   COUNTER
90 HTAB (5)
91 VTAB (35)
92 PRINT "TIMES GUESSED";X
95 REM COMPUTER DECIDES IF AN-
   SWER IS CORRECT
100 IF F = A THEN GOTO 160 ELSE
    110
105 REM COMPUTER TELLS IF AN-
    SWER IS WRONG
110 HTAB (15)
111 VTAB (25)
112 PRINT "WRONG ANSWER"
115 REM TIMING LOOP
120 FOR EE = 1 TO 150
130 DD = EE + 1
140 NEXT EE
145 REM LOOP TO BEGINNING OF AN-
    OTHER CHANCE
150 GOTO 40
155 REM COMPUTER TELLS IF AN-
    SWER IS RIGHT
160 HTAB (15)
161 VTAB (25)
162 PRINT "RIGHT"
165 REM REGISTER STATEMENT
170 C = C + 1
175 REM COMPUTER TELLS
    OPERATOR HIS OR HER SCORE
180 HTAB (20)
181 VTAB (35)
182 PRINT "YOUR SCORE IS";C
185 REM TIMING LOOP
190 FOR EE = 1 TO 150
200 SS = EE + 1
210 NEXT EE
215 REM LOOP TO BEGINNING OF AN-
    OTHER CHANCE
220 GOTO 40
```

the day, the totals for each register are printed out on the register tape. The equipment is then reset to zero and is ready to record the next day's transactions.

The register in our computer program operates in a similar manner. First, the registers are set to zero. This must be done at the beginning of the program. For example, we will call the register A. At the start of the program, we use the statement "A = 0." The program will then be executed. Before the program is concluded or looped to its beginning again, the register (counter) statement must be inserted into the program. This is "A = A + 1." (Read as "A equals A, incremented by one.")

The program can then continue and be looped to the line that immediately follows the statement "A = 0." When the program once again reaches the line with the statement "A = A + 1," the computer will add 1 to the value of A. Since this is the second time the program was executed, the value of A is now 1. The new value of "A = A + 1" is 2. This statement has just recorded that the program was executed twice.

To find the final tally, we must insert the statement "PRINT A." This is usually the last statement in the program loop. Briefly, the computer executes the program and adds the number of times the program is executed to the previous total in the register. At the end of the program, the computer prints the final tally of each register.

The following set of commands illustrates a program register:

```
10 A = 0
20 REM BODY OF PROGRAM IS
   EXECUTED
30 A = A + 1
40 PRINT A
50 GOTO 20
```

To illustrate the application of this subroutine, the following guessing game was developed. It is rather simple, using two registers. The first register counts the number of right guesses while the second counts the total number of guesses, whether right or wrong.

The program also includes a random number generator. The computer will generate a random number from one to five without displaying the number. It is up to the operator to guess which number the computer picked. If the guess is correct, the computer will print the word "RIGHT" and score the answer as being correct. Both registers will increase by one. If the guess is wrong, the computer will print "WRONG ANSWER" and increase the second register count by one.

By reviewing the details of the program, you should be able to develop a thorough understanding of how computer registers within a program operate. You can have as many registers as you require by just using a few command statements and let the computer do all the counting for you. ◇

SOLID-STATE DEVELOPMENTS

By Forrest M. Mims

The Microprocessor Enters its Second Decade

IMAGINE a 4-bit microprocessor that can process 45 instructions, add two numbers in 850 microseconds, and directly drive up to 4K by 8 bits of ROM. As a bonus, this microprocessor, which is supplied in a 16-pin DIP, can be operated as a microcomputer with the addition of a single ROM.

Impressive? It certainly is, particularly when you consider that these are the specifications for history's *first* microprocessor, Intel's 4004.

The microprocessor is now nearly a full year into its second decade. With sales of around 150 million chips per year, it has become far more successful than anyone could have imagined when first announced back in November of 1971.

This pioneering 2300-transistor chip was the brainchild of Marcian E. "Ted" Hoff, an Intel employee. Hoff had been assigned the development of a complex set of new integrated circuits for a Japanese company that planned to use them in a new programmable calculator. He found that the proposed design was much too complex for implementation with conventional random logic. Instead, falling back on his knowledge of minicomputers, he proposed integrating on a small number of chips a sequential processor designed like the central-processing unit of a digital computer. The operation of the processor would be controlled by a program in one or more ROMs.

Meanwhile, Gary Boone at Texas Instruments was also involved in pioneering microprocessor-related work. In 1971, Texas Instruments filed patent applications for a single-chip microprocessor and a single-chip microcomputer. By 1974, the TMS-100 family of 4-bit microcomputers had evolved from this early work.

The microprocessor is one of the most important integrated circuits yet developed. They are used in industrial controllers, traffic lights, scientific instrumentation, and such consumer products as calculators, appliances, and toys. But their most important application is as the processing unit for personal computers.

The Birth of the Personal Computer. One of the first engineers to anticipate the eventual role of microprocessors in small computers was H. Edward Roberts. In 1969, Ed, Robert Zaller and I were young officers at the Air Force Weapons Laboratory in Albuquerque, NM. Stan Cagle was an engineer for a private consulting firm. Under Ed's leadership, the four of us formed a small company to manufacture telemetry gear for model rockets. Later, we made a lightwave-communicator kit that was featured as a construction project in POPULAR ELECTRONICS ("The Opticom," November 1970).

By late 1970, our company, M.I.T.S. was not faring well, and Bob and Stan had developed other interests. I had decided to become a full-time freelance writer, and the three of us sold our shares to Ed. Staying with the nearly bankrupt company, Ed managed to get the backing required to bring out a line of kit calculators, some of which were featured as construction projects in POPULAR ELECTRONICS. The calculator market, however, soon dried up in the face of massive competition from major companies.

Again facing bankruptcy, Ed sought new electronic products to market. About that time, Intel introduced its 8080 microprocessor, a $360 chip that could handle 78 basic instructions and directly access 64 kilobytes of memory. Having had previous experience with minicomputers, Ed immediately realized that the 8080 could be used as the processor in a small-computer system. I well remember the excitement in his voice as he told me this new product would "revolutionize" computers. At the time, I could not understand how a computer in a metal box that was programmed in machine language by a laborious process of manually actuating a row of toggle switches could revolutionize anything. Nevertheless, I agreed to write the operator's manual in exchange for an early production model of one of the computers.

The story of how the Altair 8800 was featured on the cover of the January 1975 issue of POPULAR ELECTRONICS is now legend in the annals of personal computer history. Ed's company, by then known simply as MITS, sold thousands of Altair 8800's as a result of that article. Many of them are still in use today. With no keyboard or CRT, the Altair 8800 was far from a user-friendly system. Nevertheless, at $397 for a complete kit, which included the $360 8080 microprocessor, it ushered in the era of affordable, personal computing.

Though the concept of sequential program operation remains unchanged, microprocessors have come a long way since the development of the 4004 and 8080. Now 16- and even 32-bit microprocessors are available. They permit faster program execution, and can address considerably more memory than the older 8-bit units. Let's examine one of these new microprocessors to see just how far their development has come.

A 16-Bit Microprocessor. Intel's latest microprocessor, the 80186, is light years ahead of the 4004. This chip, which is also known as the iAPX 186 CPU, contains the functional equivalent of a single-board, 16-bit, digital-computer, central-processing unit. In other words, the 80186 replaces the microprocessor and from 15 to 20 associated chips normally required to provide a 16-bit central-processing unit (CPU).

Intel claims the 80186 delivers double the performance of their older 8086 microprocessor. It includes such on-chip features as provisions for selecting memory and peripherals, counting and timing functions, interrupt control, direct memory access, local bus control, and system timing (clock). Most previous high-level microprocessor chips require additional support chips to implement most or even all these functions. These as well as many other features, plus its 8-MHz clock speed make the 80186 ideally suited for use as the processor in high-power, multi-language personal and business computers.

Thanks to on-chip hardware, the 80186 chip accomplishes multiplication and division five times faster than the 8086. Software compatible with both the 8086 and 8088, the 80186 includes ten new instructions that provide what Intel calls a "superset" of instructions. Among the new instructions are provisions for efficiently moving long strings of data from memory to an I/O (input/output) port at high speed. New "Enter" and "Leave" instructions facilitate the implementation of high-level languages like Pascal.

Two new multiplication instructions enhance the 80186's ability to perform advanced calculations. Furthermore, the 80186 can be used with the 8087 Numeric Processor Extension chip for high-performance, floating-point math.

Intel's existing line of graphic, keyboard, cathode-ray-tube, floppy-disk, and parallel- and serial-interface controllers is fully compatible with the 80186. The actual chip, which measures 300 mils on a side, is installed in a 68-pin, hermetically sealed, chip carrier. It operates from a single 5-V supply and sells for $50 each in quantities of 100. For more information, contact an Intel distributor or write Intel (2625 Walsh Avenue, Santa Clara, CA 95051).

A CRT Controller Chip Set. If you remember Don Lancaster's pioneering designs for do-it-yourself TV typewriters, you know something about the complexity of the circuits required to display information on a CRT screen. Fortunately, things have changed for the better with the introduction by Signetics of a new CRT-controller LSI chip set. It halves the number of ICs formerly required to implement a full-featured terminal for a microcomputer.

According to Steve Stewart, Marketing Manager for Signetics' MOS Microprocessor Division, a complete CRT terminal can be implemented with as few as 15 ICs. The resulting product, Stewart added, will "simplify production, increase reliability, and reduce field-maintenance costs."

A complete CRT controller board has been designed around four new chips. An SC2670 Display Character and Graphics Generator converts character and line address information into dot patterns for raster-scanned displays and stores 128 characters. It also provides up to 256 graphic characters, 15 of which are segments for producing line drawings on a CRT display.

The SC2671 Programmable Keyboard and Communications Controller provides keyboard encoding and an asynchronous transmitter/receiver. It also includes a baud-rate generator. The SC2672 Programmable Video Timing Controller generates the necessary sync and blanking signals. It also provides timing signals for such features and functions as a cursor, underlining, blinking, and a light pen. The SC2673 Video Attributes Controller takes care of a variety of housekeeping functions and adds such extras as control over intensity, blink, underline, reverse video, nondisplay, and graphics.

The new circuit controller board also includes an SC8049 microcomputer, some memory, and several TTL logic chips to complete the controller. All that's necessary to assemble a complete terminal is a nonencoded electromechanical or capacitive keyboard, a CRT monitor, and appropriate power supplies. The result is a terminal that provides such "nice-to-have" features as four-key rollover, autorepeating keyboard, underlining, both thin-line and block graphics, screen reversal, variable cursor type, and an audio-alarm signal.

In quantities of 100, the SC2670 and SC2671 sell for $7.30 and $13.65, respectively. The SC2672 and SC2673 are $16.00 and $20.40, respectively. If you work for a company, you can get a complete CRT Information Kit that fully describes the new chip set (and includes data sheets, article reprints, application notes, and other information) by sending a request *on your company letterhead* to Microprocessor Marketing, Signetics Corp., Main Stop 1276, P.O. Box 409, Sunnyvale, CA 94086.

Latchable CMOS Multiplexers. Interfacing a microprocessor to the analog world can become a rather complex problem. Siliconix (2201 Laurelwood Road, Santa Clara, CA 95054) has substantially simplified this chore with its recent introduction of two new microprocessor-compatible CMOS multiplexer/demultiplexer IC's.

The DG528 provides eight channels of single-ended multiplexing of ±15-V analog signals. Since it has an enable input, two or more DG528's can be cascaded to provide 16 or more multiplexed lines under program control.

The DG529 provides four channels of differential multiplexing of both common- and differential-mode signals. Like the DG528, the DG529 is installed in an 18-pin DIP.

In a typical application, any of up to eight-channels of analog data (e.g. temperature, wind speed, pressure, etc.) is applied under microprocessor control to an analog-to-digital converter. The digitized output is then applied to the microprocessor for processing or stored for later use in a RAM.

Some of the specific applications Siliconix has targeted for these new interface chips include microcomputer-based communications systems, environmental control, home security systems, avionics equipment employing scanning techniques, and automatic test equipment. The company points out that the latter application will be served well by the bidirectional capability of the new chips. In this role, for example, a single channel might be used to transmit signals in *both* directions between a microprocessor in the test equipment and the device or system undergoing testing. ◇

EXPERIMENTER'S CORNER

By Forrest M. Mims

Experimenting With a Servomechanism

A SERVOMECHANISM is an automatic control system. The word servo comes from the Latin *servus,* which means *slave.* The terminology is accurate, for under the proper conditions a servo (to use the normal short form) is totally obedient to any control or input signals applied to it.

In operation, a servo develops an output signal that is continually compared to the input signal. Any difference or error between the two signals is fed back to the input, thus causing the output signal to move toward and eventually match the input signal.

The feedback loop is shown in Fig. 1. This simplified diagram illustrates the operation of servos that are entirely electronic, such as phase-locked loops, and those that incorporate electromechanical devices, such as motors or solenoids.

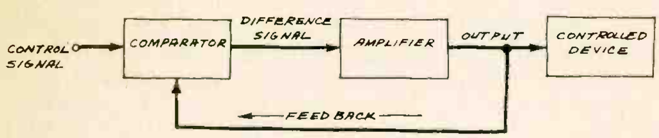


Fig. 1. A basic closed-loop servomechanism.

Previous installments of "Experimenter's Corner" have covered the operation and use of various kinds of phase-locked loops. See, for example, the installments of July and August of 1980. If you cannot find these issues of POPULAR ELECTRONICS at a library, both of the columns cited above are scheduled to be published by McGraw-Hill in *The Forrest Mims Circuit Scrapbook*. You may also want to refer to Howard Berlin's excellent book *Design of Phase-Locked Loop Circuits, With Experiments* (Howard W. Sams & Co., Inc., 1978).

The servos discussed in this column are electromechanical. Considering the increasing interest in robotics, radio control, and computer control, electronics experimenters should be fully aware of the operation and capabilities of such servomechanisms.

The Electromechanical Servo. Many kinds of electromechanical servomechanisms exist. Most incorporate a motor, a comparator, and a position-sensing transducer connected as shown in Fig. 2. In this figure, the input voltage is provided by one potentiometer of a two-axis joystick. The position-sensing transducer is a potentiometer whose wiper arm is rotated by the motor's armature. Both potentiometers are connected as voltage dividers.

To understand the operation of this servo, assume the voltages applied to both inputs of the comparator are equal. The output of the comparator will then be low and the motor will be off. When the joystick is moved so that the voltage applied to the noninverting input of the comparator exceeds the voltage from the position-sensing potentiometer, the comparator output will be high and the motor will be activated. This will cause the position-sensing potentiometer to deliver a progressively higher voltage.

When the two voltages are again equal or when the voltage from the position-sensing potentiometer is slightly higher than that from the joystick, the comparator will switch off and the motor will cease rotation. The end result is that the motor has *tracked* the position of the joystick. In other words, the physical movement of the motor's armature is directly proportional to the movement of the joystick.

The simple servo shown in Fig. 2 is not suitable for mosf practical applications since no provision is made for reversing the motor. Motor reversal can be achieved under mechanical control by using the dpdt switch arrangement shown in Fig. 3.

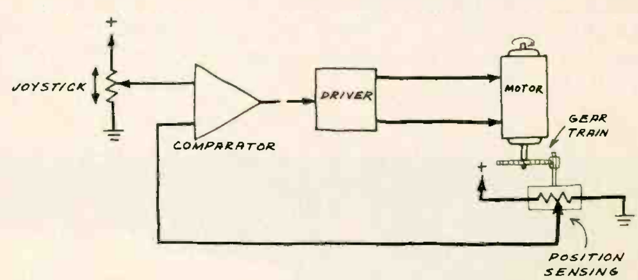


Fig. 3. Double-pole double-throw motor reverser.

Forward-reverse operation can also be achieved by substituting transistors for the switches, as in Fig. 4. The circuit in Fig. 4 is actually the motor-driver portion of Signetics' NE544 Servo Amplifier, a chip designed specifically for controlling a dc servo motor.

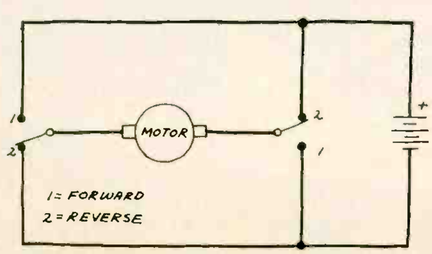


Fig. 2. Components of an electromechanical servo.

Integrated Servo Amplifiers. The input to an NE544 and similar servo-amplifier chips is a train of variable-duration pulses. The output signal causes a small dc motor to rotate in proportion to the average duration of the incoming pulses. Pulse-duration (or width) modulation is used because it makes it easy to transmit signals via radio or infrared for remote-control applications. Even though this method is not a true digital-control system, it's commonly referred to as digital proportional control.

Figure 5 is a block diagram and connection network for the

Signetics NE543 Servo Amplifier. In operation, pulse-duration-modulated pulses from a receiver are applied to the input. If the pulse duration *exceeds* that of an internally generated pulse, the difference is stretched and applied to the appropriate output stage. This causes the motor to rotate the wiper of feedback potentiometer *R3*. The resistance of *R3* governs the duration of the internally generated pulses. When *R3*'s value has been altered so that the duration of the internally generated pulses matches that of the incoming pulses, the motor is deactivated.

If the duration of the incoming pulses is *less* than that of the internally generated pulses, then the difference is stretched and applied to the output stage that rotates the motor in the opposite direction. When the value of *R3* causes the duration of the

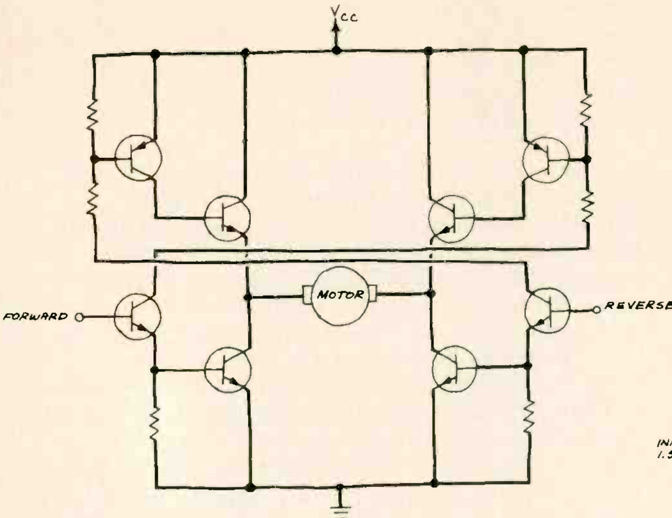


Fig. 4. Motor control circuit in Signetics NE544.

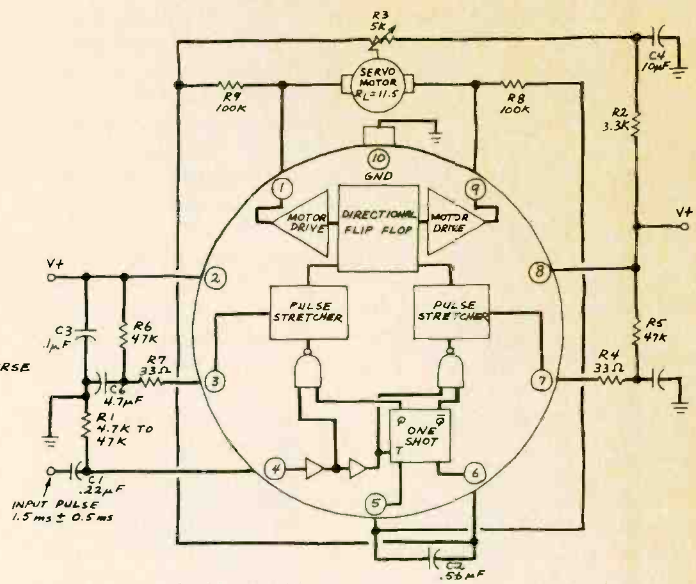


Fig. 5. Block diagram of NE543 servo amplifier.

internally generated pulses to match the incoming pulse duration, the motor is deactivated.

The net result of this feedback operation is that the motor armature position follows the duration of the input pulse. If the input pulses are received from a transmitter in which the duration of pulses is controlled by the position of a joystick, the armature position accurately tracks the joystick position, even though the two are separated by a considerable distance.

The successful operation of a servo amplifier such as the one in Fig. 5 involves some important subtleties. Assume, for example, that the motor has rotated the feedback potentiometer's wiper to the point where the duration of the internal reference pulses matches that of the incoming pulses. Though the motor-drive transistor is switched off, the inertia of the motor's Armature causes it to rotate *beyond* the null point. Now the duration of the reference and incoming pulses again differs, so the servo amplifier switches the motor into reverse in an effort to find the null point. The motor may again *overshoot* the null, thus requiring a series of command pulses before it assumes the desired position.

The forward-reverse oscillation of the motor around the null point is called *hunting* or *seeking.* In most cases, the damping effect of the motor's gears will cause progressively less hunting per cycle, thus allowing the motor to eventually stop at the desired position. In very sensitive systems, however, the motor may never settle down and will hunt continuously.

The hunting problem can be controlled by purposely designing a margin of error or, as it is sometimes called, *slop* into the system. In Fig. 5, this is accomplished by the inclusion of resistors *R4* and *R7.* They establish what is called a *deadband* of about 5 μs. The motor will not be switched on until the input pulse duration differs from that of the internal reference pulses

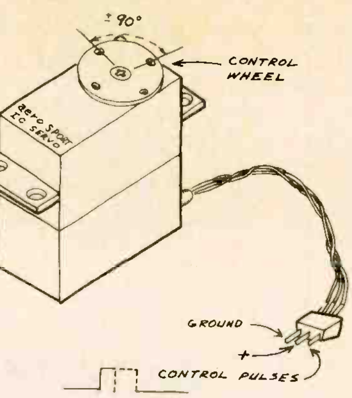


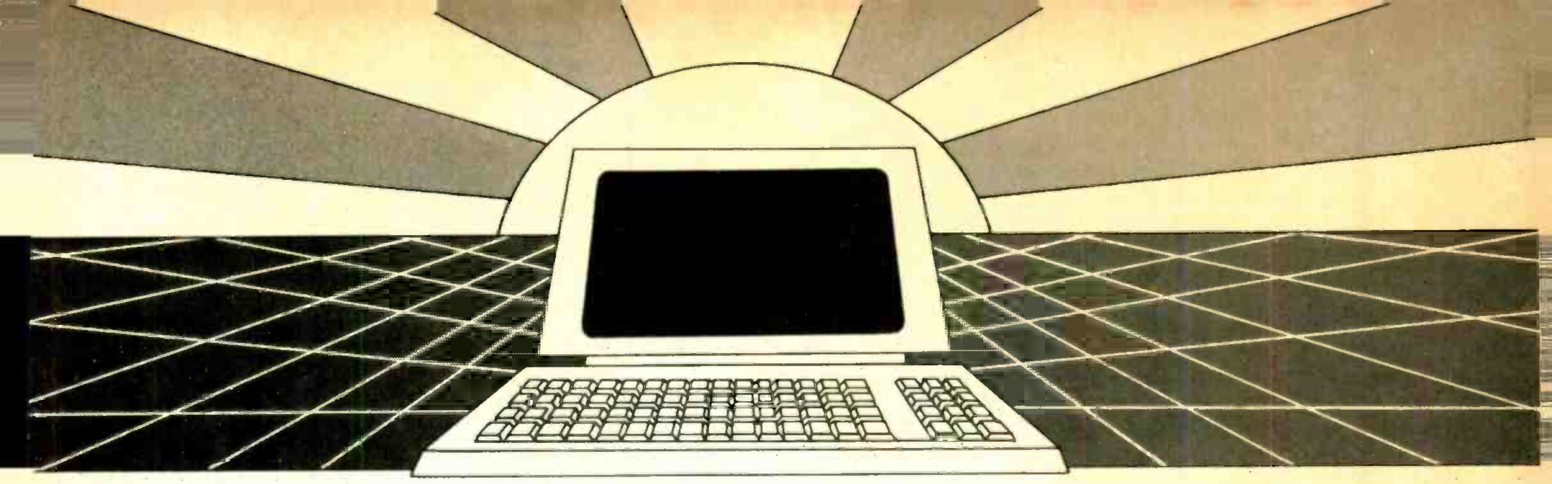
Fig. 6. A typical miniature servomechanism.

by *more* than the deadband. If hunting still occurs, the deadband can be widened by increasing *R4* and *R7.*

The NE544, whose motor-drive section is shown in Fig. 4, is a second-generation servo amplifier that features more precise operation than the NE543. You can find out more about both these chips by referring to their data sheets in the Signetics Analog Data Manual. The data sheets for the NE544 include two pc-board layouts suitable for use in miniature servos.

Servo amplifier chips are also made by Texas Instruments and Exar. TI's SN76602 and SN76604 both feature an adjustable deadband and bidirectional motor drive.

Exar's XR-2264 is a pulse-proportional servo amplifier designed to directly drive a motor. The XR-2265 is a similar chip designed to drive relays, optical couplers, and triacs. The XR-2266 is designed specifically to provide two control channels



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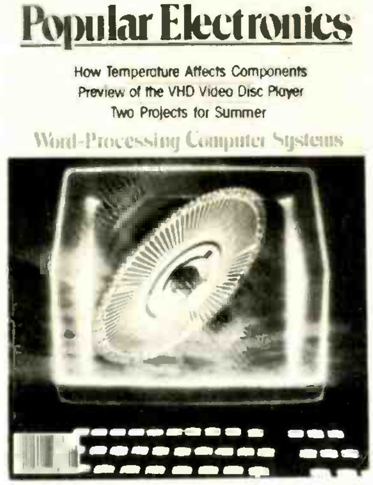

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for radio-controlled cars. One channel controls the direction and speed of travel. The second controls the steering. The direction/speed control channel can also directly drive a pair of back-up lights to provide another degree of realism.

Experimenting With a Servo. Though it's possible to assemble a servomechanism from scratch, you can buy many different preassembled servos ranging in price from about \$12 to \$50 from suppliers of radio-controlled cars, boats, and planes. Nearly all these servos are installed in tough plastic cases no larger than two side-by-side 9-V batteries.

A typical inexpensive servo is shown in Fig. 6. For a device of such compact size and relatively low price (around \$20), it is quite sophisticated. Typically, it contains a high-quality miniature motor coupled to a train of three or four reduction gears. The feedback potentiometer is mechanically coupled to the gear train. The electronics are installed on a small circuit board adjacent to the motor and below the gear train. The axle of the output gear passes through a bushing or ball-bearing assembly in the top of the servo case. Various wheels and arms can be attached to the axle by means of a small screw.

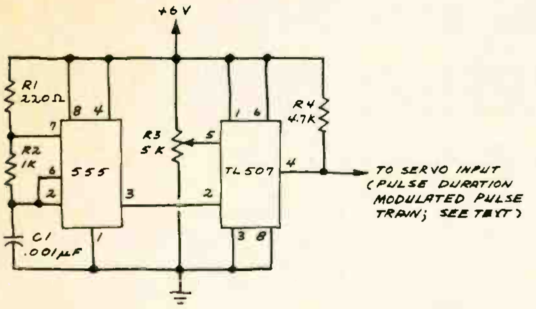

Fig. 7. Pulse-duration modulator for miniature servo.

A servo like the one in Fig. 6 weighs about 1.25 to 2 ounces and can deliver several *pounds* of thrust. It can travel through its rotational limit of 90 degrees in about half a second. Typical no-load current is around 80 mA, and stall current is approximately 450 mA.

Figure 7 is a simple variable-pulse-duration pulse generator I've used to drive an Aero Sport GS-ICR Servo. This servo, which is typical of those used in radio-controlled cars, boats and planes, responds to a pulse duration of from 1 to 2 ms. The servo is at its center (neutral) position when the incoming pulse has a duration of 1.5 ms. At 6V, it consumes around 25 mA at idle and around 80 mA when travelling. Its stall current is around 250 mA.

Resistor *R3* in Fig. 7 can be a potentiometer in a joystick assembly or a standard potentiometer. It can even be a variable-resistance transducer to give a mechanical movement in response to some environmental change. For example, a fixed resistor in series with a pair of electrodes inserted into soil will provide a transducer that gives a voltage output dependent upon soil moisture content. The servo to which this transducer is connected could open and close a small water valve to keep the soil moisture at any desired level.

Applications for Servo. By now you've probably thought of several applications for servomechanisms in addition to those mentioned thus far. Servos are used in remote-controlled television cameras, self-focusing film cameras, toys, industrial robots, and military hardware. ◇

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Practical Troubleshooting Techniques for Microprocessor Systems

by James W. Coffron

This text deals with troubleshooting techniques for 8-bit devices, covering circuits that utilize the 8080, 8085, Z80, and 6800 microprocessor systems. Chapter One begins with an overview of 3-bus system architecture and its role in 8-bit systems. Then the various microprocessors are compared in terms of circuit organization and operating parameters. The bulk of the book, however, details methods of hardware testing and the practical aspects of hardware debugging. The central premise is that most hardware faults can be located using simple and inexpensive static techniques.
Published by Prentice-Hall, Inc., Englewood Cliffs, NJ 07632. Hard Cover. 246 pages, $19.95

The Radio Amateur's Handbook

This is the 1982 edition, and it contains some important new information not found in previous handbooks. The additional material includes a six-page spectrum chart, 10-MHz information added to several construction projects, an introduction to Packet Radio and Spread Spectrum Techniques, a new RFI chart showing the frequency relationship between amateur bands and other telecommunications services, 10-GHz Gunnplexer communications, new antennas for vhf FM, and an updated list of parts suppliers. Among the construction projects are: a code-practice oscillator, 250-W linear covering of the 30-meter WARC band, a two-tone generator, an SSB speech processor, a general-purpose RTTY demodulator, etc. In addition, there is the customary information concerning the electronic principles of radio transmission; calibration and use of test equipment; and standards and procedures for operating a ham station.
Published by the American Radio Relay League, Newington, CT 06111. Soft cover. 23 chapters. $10.

The Multilingual Computer Dictionary

By Alan Isaacs, Editor

If you deal with computers on an international basis, you might need a working knowledge of foreign computer terminology. This dictionary is a useful reference that lists 1600 of the most common computer terms in six languages: English, French, German, Italian, Spanish, and Portugese. Each term is listed so that you can look it up in any one of the six languages, and immediately see its equivalent in the other five. Separate entries are given for British and American English where usage differs in the two countries.
Published by Facts on File, Inc., 119 W. 57th St., New York, NY 10016. Hard Cover. 332 pages. $19.95

Automotive Ignition Systems

by Frank C. Derato

Here is a guide for the do-it-yourselfer who wants to be able to tune-up his rig and troubleshoot ignition problems. In order to be able to perform the procedures given in the book you'll need a voltmeter, ohmmeter, tack, and dwellmeter, as well as a set of basic automotive tools. The book starts with a description of the principles of electricity, and an overview of how a standard ignition system works. If you are familiar with these things, the author suggests you go right to Chapter 11 (the book has 29 chapters), which provides an introduction to electronic ignition systems; or to Chapter 20, which begins the discussion of computer-controlled ignition. The book is clearly written in a step-by-step, how-to fashion, and the illustrations are good, but there is not quite enough information pertaining to foreign cars.
Published by McGraw-Hill, 1271 Ave. Americas, N.Y., NY 10020. Soft cover. 272 pages. $13.50

Apple Pascal Games

by Douglas Hergert and Joseph T. Kalash

This book presents a collection of the most popular games written in Apple Pascal (Apple Pascal incorporates UCSD Pascal plus Apple extensions). For each game, the book covers game rules and includes a guide to understanding the programs. A structure chart is also offered to graphically show the organization and listing of the whole program. Thus, the reader learns not only how to play the game, but also to discover how the games are implemented on the computer. Some of the games are: Baccarat, Nim, Snake, Hangman, and Blackjack.
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BASIC Betting

by James Jasper

Those of you with sporting blood should find this one interesting: it's about using your home microcomputer to make money through gambling. That is, the book contains BASIC programs that are written to allow you to predict more accurately the probabilities and point spreads for football, basketball, horse racing, and blackjack. The football program, for example, divides a team's record into discrete categories—such as, teams beaten, teams beaten by seven or more points, teams lost to, teams lost to by a given spread, etc. At the end of the book, there is a program for money management, in case you don't know what to do with your winnings.
Published by St. Martin's Press, 175 Fifth Ave., N.Y., NY 10010. Soft cover. 283 pages. $9.95.

PROJECT OF THE MONTH

By Forrest M. Mims

Controller for Small DC Motors

SMALL dc motors that operate in both forward and reverse directions are used in many kinds of devices such as tape recorders, toy cars, and card readers. The rotational direction of these motors is reversed by means of a dpdt switch connected as shown in Fig. 1. Also shown is a pictorial view of the switch contacts wired for forward-reverse directional control.

Many applications require that the rotational direction of a small motor be controlled by a low-level logic signal rather than a mechanical switch. This is readily accomplished by substituting transistors for the switches in Fig. 1. Bipolar transistors can be used, but VMOS power transistors are a better choice since they can be readily interfaced with TTL, LS and CMOS logic.

A Solid-State Motor Reverser. Figure 2 shows one way to substitute VMOS FETs in the circuit of Fig. 1. Two gates in a CMOS 4011 quad NAND gate provide the steering logic necessary to switch the appropriate VMOS FETs on and off.

In operation, when the input is low, *Q1* and *Q2* are switched on, and *Q3* and *Q4* are switched off. This applies a positive polarity to the A terminal of the motor, and the motor rotates in a corresponding direction. When the input is high, *Q3* and *Q4* are switched on, and *Q1* and *Q2* are switched off. This reverses the polarity of the voltage applied to the motor and causes it to reverse its direction of rotation.

An interesting feature of the circuit is that, in a low-noise environment, directional control can be implemented by making the input high or low momentarily and then allowing it to float. The motor will stop and reverse direction even *after* a momentary change in the input level has taken place. Of course the input should not be allowed to float in a noisy environment since the CMOS gate may switch in response to spurious signals.

Adding a Speed Control. Figure 3 shows how the circuit in Fig. 2 can be expanded to include adjustable rotational speed. A bonus feature of the expanded circuit is that the two unused gates in the 4011 are connected as a free-running oscillator—no additional chips are required.

The pulse-repetition rate of the oscillator is governed by *R2* and *C1*. VMOS FET *Q5* is connected as a solid-state switch that applies power to the motor-reverser circuit under control of the oscillator.

The oscillator has a fixed duty cycle of about 50 percent. In other words, the duration of each output pulse is about equal to the time between pulses. When the oscillation frequency is high, the pulses are narrow and the motor turns slowly. When the oscillation frequency is low, the pulses are wide and the motor turns more rapidly.

When the pulses are too wide (a few hundred or more milliseconds), the motor pulsates and may even operate in a start-stop mode. When the pulses are too narrow (50 to 100 microseconds), the motor will cease operation and may emit a high-pitched tone. Different motors may behave in different ways as the pulse train is altered.

Operating Tips. The circuit in Fig. 3 is designed for use with low-voltage, low-power hobby motors such as those in model cars and robots.

Though I used VN67 VMOS FETS (available from Siliconix distributors and Radio Shack stores), most other types will work. But be sure the motor's current drain doesn't exceed the ratings for the VMOS FETs, and use heat sinks if necessary. You can parallel VMOS FETs to obtain a lower *on* resistance and more efficient operation.

Finally, remember that this circuit uses MOS semiconductors. Be sure to follow appropriate handling precautions to avoid causing damage to either the 4011 or any of the transistors. If your circuit fails to operate properly, one of the gates in the 4011 or one of the VMOS FETs may be defective. ◊

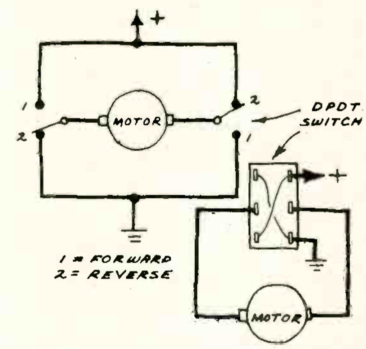

Fig. 1. (Above right.) A mechanical switch motor reverser.

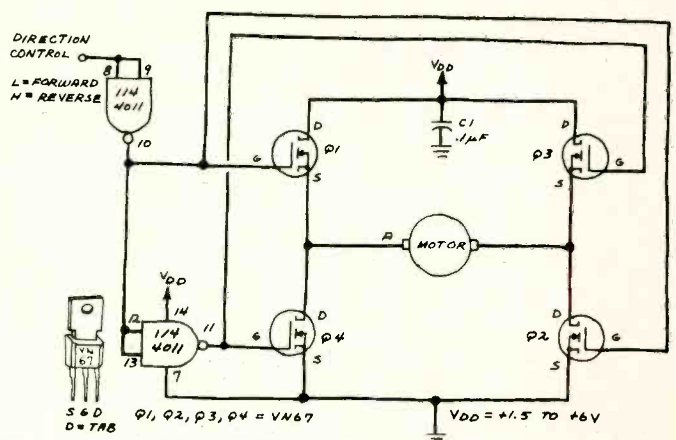

Fig. 2. (Right) A solid-state motor reverser circuit.

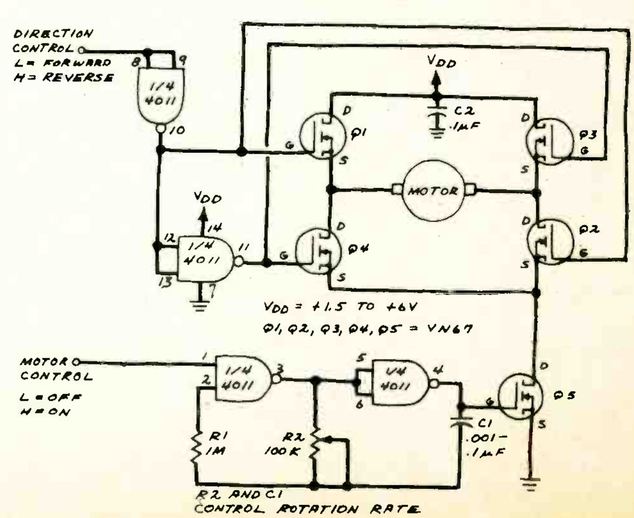

Fig. 3. Small motor direction and speed controller.

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1224 S. Bascom Avenue
San Jose, CA 95128
800-538-5000 • 800-662-6279 (CA)
(408) 995-5430 • Telex 171-110

VISIT OUR RETAIL STORE

HOURS:
M-F, 9-5; Sat. 11-3

PLEASE USE YOUR CUSTOMER NUMBER WHEN ORDERING

TERMS: For shipping include $2 for UPS Ground or $3 for UPS Blue Label Air. Items over 5 pounds require additional shipping charges. Foreign orders, include sufficient amount for shipping. There is a $10 minimum order. Bay Area and Los Angeles Counties add 6½% Sales Tax. Other California residents add 6% Sales Tax. We reserve the right to substitute manufacturer. Not responsible for typographical errors. Prices are subject to change without notice. We will match or beat any competitor's price provided it is not below our cost.

4116 16K DYNAMIC 250NS 8/$11.95 SET

2114 1KX4 STATIC LOW POWER 200NS 8/$15.95 SET

ALL MERCHANDISE 100% GUARANTEED!

CALL US FOR VOLUME QUOTES

STATIC RAMS

2101	256 x 4 (450ns)	1.95
5101	256 x 4 (450ns) (cmos)	3.95
2102-1	1024 x 1 (450ns)	.89
2102L-4	1024 x 1 (450ns) (LP)	1.29
2102L-2	1024 x 1 (250ns) (LP)	1.69
2111	256 x 4 (450ns)	2.99
2112	256 x 4 (450ns)	2.99
2114	1024 x 4 (450ns)	8/14.95
2114L-4	1024 x 4 (450ns) (LP)	8/15.25
2114L-3	1024 x 4 (300ns) (LP)	8/15.45
2114L-2	1024 x 4 (200ns) (LP)	8/15.95
2147	4096 x 1 (55ns)	9.95
TMS4044-4	4096 x 1 (450ns)	3.49
TMS4044-3	4096 x 1 (300ns)	3.99
TMS4044-2	4096 x 1 (200ns)	4.49
MK4118	1024 x 8 (250ns)	9.95
TMM2016-200	2048 x 8 (200ns)	5.95
TMM2016-150	2048 x 8 (150ns)	6.95
TMM2016-100	2048 x 8 (100ns)	7.95
HM6116-4	2048 x 8 (200ns) (cmos)	6.95
HM6116-3	2048 x 8 (150ns) (cmos)	7.10
HM6116-2	2048 x 8 (120ns) (cmos)	9.95
HM6116LP-4	2048 x 8 (200ns) (cmos)(LP)	8.75
HM6116LP-3	2048 x 8 (150ns) (cmos)(LP)	8.95
HM6116LP-2	2048 x 8 (120ns) (cmos)(LP)	12.95
Z-6132	4096 x 8 (300ns) (Qstat)	34.95

LP = Low Power Qstat = Quasi-Static

DYNAMIC RAMS

TMS4027	4096 x 1 (250ns)	2.50
MK4108	8192 x 1 (200ns)	1.95
MM5298	8192 x 1 (250ns)	1.85
4116-300	16384 x 1 (300ns)	8/11.75
4116-250	16384 x 1 (250ns)	8/11.95
4116-200	16384 x 1 (200ns)	8/13.95
4116-150	16384 x 1 (150ns)	8/15.95
4116-120	16384 x 1 (120ns)	8/29.95
2118	16384 x 1 (150ns) (5v)	4.95
MK4816	2048 x 8 (300ns) (5v)	24.95
4164-200	65536 x 1 (200ns) (5v)	7.25
4164-150	65536 x 1 (150ns) (5v)	8.25

5V = single 5 volt supply

EPROMS

1702	256 x 8 (1us)	4.50
2708	1024 x 8 (450ns)	3.95
2758	1024 x 8 (450ns) (5v)	9.95
2716	2048 x 8 (450ns) (5v)	3.95
2716-1	2048 x 8 (350ns) (5v)	7.95
TMS2716	2048 x 8 (450ns)	9.95
TMS2532	4096 x 8 (450ns) (5v)	7.95
2732	4096 x 8 (450ns) (5v)	6.95
2732-250	4096 x 8 (250ns) (5v)	12.95
2732-200	4096 x 8 (200ns) (5v)	16.95
2764	8192 x 8 (450ns) (5v)	16.95
2764-250	8192 x 8 (250ns) (5v)	18.95
2764-200	8192 x 8 (200ns) (5v)	19.95
TMS2564	8192 x 8 (450ns) (5v)	24.95
MC68764	8192 x 8 (450ns) (5v)(24 pin)	call

5v = Single 5 Volt Supply

EPROM ERASERS

	Timer	Capacity Chip	Intensity (uW/Cm²)	
PE-14		6	5,200	83.00
PE-14T	X	6	5,200	119.00
PE-24T	X	9	6,700	175.00
PL-265T	X	20	6,700	255.00
PR-125T	X	16	15,000	349.00
PR-320	X	32	15,000	595.00

DISC CONTROLLERS

1771	20.95
1791	29.95
1793	38.95
1795	54.95
1797	54.95
6843	34.95
8272	39.95
UPD765	39.95
1691	18.95
2143	18.95

INTERFACE

8T26	1.69
8T28	2.49
8T95	.99
8T96	.99
8T97	.99
8T98	.99
DM8131	2.95
DP8304	2.29
DS8835	1.99
DS8836	.99

MISC.

3242	7.95
3341	4.95
MC3470	4.95
MC3480	9.00
11C90	13.95
95H90	7.95
2513-001 UP	9.95
2513-002 LOW	9.95

SOUND CHIPS

76477	3.95
76489	8.95
AY3-8910	12.95
MC3340	1.49

CRT CONTROLLERS

6845	14.95
68B45	35.95
HD46505SP	15.95
6847	12.25
68047	24.95
8275	29.95
7220	99.95
CRT5027	39.95
CRT5037	49.95
TMS9918A	39.95

BIT-RATE GENERATORS

MC14411	11.95
BR1941	11.95
4702	12.95
COM5016	16.95
COM8116	10.95
MM5307	10.95

UARTS

AY3-1014	6.95
AY5-1013	3.95
PT1472	9.95
TR1602	3.95
2350	9.95
2651	18.95
TMS6011	5.95
IM6402	7.95
IM6403	8.95
INS8250	14.95

KEYBOARD CHIPS

AY5-2376	11.95
AY5-3600	11.95
74C922	5.25
74C923	5.50

CLOCK CIRCUITS

MM5314	4.95
MM5369	3.95
MM5375	4.95
MM58167	8.95
MM58174	11.95
MSM5832	6.95

Z-80

2.5 Mhz

Z80-CPU	3.95
Z80-CTC	5.95
Z80-DART	15.25
Z80-DMA	17.50
Z80-PIO	5.75
Z80-SIO/0	18.50
Z80-SIO/1	18.50
Z80-SIO/2	18.50
Z80-SIO/9	16.95

4.0 Mhz

Z80A-CPU	6.00
Z80A-CTC	8.65
Z80A-DART	18.75
Z80A-DMA	27.50
Z80A-PIO	6.00
Z80A-SIO/0	22.50
Z80A-SIO/1	22.50
Z80A-SIO/2	22.50
Z80A-SIO/9	19.95

6.0 Mhz

Z80B-CPU	17.95
Z80B-CTC	15.50
Z80B-PIO	15.50

ZILOG

Z6132	34.95
Z8671	39.95

CRYSTALS

32.768 khz	1.95
1.0 mhz	4.95
1.8432	4.95
2.0	3.95
2.097152	3.95
2.4576	3.95
3.2768	3.95
3.579535	3.95
4.0	3.95
5.0	3.95
5.0688	3.95
5.185	3.95
5.7143	3.95
6.0	3.95
6.144	3.95
6.5536	3.95
8.0	3.95
10.0	3.95
14.31818	3.95
15.0	3.95
16.0	3.95
18.0	3.95
18.432	3.95
20.0	3.95
22.1184	3.95
32.0	3.95

DATA ACQUISITION

ADC0800	15.55
ADC0804	4.95
ADC0809	5.25
ADC0817	10.95
DAC0800	4.95
DAC0806	2.25
DAC0808	4.95
DAC1020	8.25
DAC1022	8.25
MC1408L6	2.25
MC1408L8	4.95

8000

8035	7.25
8039	7.95
INS-8060	17.95
INS-8073	29.95
8080	3.95
8085	7.95
8085A-2	11.95
8086	29.95
8087	CALL
8088	39.95
8089	89.95
8155	7.95
8156	8.95
8185	29.95
8185-2	39.95
8741	39.95
8748	29.95
8755	32.00

8200

8202	29.95
8203	39.95
8205	3.50
8212	1.85
8214	3.85
8216	1.80
8224	2.50
8226	1.80
8228	4.90
8237	19.95
8238	4.95
8243	4.45
8250	14.95
8251	4.75
8253	9.25
8253-5	9.85
8255	4.75
8255-5	5.25
8257	8.50
8257-5	8.95
8259	6.90
8259-5	7.50
8271	39.95
8272	39.95
8275	29.95
8279	9.50
8279-5	10.00
8282	6.65
8283	6.65
8284	5.70
8286	6.65
8287	6.50
8288	25.00
8289	49.95

FUNCTION GENERATORS

MC4024	3.95
LM566	1.49
XR2206	3.75
8038	3.95

INTERSIL

ICL7103	9.50
ICL7106	9.95
ICL7107	12.95
ICL8038	3.95
ICM7107A	5.59
ICM7208	15.95

6800

68000	99.95
6800	4.95
6802	10.95
6808	13.90
6809E	19.95
6809	12.95
6810	2.95
6820	4.95
6821	4.95
6828	14.95
6840	12.95
6843	34.95
6844	25.95
6845	14.95
6847	12.25
6850	3.45
6852	5.75
6860	10.95
6862	11.95
6875	6.95
6880	2.95
6883	24.95
68047	24.95
68488	19.95

6800 = 1MHZ

68B00	10.95
68B02	22.25
68B09E	29.95
68B09	29.95
68B10	7.95
68B21	12.95
68B45	35.95
68B50	12.95

68B00 = 2 MHZ

6500

1 MHZ

6502	5.95
6504	6.95
6505	8.95
6507	9.95
6520	4.35
6522	8.75
6532	11.25
6545	22.50
6551	11.85

2 MHZ

6502A	9.95
6522A	11.70
6532A	12.40
6545A	28.50
6551A	12.95

3 MHZ

6502B	14.95

EXAR

XR 2206	3.75
XR 2207	3.85
XR 2208	3.90
XR 2211	5.25
XR 2240	3.25

9000 SERIES

9316	1.00
9334	2.50
9368	3.95
9401	9.95
9601	.75
9602	1.50
96S02	1.95

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2716 16K EPROMS $3.95 EACH

2732 32K EPROMS $6.95 EACH

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74LS00

74LS00	.25	74LS86	.40	74LS169	1.75	74LS323	2.75
74LS01	.25	74LS90	.65	74LS170	1.75	74LS324	1.75
74LS02	.25	74LS91	.89	74LS173	.80	74LS352	1.55
74LS03	.25	74LS92	.70	74LS174	.95	74LS353	1.55
74LS04	.25	74LS93	.65	74LS175	.95	74LS363	1.35
74LS05	.25	74LS95	.85	74LS181	2.15	74LS364	1.95
74LS08	.35	74LS96	.95	74LS189	9.95	74LS365	.95
74LS09	.35	74LS107	.40	74LS190	1.00	74LS366	.95
74LS10	.25	74LS109	.40	74LS191	1.00	74LS367	.70
74LS11	.35	74LS112	.45	74LS192	.85	74LS368	.70
74LS12	.35	74LS113	.45	74LS193	.95	74LS373	1.75
74LS13	.45	74LS114	.50	74LS194	1.00	74LS374	1.75
74LS14	1.00	74LS122	.45	74LS195	.95	74LS377	1.45
74LS15	.35	74LS123	.95	74LS196	.85	74LS378	1.18
74LS20	.25	74LS124	2.99	74LS197	.85	74LS379	1.35
74LS21	.35	74LS125	.95	74LS221	1.20	74LS385	1.90
74LS22	.25	74LS126	.85	74LS240	1.29	74LS386	.65
74LS26	.35	74LS132	.75	74LS241	1.29	74LS390	1.90
74LS27	.35	74LS133	.89	74LS242	1.85	74LS393	1.90
74LS28	.35	74LS136	.55	74LS243	1.85	74LS395	1.65
74LS30	.25	74LS137	.99	74LS244	1.29	74LS399	1.70
74LS32	.35	74LS138	.75	74LS245	1.90	74LS424	2.95
74LS33	.55	74LS139	.75	74LS247	.75	74LS447	.37
74LS37	.55	74LS145	1.20	74LS248	1.25	74LS490	1.95
74LS38	.35	74LS147	2.49	74LS249	.99	74LS624	3.99
74LS40	.35	74LS148	1.35	74LS251	1.30	74LS668	1.69
74LS42	.55	74LS151	.75	74LS253	.85	74LS669	1.89
74LS47	.75	74LS153	.75	74LS257	.85	74LS670	2.20
74LS48	.75	74LS154	2.35	74LS258	.85	74LS674	9.65
74LS49	.75	74LS155	1.15	74LS259	2.85	74LS682	3.20
74LS51	.25	74LS156	.95	74LS260	.65	74LS683	3.20
74LS54	.35	74LS157	.75	74LS266	.55	74LS684	3.20
74LS55	.35	74LS158	.75	74LS273	1.65	74LS685	3.20
74LS63	1.25	74LS160	.90	74LS275	3.35	74LS688	2.40
74LS73	.40	74LS161	.95	74LS279	.55	74LS689	3.20
74LS74	.45	74LS162	.95	74LS280	1.98	74LS783	24.95
74LS75	.50	74LS163	.95	74LS283	1.00	81LS95	1.69
74LS76	.40	74LS164	.95	74LS290	1.25	81LS96	1.69
74LS78	.50	74LS165	.95	74LS293	1.85	81LS97	1.69
74LS83	.75	74LS166	2.40	74LS295	1.05	81LS98	1.69
74LS85	1.15	74LS168	1.75	74LS298	1.20	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	3.25
RS232 FEMALE	3.75
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	.65
7410	.19	74152	.65
7411	.25	74153	.55
7412	.30	74154	1.40
7413	.35	74155	.75
7414	.55	74156	.65
7416	.25	74157	.55
7417	.25	74159	1.65
7420	.19	74160	.85
7421	.35	74161	.70
7422	.29	74162	.85
7423	.29	74163	.85
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	.59	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	.35	74196	.79
7475	.49	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	.65	74248	1.85
7486	.35	74249	1.95
7489	4.95	74251	.75
7490	.35	74259	2.25
7491	.40	74265	1.35
7492	.50	74273	1.95
7493	.49	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	74298	.85
74110	.45	74351	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	.55	74390	1.75
74125	.45	74393	1.35
74126	.45	74425	3.15
74128	.55	74426	.85
		74490	2.55

CMOS

4000	.35	4528	1.25
4001	.35	4531	.95
4002	.25	4532	1.95
4006	.95	4538	1.95
4007	.29	4539	1.95
4008	.95	4543	2.70
4009	.45	4555	.95
4010	.45	4556	.95
4011	.35	4581	1.95
4012	.25	4582	1.95
4013	.45	4584	.95
4014	.95	4585	.95
4015	.95	4702	12.95
4016	.45	74C00	.35
4017	1.15	74C02	.35
4018	.95	74C04	.35
4019	.45	74C08	.35
4020	.95	74C10	.35
4021	.95	74C14	1.50
4022	1.15	74C20	.35
4023	.35	74C30	.35
4024	.75	74C32	.50
4025	.35	74C42	1.75
4026	1.65	74C48	1.20
4027	.65	74C73	.65
4028	.80	74C74	.85
4029	.95	74C76	.80
4030	.45	74C83	1.95
4034	2.95	74C85	1.95
4035	.85	74C86	.95
4040	.95	74C89	4.50
4041	1.25	74C90	1.75
4042	.75	74C93	1.75
4043	.85	74C95	1.75
4044	.85	74C107	1.00
4046	.95	74C150	5.75
4047	.95	74C151	2.25
4049	.55	74C154	3.25
4050	.55	74C157	1.75
4051	.95	74C160	2.00
4053	.95	74C161	2.00
4060	1.45	74C162	2.00
4066	.75	74C163	2.00
4068	.40	74C164	2.00
4069	.35	74C165	2.00
4070	.35	74C173	2.00
4071	.30	74C174	2.25
4072	.30	74C175	2.25
4073	.30	74C192	2.25
4075	.30	74C193	2.25
4076	.95	74C195	2.25
4078	.30	74C200	5.75
4081	.30	74C221	2.25
4082	.30	74C373	2.75
4085	.95	74C374	2.75
4086	.95	74C901	.80
4093	.95	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	4.95	74C910	9.95
4502	.95	74C911	10.00
4503	.65	74C912	10.00
4508	1.95	74C914	1.95
4510	.95	74C915	2.00
4511	.95	74C918	2.75
4512	.95	74C920	17.95
4514	1.25	74C921	15.95
4515	2.25	74C922	5.59
4516	1.55	74C923	5.95
4518	1.25	74C925	6.75
4519	1.25	74C926	7.95
4520	1.25	74C927	7.95
4522	1.25	74C928	7.95
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74S65	.40	74S253	.95
74S74	.50	74S257	.95
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74S112	.50	74S274	19.95
74S113	.50	74S275	19.95
74S114	.55	74S280	2.25
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	.95	74S374	2.45
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	1-99	100-up
Jumbo Red	.10	.09
Jumbo Green	.18	.15
Jumbo Yellow	.18	.15

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2N3904	NPN SWITCH	TO-92	10/1.00	100/8.99
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TEXAS INSTRUMENTS I.C. SOCKETS

Solder Tail Single Beam Dip Sockets

Body — 94 V-O polyester with Copper Alloy contacts. Accommodates standard IC leads up to .014" thick and .025" wide. Contact is designed and oriented to the insulator to grasp the broad "face" of the IC lead, allowing for low insertion and high retention forces. Socket is designed to achieve maximum density on boards.

TIN — Tin Plated Solder Tail Single Beam Low Profile Dip Sockets — Tin Plated, 200 Microinch Min., 40° to +75°C

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WIRE WRAP DIP SOCKETS

- Standard profile
- Universal mounting and packaging capabilities
- Contacts accommodate .015" through .021" rectangular or round dual-in-line leads
- Wire wrap posts hold to true position of .015 providing a true position of .030 on boards for efficient automatic wire wrapping
- YOUR CHOICE — TIN OR GOLD
- TEXAS INSTRUMENTS QUALITY

TIN PLATED WIRE WRAP — GOLD INLAY WIRE WRAP

MOLEX I.C. SOCKET PINS

1.25/C 11.25/M 52.50/5M 500.00/M

TEXAS INSTRUMENTS GOLD EDGEBOARD CONNECTORS

Solder Tab • Solder Eye • Wire Wrap

- RELIABLE, COST-EFFICIENT CONTACT DESIGN
- 50 (Wire Wrap) to 50 (Solder Tail) microinches gold inlay over a nickel diffusion barrier
- Copper-nickel-tin CA 725 alloy
- Bifurcated contact points
- Preloaded, cantilever spring design
- Contacts are user removable

H6 SERIES .100"×.200" EDGEBOARD CONNECTORS

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H4 SERIES .156"×.200" EDGEBOARD CONNECTORS

TIME-TEMPERATURE PROGRAMMABLE MODULE

USER PROGRAMMABLE FOR:

79F

THE "PROGRAMMABLE" CLOCK MODULES

Cat. No.	Description	Cost
MA1020M	MA1020 Clock Module (Assembled and tested)	$ 9.95
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MA1020B	Alarm Buzzer for MA1020M	3.36
MA1020C	Includes MA1020M, P, T, & B	$23.95
MA1020P	Conventional ...	$ 4.25
MA1020B	Includes MA1020M, MA1020C & MA1020T	$17.80

3 AMP SILICON RECTIFIER

IF	PIV	Surge (10ms)	VF
3A	50V	100A	1.1V

Part	1	10	100	1000
PR5400	.35	3.00	27.50	250.00

ITT RECTIFIERS

ITT SILICON ZENER DIODES

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5% CARBON FILM RESISTORS

½ WATT RESISTOR ASSORTMENTS

RS125		$9.90
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180 COMPONENTS — ASSORTMENT OF 180 POPULAR ALUMINUM ... SPACERS — Cat. No. J200-Kit ONLY $29.95

"NEW" MA1032 Clock

Digital LCD Clock Module

- Operates from a single 1.5V Battery
- 0.5" LCD Display

Instructions included in All Orders

Catalog No.	Description	Price
MA1032M	LCD Clock Module only	$17.95
MA1032C	Switch for MA1032M	2.85
MA1032K	MA1032M, MA1032C, & AA battery holder	$21.20

DIGI-CLOCK KIT

- 12 VDC — Ideal for Car, Van or Boat!

12:48

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150 CAPACITORS — Price includes convenient divided plastic box with bin guide for easy storage and quick access — ASSORTMENT OF 15 POPULAR CAPACITORS — Cat. No. P6200-Kit ONLY $35.95

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ELECTRONIC HARDWARE KIT

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PANASONIC DISC CAPACITORS

NEW! KIT — 310 DISC CAPACITORS — ASSORTMENT OF 18 POPULAR VALUES PANASONIC QUALITY — CAT. NO. DH KIT ONLY $24.95

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100 VDC plus minus 10% TOLERANCE

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Shielded Transformers

Low As 2⁹⁹ NEW!

Color-coded wire leads for easy hookup. U.L. listed. 120VAC primaries. CT = center tap.

Secondary	Mounting Centers	Cat. No.	Only
6.3VAC at 450 mA	2"	273-1364	2.99
12VAC at 450 mA (CT)	2"	273-1365	3.59
24VAC at 450 mA (CT)	2⁷/₁₆"	273-1366	3.99

Miniature SPDT Relays

NEW! 3⁴⁹ Each

Contacts Rated 3 Amps at 125VAC

⁹/₁₆ x ²⁵/₃₂ x ⁵/₈"

5VDC, 70-Ohm Coil. 275-246 .... 3.49
12VDC, 400-Ohm Coil. 275-247 .... 3.49

LCD 3½-Digit Autoranging Multimeter

NEW! 89⁹⁵

It's the DVM That "Thinks"!

- *Built-In "Beep" Continuity Check*
- *Low-Battery And Over-Range Indicators*
- *With Test Leads, Spare Fuse and Instructions*

You choose the function, it selects and displays the range automatically—even if probes are reversed! Convenient "beep" continuity and range-change indicator (switchable). Range-hold feature overrides auto-ranging when desired. Measures up to 1000 VDC, 500 VAC, 200 mA (DC and AC), 2 megohms with very accurate low-resistance readings. 6³/₈ x 3¹/₂ x 1³/₈". Requires two "AA" batteries. 22-192 .... 89.95

NFET IC Op Amps

NEW! *Frequency Compensated* Low As 1⁷⁹

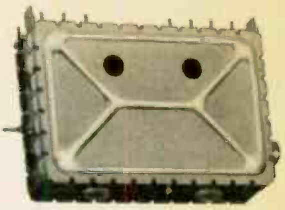
Input: one trillion ohms, typical. Short-circuit protected. Senses input levels at or near ground potential. 3 to 36VDC, single or split supply.

Type	DIP	Cat. No.	Each
TL091 (Single)	8-pin	276-1745	1.79
TL092 (Dual)	8-pin	276-1746	2.29
TL094 (Quad)	14-pin	276-1747	4.49

Varactor UHF-TV Tuner

NEW! 24⁹⁵

Brand New—NOT Surplus



UES-A56F. Sensitive, stable—great for projects, replacement, conversion to 450 MHz ATV. 75-ohm in/out. V+: 12VDC. 0 to 28VDC for tuning. With data. 277-220 .... 24.95

Pigtail Fuses

NEW! Fast-Acting

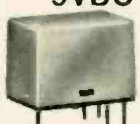
Amps	Cat. No.	Pkg. of 2
¹/₄	270-1220	.99
¹/₂	270-1221	.99
³/₄	270-1222	.99
1	270-1223	.99
1.5	270-1224	.99
2	270-1225	.99
2.5	270-1226	.99
3	270-1227	.99

Push-In Neon Lamps

NEW! Pkg. of 2 1⁹⁹

One red, one green. Built-in dropping resistors for 120VAC. Mount instantly in ⁷/₁₆" holes.
272-709 .... Pkg. of 2/1.99

5VDC DIP Relay



2⁹⁹ NEW!

³/₈ x ⁹/₁₆ x ³/₈"

Fits 14-pin DIP socket or mounts on PC board. SPDT contacts: 2 amps at 125VAC. 72 mA, 70-ohm coil.
275-243 .... 2.99

PC-Mount Electret Mike

1¹⁹ NEW!

Omnidirectional, with 20 to 15,000 Hz ±4 dB response. 2-10VDC, 1 milliamp max. current drain. 9.4mm dia. × 6.6mm. 270-090 .... 1.19

Boards & Connectors for Computer Projects

Low As 1²⁹ NEW!

Radio Shack Exclusive!

For clean—not kluged—projects! Ideal for peripheral circuits and transforming one computer format to another. These top quality, dual-sided glass boards accept card edge connectors, sockets and headers. They are indexed to save time and reduce wiring errors.

Fig.	Connectors	Contact Points	Size	Cat. No.	Each
A	40 position	1520	4¹/₄ x 5¹/₄	276-163	4.95
A	50 position	1520	4¹/₄ x 5¹/₄	276-164	4.95
B	40 position	2898	5¹/₄ x 8¹/₄	276-165	9.95
B	50 position	2898	5¹/₄ x 8¹/₄	276-166	9.95

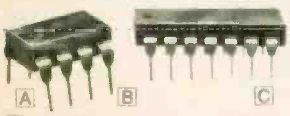
C 40-Pin Card Edge Socket. Solder eyelets. 276-1544 .... 2.59
50-Position Card Edge Socket. Solder eyelets. 276-1545 .... 2.99
D 40-Position Socket With 12" Cable. 276-1542 .... 4.99
50-Position Socket With 12" Cable. 276-1543 .... 5.49
E 40-Position Header. 276-1540 ... 1.29 50-Pos. 276-1541 ... 1.49

PC-Mount Piezo Buzzer

NEW! 2⁴⁹

Great for security, use in clock radios, digital projects and more. 3.0-20VDC. 12 milliamps at 12VDC. 17.5 x 4.5mm diameter. 273-065 .... 2.49

IF, FM/Audio and Video Detector ICs



A **MC1330.** 3rd IF, video detector, video and AFC buffers. High linearity. Outputs: Wideband video, AFT, narrow-band reverse video. 8-pin w/specs.
276-1757 .... 2.49

B **MC1350 Universal IF Amp With AGC.** For radio and TV circuits to 60 MHz. Typical gain at 45 MHz: 50 dB. 8-pin w/specs.
276-1758 .... 2.19

C **MC1358/CA3065.** IF amp (100 kHz to 5.5 MHz), limiter, FM detector, electronic attenuator, audio driver. 14-pin w/specs.
276-1759 .... 1.79

Micro-Mini 5VDC Relay

NEW! 2⁴⁹

Just ¹¹/₃₂ x ³/₈ x ¹/₄", and ideal for crowded boards with .100" centers. SPDT contacts: 1 amp at 125VAC. 55-ohm, 90 mA coil.
275-240 .... 2.49

Actual Size

AC Outlet Analyzer

NEW! 5⁹⁵

Neon readout warns you instantly if a 3-wire (grounded) outlet or extension cord is faulty. Just plug it in before using tools, appliances or amplified musical instruments.
22-101 .... 5.95

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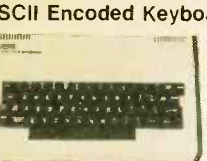
JE600 Hexadecimal Encoder Kit

FULL 8-BIT LATCHED OUTPUT 19-KEY KEYBOARD

The JE600 Encoder Keyboard Kit Provides two separate hexadecimal digits produced from sequential key entries to allow direct programming for 8-bit microprocessor or 8-bit memory circuits. Three additional keys are provided for user operations with one having a bistable output available. The outputs are latched and monitored with 9 LED readouts. Also included is a key entry strobe. Features: Full 8 bit latched output for microprocessor use. Three user-define keys with one being bistable operation. Debounce circuit provided for all 19 keys. 9 LED readouts to verify entries. Easy interfacing with standard 16-pin IC connector. Only +5VDC required for operation. Size: 3½"H x 8¼"W x 8¾"D

JE600/DTE-HK (After assembled as pictured above) **$99.95**
JE600 Kit 19-Key Hexadec. Keyboard, PC Board & Cmpnts. (no case) .. **$59.95**
K19 19-Key Keyboard (Keyboard only) **$14.95**
DTE-HK (case only 3½"Hx8¼"Wx8¾"D) **$44.95**

JE610 ASCII Encoded Keyboard Kit



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

JE610/DTE-AK (After assembled as pictured above) ... **$124.95**
JE610 Kit 62-Key Keyboard, PC Board, & Components (no case) . **$ 79.95**
K62 62-Key Keyboard (Keyboard only) ... **$ 34.95**
DTE-AK (case only 3¼"Hx11"Wx8¾"D) **$ 49.95**

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

JE215 Adjustable Dual Power Supply

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

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

JE215 Adj. Dual Power Supply Kit (as shown) .. **$24.95**
(Picture not shown but similar in construction to above)
JE200 Reg. Power Supply Kit (5VDC, 1 amp) .. $14.95
JE205 Adapter Brd. (to JE200) ±5,±9 & ±12V .. $12.95
JE210 Var. Pwr. Sply. Kit, 5-15VDC, to 1.5amp .. $19.95

HP-Display Sale-National

5082 Series — 0.43 Inch — 7-Segment

Part Number	Color	Description	1-3 Price	SALE PRICE
5082-7650	Hi Eff Red	CA - LHD	.99	4/$2.49
5082-7651	Hi Eff Red	CA - RHD	.99	4/$2.49
5082-7653	Hi Eff Red	CC - RHD	.99	4/$2.49
5082-7656	Hi Eff Red	Overflow ± 1RHD	.99	4/$2.49
5082-7660	Yellow	CA - LHD	.99	4/$2.49
5082-7661	Yellow	CA - RHD	.99	4/$2.49
5082-7663	Yellow	CC - RHD	.99	4/$2.49
5082-7670	Green	CA - LHD	.99	4/$2.49
5082-7671	Green	CA - RHD	.99	4/$2.49
5082-7673	Green	CC - RHD	.99	4/$2.49
5082-7676	Green	Overflow ± 1RHD	.99	4/$2.49
5082-7750	Red	CA - LHD	.99	4/$2.49
5082-7751	Red	CA - RHD	.99	4/$2.49
5082-7756	Red	Overflow ± 1RHD	.99	4/$2.49
5082-7760	Red	CC - RHD	.99	4/$2.49

CA-Comm. Anode CC-Comm. Cathode LHD/RHD-Left/right hand dec.

UTIC
Mini Stereo AM/FM Receiver

CLOSE-OUT!

WITH HEADPHONES For Joggers, Cyclists, Skaters & Sports Events

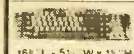
FEATURES: Lightweight headphones. Left/right balance control. Full fidelity stereo sound. Additional black soft carrying case & shoulder strap. Belt clip (hands free). Operates on 3 AA cell batteries (not incl.). Compact size: 3⅛" x 4⅞" x 1". Wt. 6 oz.

Model 2830 .... **$29.95**

KEYBOARDS — POWER SUPPLIES

9¼"Lx4¼"Wx1"H

ALPS 26-KEY CALCULATOR KEYBOARD
Features: 7 Position, 3 Position and 2 Position Switches (ON/OFF). These are from Olivetti's Top of the Line. Mechanical SPST Switching: 22-pin Edge Card Connection
Part No. KB26 .... $1.95 each or 2/$3.49

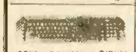


16⅝"L x 5¼" W x 1⅞"H

MICRO SWITCH 69-KEY KEYBOARD
Data Entry Keyboard. Encoded Output. 8-bit Parallel EBC DIC. Switching: Hall Effect. 24-pin Edge Card Connection. Complete with Pin Connection
Part No. KB69SD12-2 (Fits into DTE-20 Enclosure) .... $19.95 each

16¾"L x 5½"W x 1¾"H

DATANETICS 74-KEY KEYBOARD
ASCII Encoded Keyboard. Output: Even Parity ASCII. Supply voltage +5, -12 volt. Switching: Mechanical SPST — 50-pin Connection. Complete with Pin Connection.
Part No. K8354 (Fits into DTE-20 Enclosure) .... $29.95 each



23"Lx5¼"Wx1-3/8"H

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. 85SD18-1 .... $29.95 each

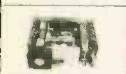
18¼"L x 5¼" W x 1⅝"H

MICRO SWITCH 88-KEY KEYBOARD (PARALLEL ASCII)
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. 88SD22 (Fits into DTE-20 Enclosure) .... $69.95 each

POWER SUPPLY — 5VDC @ 1 AMP REGULATED Transaction Tech
Output: +5VDC @ 1 amp (also +30VDC) reg. Input 115VAC 60Hz. Two-tone (black/beige) self-enclosed case. 6 ft., 3 cond. black power cord. Size: 6½"W x 7"D x 2¼"H. Wt. 3 lbs.
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 7¾"D x 3-7/8"H - wt. 7 lbs.
Part No. PS407D .... $24.95 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 @ 7.5 amp, 12VDC @ 1.6 amp. 8 ft. blk. pow. cord. 11½"W x 13¾"D x 3¾"H. Wt. 6 lbs.
Part No. PS94V0 .... $49.95 each



POWER PAC — Heavy Duty Multi-Voltage Power Supply — 5VDC, 12VDC, 24VDC
Output: +5VDC @ 30A, +12VDC @ 2A, -12VDC @ 4A & +24VDC @ 3A. Input: 115VAC, 7A, 220VAC 3.5A. Reg.: ±.15% line & load comb. Ripple: 10MV peak to peak (3MV RMS). Overvolt protect.: 5V, +12V, -12V. Overcur. protect. Incl. 15½"L x 6"H x 11-7/8"D. Wt. 40 lbs.
Part No. 285-016 .... $89.95 each

SOC 2-6 (Pictured)

SORENSEN Regulated Power Supplies

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	1.8	2.1	6.0	4.9	3.8	5.62 x 4.88 x 7.50	4.3 lbs	$19.95
SOC 2-25	F	1.8	2.1	25.0	21.5	17.5	16.00 x 4.88 x 4.88	16 lbs	29.95
SOC 5-3	A	4.75	5.25	3.0	2.4	1.8	4.00 x 4.88 x 1.62	2 lbs	24.95
SOC 5-18	E	4.25	5.75	18.0	15.0	12.0	14.00 x 4.88 x 2.75	12 lbs	39.95
SOC 5-25	F	4.25	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	8.2	6.8	14.00 x 4.88 x 1.62	12 lbs	44.95
SOC 12-15	F	11.4	12.6	15.0	12.75	9.5	16.00 x 4.88 x 4.88	16 lbs	49.95
SOC 15-5	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 15-9.5	E	14.25	15.75	9.5	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	10.5	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	.47	4.00 x 4.88 x 1.62	2 lbs	24.95

220300 (Pictured)

Powertec Sub-Modular DC Power Supplies

SM Series power supplies include rectifying, filtering, regulating, overload and overvoltage protection functions. You need only connect the sub-module to the appropriate secondary transformer tap and bolt the unit to a heatsink.

REGULATION: LINE: .10% for a change from -10% to +10% input voltage. LOAD: .15% for a 0-100% load change (units below 5V output maintain 5V regulation). OUTPUT RIPPLE: 1mV RMS, 3mV P-P typical, 5mV P-P maximum. INPUT CHARACTERISTICS: Requires low-level AC input. Derate output current 15% for operations at 50Hz.

Part Number	-100 *4.75V to 7.0V	-200 *7.0V to 10.5V	-300 *10.5V to 15.75V	-500 *22.0V to 30.0V	Power Transformer Requirements (Transformers Not Included) Primary	Secondary	Size (Inches)	Wt.	Price
22AA 300			0.23A		115-120VAC	17VAC .5A no CT	2.50 x 3.00 x .98	2 oz	$14.95
22B 200		2.2A			115-120VAC	22VAC 3A w CT	3.00 x 5.75 x 1.18	8 oz	14.95
22B 300			1.8A		115-120VAC	28VAC 2.5A w CT	2.75 x 5.75 x 1.18	8 oz	19.95
22C 100	6.0A				115-120VAC	18VAC 8A w CT	2.80 x 7.50 x 1.18	8 oz	24.95
22C 500				2.5A	115-120VAC	48VAC 3A w CT	2.80 x 7.50 x 1.18	8 oz	24.95
22D 300			6.8A		115-120VAC	28VAC 10A w CT	3.00 x 7.00 x 3.30	2 lbs	24.95
22E 100	18.00A				115-120VAC	16VAC 24A w CT	2.90 x 7.00 x 3.30	2 lbs	29.95

*Voltage Adjustment Range — Current ratings apply over entire voltage range

★ **SHIPMENT IN 24 HOURS** ★

MONDAY THRU FRIDAY

7:00AM to 5:00PM (PST)

NEW HOURS

Call: (415) 592-8097

JUMPER AND CABLE ASSEMBLIES

Custom Jumpers! Custom Cables!

STANDARD DIP JUMPERS

All jumpers use low profile dip plugs with heavy duty pins for repeated disconnect applications.

JAMECO Part No.	3M 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	924108-12	14	double end	12"	3.20
DJ14-2-14	924106-24	14	double end	24"	3.49
DJ14-3-14	924106-36	14	double end	36"	3.79
DJ16-1	924112-12	16	single end	12"	1.85
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"	3.35
DJ16-2-16	924116-24	16	double end	24"	3.69
DJ16-3-16	924116-36	16	double end	36"	4.05
DJ24-1	924122-12	24	single end	12"	2.69
DJ24-2	924122-24	24	single end	24"	3.39
DJ24-3	924122-36	24	single end	36"	3.95
DJ24-1-24	924126-12	24	double end	12"	4.79
DJ24-2-24	924126-24	24	double end	24"	5.29
DJ24-3-24	924126-36	24	double end	36"	5.89
DJ40-1	924132-12	40	single end	12"	5.69
DJ40-2	924132-24	40	single end	24"	6.79
DJ40-3	924132-36	40	single end	36"	7.69
DJ40-1-40	924136-12	40	double end	12"	10.95
DJ40-2-40	924136-24	40	double end	24"	11.89
DJ40-3-40	924136-36	40	double end	36"	12.79

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	$ 9.95 ea.
DB25S-4	4 feet	1 DB25S	10.95 ea.
DB25P-4-P	4 feet	2 DB25P	16.95 ea.
DB25P-4-S	4 feet	1 DB25P 1 DB25S	17.95 ea.
DB25S-4-S	4 feet	2 DB25S	18.95 ea.

$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

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NEW! Telex Number Telex 176043

1355 SHOREWAY ROAD, BELMONT, CA 94002

10/82 *PHONE ORDERS WELCOME — (415) 592-8097*

5¼" Mini-Floppy Disc Drive

Perlec Computer Corp.

FOR TRS-80 MODEL I, III (Industry Standard)
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	$179.95

Single-sided, 40 tracks, 250K bytes capacity

Part No.	Price
FD250	$199.95

Double-sided, 35 tracks, 430K bytes capacity

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 $16.95
TRS-16K3 *200ns $14.95
TRS-16K4 *250ns $10.95

TRS-80 Color 32K Conversion Kit

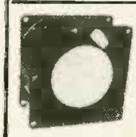
Kit comes complete with 8 ea 4164-2 (200ns) 64K Dyn. RAMs & conversion documentation. Converts TRS-80 color computers with E-Revision Boards from 16K to 32K.

TRS-64K2 (200ns) $69.95

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" **$39.95**



Pee Wee Boxer 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

PWS2107U Cleaned & tested (used) .... $ 7.95 ea.
PWS2107F New .... $12.95 ea.

Muffin® 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

MU2A1-U Cleaned & tested (used) .... $ 7.95 ea.
MU2A1-N New .... $12.95 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**

AC250 (Pictured)

Wall Transformers AC and DC Types

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
AC1700	117V/60Hz	9VAC 1.7 amp	$3.95
AC9004	117V/60Hz	9.2VAC 2.5 amp	$2.95 or 2/$4.95
DC 800	120V/60Hz	8VDC 400mA	$1.95 or 2/$2.95
DC6912	120V/60Hz	6,9,12VDC 300mA	$9.95
DS5490	117V/60Hz	9.5VDC 275mA	$2.49 or 2/$3.95
DC900	120V/60Hz	9VDC 500mA	$3.95
DC1200	120V/60Hz	12VDC 300mA	$2.95 or 2/$4.95

MOTOROLA AM/FM Stereo Push Button Car Radio

FOR VOLKSWAGEN SCIROCCO, RABBIT, AUDI 5000 AND FOX (with minor adjustments, can be used in any automobile)

Includes bezel trim & everything pictured. Two ea. 4x6 speakers & grille (1½" deep). All cables & leads for hook-up. Incl. all instruction Manuals for easy installation. Cut-out dim.: 7"W x 1¾"H x 6½"L.

Model 5VW3901 .... **$49.95**

7400

**Number of Pins of each I.C. for easy Socket purchase

Part No.	**Pins	Price
SN7400N	14	.19
SN7401N	14	.19
SN7402N	14	.25
SN7403N	14	.25
SN7404N	14	.25
SN7405N	14	.25
SN7406N	14	.29
SN7407N	14	.29
SN7408N	14	.25
SN7409N	14	.25
SN7410N	14	.25
SN7411N	14	.25
SN7412N	14	.35
SN7413N	14	.35
SN7414N	14	.49
SN7416N	14	.25
SN7417N	14	.25
SN7420N	14	.19
SN7421N	14	.35
SN7422N	14	.45
SN7423N	16	.59
SN7425N	14	.29
SN7426N	14	.29
SN7427N	14	.25
SN7428N	14	.49
SN7430N	14	.25
SN7432N	14	.29
SN7437N	14	.25
SN7438N	14	.29
SN7439N	14	.59
SN7440N	14	.19
SN7441N	16	.89
SN7442N	16	.45
SN7443N	16	.99
SN7444N	16	.99
SN7445N	16	.69
SN7446N	16	.69
SN7447N	16	.69
SN7448N	16	.69
SN7450N	14	.19
SN7451N	14	.19
SN7453N	14	.19
SN7454N	14	.19
SN7459A	14	.25
SN7460N	14	.19
SN7470N	14	.29
SN7472N	14	.29
SN7473N	14	.35
SN7474N	14	.35
SN7475N	16	.45
SN7476N	16	.35
SN7479N	14	4.95
SN7480N	14	.69
SN7482N	14	1.19
SN7483N	16	.59
SN7485N	16	.59
SN7486N	14	.35
SN7489N	16	2.25
SN7490N	14	.39
SN7491N	14	.59
SN7492N	14	.39
SN7493N	14	.39
SN7494N	14	.69
SN7495N	14	.49
SN7496N	16	.49
SN7497N	16	2.75
SN74100N	24	1.49
SN74104N	14	.89
SN74105N	14	.89
SN74107N	14	.29
SN74109N	16	.39
SN74116N	24	1.49
SN74121N	14	.39
SN74122N	14	.55
SN74123N	16	.49
SN74125N	14	.45
SN74126N	14	.45
SN74132N	14	.49
SN74136N	14	.69
SN74141N	16	.69
SN74142N	16	2.95
SN74143N	24	2.95
SN74144N	24	2.95
SN74145N	16	.59
SN74147N	16	1.49
SN74148N	16	1.19
SN74150N	24	1.19
SN74151N	16	.59
SN74152N	14	.59
SN74153N	16	.59
SN74154N	24	1.25
SN74155N	16	.59
SN74156N	14	.59
SN74157N	16	.55
SN74160N	16	.69
SN74161N	16	.69
SN74162N	16	.69
SN74163N	16	.69
SN74164N	14	.69
SN74165N	16	.69
SN74166N	16	.89
SN74167N	16	2.79
SN74170N	16	1.29
SN74172N	24	4.95
SN74173N	16	.69
SN74174N	16	.69
SN74175N	16	.69
SN74176N	14	.69
SN75177N	14	.69
SN74179N	16	1.49
SN74180N	14	.69
SN74181N	24	1.95
SN74182N	16	.69
SN74184N	16	1.95
SN74185N	16	1.95
SN74190N	16	.69
SN74191N	16	.69
SN74192N	16	.69
SN74193N	16	.69
SN74194N	16	.69
SN74195N	16	.69
SN74196N	14	.69
SN74197N	14	.69
SN74198N	24	1.19
SN74199N	24	1.19
SN74221N	16	1.19
SN74251N	16	.79
SN74276N	20	1.95
SN74279N	16	.79
SN74283N	16	1.49
SN74284N	16	2.95
SN74285N	16	2.95
SN74365N	16	.55
SN74366N	16	.55
SN74367N	16	.55
SN74368N	16	.55
SN74390N	16	1.49
SN74393N	14	1.49

74LS

Part No.	Pins	Price
74LS00	14	.25
74LS01	14	.25
74LS02	14	.25
74LS03	14	.25
74LS04	14	.29
74LS05	14	.29
74LS08	14	.29
74LS09	14	.29
74LS10	14	.29
74LS11	14	.35
74LS12	14	.35
74LS13	14	.39
74LS14	14	.59
74LS15	14	.35
74LS20	14	.29
74LS21	14	.29
74LS22	14	.29
74LS26	14	.29
74LS27	14	.29
74LS28	14	.35
74LS30	14	.29
74LS32	14	.35
74LS33	14	.55
74LS37	14	.35
74LS38	14	.35
74LS40	14	.29
74LS42	16	.55
74LS47	16	.75
74LS48	16	.75
74LS49	14	.75
74LS51	14	.25
74LS54	14	.25
74LS55	14	.29
74LS73	14	.39
74LS74	14	.39
74LS75	16	.39
74LS76	16	.39
74LS78	14	.39
74LS83	16	.69
74LS85	16	.69
74LS86	14	.39
74LS90	14	.55
74LS92	14	.55
74LS93	14	.55
74LS95	14	.79
74LS96	16	.89
74LS107	14	.39
74LS109	16	.39
74LS112	16	.39
74LS113	14	.39
74LS114	14	.39
74LS122	14	.49
74LS123	16	.79
74LS125	14	.49
74LS126	14	.49
74LS132	14	.59
74LS133	16	.59
74LS136	14	.39
74LS138	16	.59
74LS139	16	.59
74LS151	16	.59
74LS153	16	.59
74LS154	24	.99
74LS155	16	.69
74LS156	16	.69
74LS157	16	.69
74LS158	16	.59
74LS160	16	.69
74LS161	16	.69
74LS162	16	.69
74LS163	16	.69
74LS164	14	.69
74LS165	16	1.19
74LS168	16	1.19
74LS169	16	1.19
74LS170	16	1.49
74LS173	16	.69
74LS174	16	.59
74LS175	16	.59
74LS181	24	2.49
74LS190	16	.89
74LS191	16	.89
74LS192	16	.79
74LS193	16	.79
74LS194	16	.69
74LS195	16	.69
74LS197	14	.79
74LS221	16	.89
74LS240	20	1.09
74LS241	20	1.09
74LS242	14	1.09
74LS243	14	1.09
74LS244	20	1.09
74LS245	20	1.49
74LS247	16	1.09
74LS248	16	1.09
74LS249	16	1.09
74LS251	16	.59
74LS253	16	.59
74LS257	16	.59
74LS258	16	.59
74LS260	14	.59
74LS266	14	.69
74LS273	20	1.49
74LS279	16	.49
74LS283	16	.69
74LS290	14	.89
74LS293	14	.79
74LS298	16	.89
74LS352	16	1.29
74LS353	16	1.29
74LS365	16	.49
74LS366	16	.49
74LS367	16	.49
74LS368	16	.49
74LS373	20	1.29
74LS374	20	1.29
74LS375	16	.69
74LS386	14	.45
74LS393	14	1.19
74LS399	16	1.49
74LS670	16	1.49
81LS95	20	1.49
81LS97	20	1.49

74S/PROMS*

Part No.	Pins	Price
74S00	14	.35
74S02	14	.35
74S03	14	.35
74S04	14	.45
74S05	14	.45
74S08	14	.39
74S09	14	.39
74S10	14	.35
74S11	14	.35
74S15	14	.35
74S20	14	.35
74S22	14	.35
74S30	14	.35
74S32	14	.45
74S38	14	.89
74S40	14	.39
74S51	14	.35
74S64	14	.39
74S65	14	.39
74S74	14	.55
74S86	14	.55
74S112	16	.55
74S113	14	.55
74S114	14	.55
74S124	16	2.95
74S133	16	.45
74S134	16	.50
74S135	16	.69
74S136	14	1.39
74S138	16	.89
74S139	16	.89
74S140	14	.55
74S151	16	.99
74S153	16	.99
74S157	16	.99
74S158	16	.99
74S160	16	2.49
74S174	16	.99
74S175	16	.99
74S188*	16	1.49
74S194	16	1.49
74S195	16	1.49
74S196	14	1.49
74S240	20	2.25
74S241	20	2.25
74S242	14	2.49
74S243	14	2.49
74S244	20	2.49
74S251	16	1.19
74S253	16	1.19
74S257	16	1.19
74S258	16	1.19
74S260	14	.79
74S280	14	1.95
74S287*	16	1.95
74S288*	16	1.95
74S373	20	2.49
74S374	20	2.49
74S387*	16	1.95
74S471*	20	5.95
74S472*	20	4.95
74S473*	20	4.95
74S474*	24	4.95
74S475*	24	4.95
74S570*	16	2.95
74S571*	16	2.95
74S572*	18	4.95
74S573*	18	4.95
74S940	20	2.49
74S941	20	2.49

CA—LINEAR

Part No.	Pins	Price
CA3010H		.99
CA3013H		2.15
CA3023H		3.25
CA3035H		5.95
CA3039H		1.35
CA3046N	14	.89
CA3059N	14	3.25
CA3060N	16	3.25
CA3080H		1.25
CA3081N	16	1.49
CA3082N	16	1.49
CA3083N	16	1.49
CA3086N	14	.69
CA3089N	16	1.69
CA3096N	16	1.19
CA3130H		1.95
CA3140H		1.49
CA3160H		1.95
CA3401N	14	.59
CA3600N	14	3.95

CD—CMOS

Part No.	Pins	Price
CD4000	14	.29
CD4001	14	.29
CD4002	14	.29
CD4006	14	.89
CD4007	14	.29
CD4009	16	.39
CD4010	16	.39
CD4011	14	.29
CD4012	14	.15
CD4013	14	.39
CD4014	16	.79
CD4015	16	.39
CD4016	14	.39
CD4017	16	.75
CD4018	16	.79
CD4019	16	.39
CD4020	16	.75
CD4021	16	.79
CD4022	16	.79
CD4023	14	.29
CD4024	14	.69
CD4025	14	.23
CD4026	16	2.49
CD4027	16	.45
CD4028	16	.69
CD4029	16	.79
CD4030	14	.39
CD4034	24	1.95
CD4035	16	.89
CD4040	16	.79
CD4041	14	.79
CD4042	16	.69
CD4043	16	.79
CD4044	16	.79
CD4046	16	.89
CD4047	14	.89
CD4048	16	.39
CD4049	16	.39
CD4050	16	.39
CD4051	16	.79
CD4052	16	.79
CD4053	16	.79
CD4056	16	2.95
CD4059	24	7.95
CD4060	16	.89
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	.75
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

STATIC RAMS

Part No.	**Pins		Price
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)	2.25 - 8/14.95
2114L	18	1024x4 (450ns) L P	2.49 - 8/16.95
2114-2	18	1024x4 (200ns)	2.49 - 8/16.95
2114L-2	18	1024x4 (200ns) L P	2.95 - 8/18.95
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
HM6116-4	24	2048x8 (200ns) CMOS	7.95
HM6116LP-4	24	2048x8 (200ns) L P CMOS	8.95
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

Part No.	Pins		Price
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)	24.85
TMS2716	24	2048x8 (450ns) 3 voltage	7.95
2716	24	2048x8 (450ns)	5.95
2732	24	4096x8 (450ns)	9.95
27580	24	1024x8 (450ns) single +5V	2.95
MM2764	28	8192x8 (450ns)	19.95

MICROPROCESSOR CHIPS

Part No.	Pins		Price
Z80 (780C)	40	CPU (MK3880N) (2MHz)	5.95
Z80A (780-1)	40	CPU (MK3880N-4) (4MHz)	6.95
Z80B	40	CPU (MK3880N-6)(6MHz)	14.95
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
INS8035N-6	40	MPU—8-bit (6MHz)	5.95
INS8039N-6	40	CPU-Sgl. chip 8 bit (128 bts. Ram)	6.95
INS8040N-6	40	CPU (256 bytes RAM)	14.95
INS8070N	40	CPU (64 bytes RAM)	19.95
INS8073N	40	CPU w/Basic Micro Interpreter	24.95
P8085	40	CPU	5.95

MICROPROCESSOR MANUALS

Part No.		Price
M-Z80	User Manual	7.50
M-CDP1802	User Manual	7.50
M-2650	User Manual	5.00

6800/6800 SUPPORT DEVICES

Part No.	Pins		Price
MC6800	40	MPU	4.95
MC6802CP	40	MPU with clock and RAM	7.95
MC6810API	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

8080/8080A SUPPORT DEVICES

Part No.	Pins		Price
INS8080A	40	CPU	3.95
DP8212	24	8-bit Input/Output	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 Controller/Bus Driver	3.49
DP8238	28	System Controller	4.49
INS8243	24	I/O Expander for 48 Series	5.95
INS8250	40	Asynchronous Comm. Element	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	8.95
DP8303	20	System Timing Element	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

DYNAMIC RAMS

Part No.	**Pins		Price
1103	18	1024x1 (300ns)	.99
4027	16	4096x1 (250ns)	2.49
4116N-2	16	16,384x1 (150ns)	2.25 - 8/16.95
4116N-3	16	16,384x1 (200ns)	1.95 - 8/14.95
4116N-4	16	16,384x1 (250ns)	1.49 - 8/10.95
4164N-2	16	65,536x1 (200ns)	8.95 - 8/69.95
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)	2.25 - 8/16.95
MM5290-3	16	16,384x1 (200ns)	1.95 - 8/14.95
MM5290-4	16	16,384x1 (250ns)	1.49 - 8/10.95
MM5298-3	16	8192x1 (200ns)	1.69

PROMS

Part No.	Pins			Price
74S186	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)	9.85
DM87S184N	18	2048x4	PROM O C (82S184)	9.95
DM87S185N	18	2048x4	PROM T S (82S185)	9.95
DM87S190N	24	2048x8	PROM O C (82S190)	19.95
DM87S191N	24	2048x8	PROM T S (82S191)	19.95

ROM'S

Part No.	Pins		Price
2513 (2140)	24	Character Generator (Upper Case)	9.95
2513 (3021)	24	Character Generator (Lower Case)	9.95

NMOS READ ONLY MEMORIES

Part No.	Pins		Price
MCM66710P	24	128x9x7 ASCII Shifted w. Greek	13.50
MCM66740P	24	128x9x7 Math Symbol & Pictures	13.50
MCM66750P	24	128x9x7 Alpha. Control Char. Gen.	13.50

DATA ACQUISITION

Part No.	Pins		Price
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	16	8-bit D/A Converter (DAC0808LCN)	2.95
AF100-1CN	16	Universal Active Filter 2.5%	5.95
AF121-1CJ	24	Touch Tone Low Band Filter	19.95
AF122-1CJ	24	Touch Tone High Band Filter	19.95
LM308CH		Super Gain Op Amp	1.15
LM334Z		Constant Current Source	1.30
LM335Z		Temperature Transducer	1.40
LF356N	8	JFET Input Op Amp	1.10
LF398N	8	Sample & Hold Amplifiers	3.95
LM399H		Temp Comp. Prec. Ref. (.5ppm/C°)	5.00
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
ADC0817	40	8-bit A/D Converter (16-Ch. Multi.)	9.95
DAC1000	24	10-bit D/A Conv. Micro. Comp. (0.05%)	13.95
DAC1008	20	10-bit D/A Conv. Micro. Comp. (0.20%)	7.95
DAC1020	16	10-bit D/A Converter (0.05% Lin.)	8.49
DAC1022	16	10-bit D/A Converter (0.20% Lin.)	5.95
DAC1222	18	12-bit D/A Converter (0.20% Lin.)	6.95
CD4051N	16	8-Channel Multiplexer	.79
AY-5-1013A	40	30K BAUD UART (TR1602)	3.95

SPECIAL FUNCTION

Part No.	Pins		Price
DS0025CN	8	Dual MOS Clock Driver (5MZ)	2.49
DS0026CN	8	Dual MOS Clock Driver (5MZ)	1.95
INS1771N-1	40	Floppy Disk Controller	16.95
INS2651N	28	Communication Chip	8.95
MM58167N	24	Microprocessor Real Time Clock	8.95
MM58174N	16	Micro. Compatible Time Clock	7.95
COP402N	40	Microcontroller w/64-digit RAM and Direct LED Drive	5.95
COP402MN	40	Microprocessor w/64-digit RAM & Direct LED Drive w/N Buss Int	5.95
COP470N	20	32 seg. VAC Fluor. Drvr. (20 pin pkg.)	3.25

TELEPHONE/KEYBOARD CHIPS

Part No.	Pins		Price
AY-5-9100	18	Push Button Telephone Dialer	14.95
AY-5-9200	16	Repertory Dialer	14.95
AY-5-9500	14	CMOS Clock Generator	4.95
AY-5-2376	40	Keyboard Encoder (88 keys)	9.95
HD0165-5	24	Keyboard Encoder (16 keys)	9.95
74C922	18	Keyboard Encoder (16 keys)	4.49
74C923	20	Keyboard Encoder (20 keys)	4.95
MM53130N	18	Touch Tone Dialer	5.95
MM53190N	20	Push Button Pulse Dialer	4.49

NATIONAL EPROM-RAM SALE

2708-5	24	1024x8 (550ns) EPROM (SM00246)	$2.95 each
27160-5	24	2048x8 (550ns) EPROM	3.95 each
27580-8	24	1024x8 (450ns) EPROM Single +5V	2.95 each
2732-5	24	4096x8 (550ns) EPROM	6.95 each
27640	28	8192x8 (450ns) EPROM	19.95 each
4164N-2	16	65,536x1 (200ns) Dynamic RAM	8/69.95 or 9.95 each
MM5290-4	16	16,384x1 (250ns) Dynamic RAM	8/10.95 or 1.49 each

CONNECTORS

25 Pin — D Subminiature (meets RS232)

Part No.	Description	Price
DB25P	PLUG (RS232)	2.95
DB25S	SOCKET (RS232)	3.50
DB25PF-179	PLUG (RS232) Wire Wrap style	4.95
DB51226-1	CABLE COVER for DB25P or DB25S	1.75
DB25P-831	PLUG — Right Angle — PC Mount	4.95
DB25S-831	SOCKET — Right Angle — PC Mount	5.25
D20418-2	Screw Lock for DB25 Series Connectors (Locks connector to panel)	2/.99

Solder Eyelet/Wire Wrap Edge Card

Part No.	Contacts	Sp.	Description	Price
15/30SE	15/30	.156	Solder Eyelet	1.95
18/36SE	18/36	.156	Solder Eyelet	2.49
22/44SE	22/44	.156	Solder Eyelet	2.95
22/44PC	22/44	.156	PC type (no mtg. ears)	1.49
50/100SE	50/100	.125	Solder Eyelet	9.95
22/44WW	22/44	.156	Wire Wrap - Level 3	7.95
67031-5	22/44	.156	WW (Pns .0625x.03x.75)	3.95
R681-1	50/100	.125	Wire Wrap - Level 3	12.95
R681-2	50/100	.125	Wire Wrap - Level 3	12.95

IC SOCKETS

For Socket Required, See Column After The IC Part No.

LOW PROFILE (TIN) SOCKETS

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

— Soldertail Standard Tin & Gold Also Available —

WIRE WRAP (GOLD) SOCKETS LEVEL #3

	1-24	25-49	50-100
8 pin WW	.59	.54	.49
10 pin WW	.69	.63	.58
14 pin WW	.79	.73	.67
16 pin WW	.85	.77	.70
18 pin WW	.99	.90	.81
20 pin WW	1.19	1.08	.99
22 pin WW	1.49	1.35	1.23
24 pin WW	1.39	1.26	1.14
28 pin WW	1.69	1.53	1.38
36 pin WW	2.19	1.99	1.79
40 pin WW	2.29	2.09	1.89

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INTERSIL

*Evaluation Kits

Part No.	**Pins	Function		Price
7045IPI	28	C OS 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
7216CIJI	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		14.95
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		19.95
8069CCQ		50ppm Band—GAP Volt Ref. Diode		2.50
8211CPA	8	Volt Ref/Indicator		2.95
8212CPA	24	Volt Ref/Indicator		2.95

74C—C/MOS

Part No.	Pins	Price
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
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74C240	20	1.95
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74C373	20	2.49
74C374	20	2.49
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74C903	14	.39
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TL072CP	8	.59
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TL084CN	14	.59
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LM301CH		.89
LM302H		1.95
LM304H		1.95
LM305H		.99
LM307CN	8	.45
LM308CN	8	.69
LM309H		1.95
LM309K		1.25
LM310CN	8	1.75
LM311CN	8	.69
LM312H		2.49
LM317MP		1.15
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
LM329DZ		.65
LM331N	8	3.95
LM334Z		1.19
LM335Z		1.40
LM336Z		1.19
LM337T		1.95
LM337MP		1.15
LM338K		6.95
LM339N	14	.69
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LM340K-12		1.35
LM340K-15		1.35
LM340T-5		.79
LM340T-12		.79
LM340T-15		.79
LM341P-5		.75
LM341P-12		.75
LM341P-15		.75
LM342P-5		.69
LM342P-12		.69
LM342P-15		.69
LM348N	14	.99
LM350K		4.95
LF351N	8	.60
LF353N	8	1.00
LF355N	8	1.10
LF356N	8	1.10
LM358N	8	.69
LM359N	14	1.79
LM370N	14	4.49
LM373N	14	3.95
LM377	14	1.95
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LM381N	14	1.79
LM382N	14	1.39
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LM386N-3	8	.89
LM387N	8	.89
LM389N	18	1.19
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NE550A	14	1.95
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LM566CN	8	1.49
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LM710N	14	.69
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.33/35V	.39	.34	.29	4.7/25V	.63	.56	.45
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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
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47/50V	.29	.25	.23	10/25V	.16	.14	.13
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220/50V	.49	.45	.41	100/25V	.25	.23	.21
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CIRCLE NO. 13 ON FREE INFORMATION CARD

NEW LITERATURE

Audio Microcomputer Brochure

A six-page brochure and 20-page 5½" × 8½" flip chart detailing the features of the BDP-2 Audio Microcomputer are now available from Crown International. The BDP-2 is an audio test instrument with a full-color CRT that is reported to provide a high level of computing and display capability. The brochure gives an overall description of the unit, and the flip chart provides step-by-step instructions for its setup and use. The brochure is free of charge; the chart is provided free with the BDP-2 or can be purchased separately from Crown for $2. **Address:** Advertising Dept., Crown International, 1718 W. Mishawaka Rd., Elkhart, IN 46517.

Power FETs

Siemens SIMPOS Power FETs are the subject of a new, 42-page color brochure available through the company's Components Division. Technical data, performance parameters, and inverse diode characteristics are discussed with reference to their applications in power electronics, e.g., power switches for motor control, printers, ultrasonic generators, etc. **Address:** Components Division, Siemens Corp., Box 1000, Iselin, NJ 08830.

Base and Mobile Antennas

Antenna Specialists has just released a full-line professional catalog of base and mobile antennas for the land mobile industry. More than 300 products are described, covering the entire spectrum from low band to 800 MHz. Major new products include the Dura-Flex elastomer shock mount antenna line and the Avanti no-ground plane, on-glass antennas. **Address:** Marketing Dept. Antenna Specialists Co., 12435 Euclid Ave., Cleveland, OH 44106.

Surge Protection

Engineers, designers, and operators of private and interplant telephone systems will find information on protecting interconnect telephone systems from electrical surge in a new guide available from TII Industries. The literature focuses on the various protection devices needed for a particular application: including products for single-phone stations and exposed cable runs between buildings. Typical interconnect arrangements are shown. **Address:** TII Industries, Inc., 1375 Akron St., Copiague, NY 11728.

Audio History

Buffs of the history of hi-fi and audio products might be interested in this brief overview of Bogen's fifty years in the sound business. It was printed as part of Bogen's golden anniversary celebration this year. **Address:** Dept. GAC, Bogen Division of Lear Siegler, Inc., Box 500, Paramus, NJ 07652.

ZX81 Software

A software catalog for the Sinclair ZX81 Computer has been published by Gladstone Electronics. The cassette software includes games (Chess, Backgammon, Star Trek), the Multifile Data Storage System, Vu-Calc for financial projections, machine code assembler, flight simulation, and more. **Address:** Gladstone Electronics, 901 Fuhrmann Blvd., Buffalo, NY 14202.

Switching Products Catalog

A new 16-page catalog from C&K Components includes photos, dimensions, drawings, and model numbers for the company's complete selection of conventional slide, rotary slide, rocker and pushbutton switches. Featured is the small-diameter "F" Series Rotary Slide, the Power Rocker "C" Series Switches, the low-cost "K" Series Switches, and the low-cost "K" Series pushbutton. **Address:** C&K Components c/o John Benson, 15 Riverdale Ave., Newton, MA 02158-1082.

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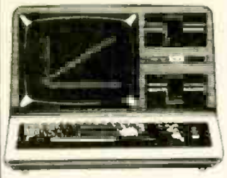

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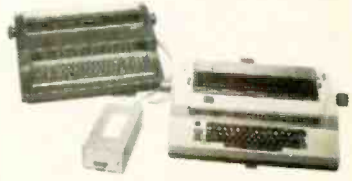

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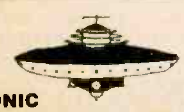

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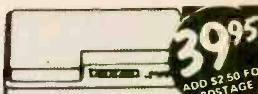

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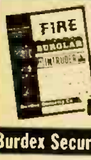

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OPERATION ASSIST

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

Gonset Model GC-105 communicator receiver. need manual, schematic and troubleshooting information. Michael R. Watson, 701 Central Ave., Sonoma, CA 95476.

Hygain Model 421 power meter. Need service data and schematic. Mark Alan, Box 2923, Greenville, NC 27834.

Allied Model TD1095 stereo reel-to-reel tape deck. Need playback head and manual. J. Dorf, Rt. 4, Box 299, Buffalo, MN 55313.

Hallicrafters Model SX-100 receiver. Need schematic and operating manual. L. Black, 4126 Hollow Creek Dr., Indianapolis, IN 46268.

Singer Model 70 phototypesetter. Need schematic. C. Biegelow, 182 E. Jefferson, Bluffton, OH 45817.

RCA Model # 195 voltomist. Need schematic and manual. Lorin S. McNutt, 5460 West 1200 South, Fairmount, IN 46928.

B&K Model 375 VTVM. Need instruction manual. B. Murphy, 260 Niagara St., Apt. 501, Buffalo, NY 14201.

Friden Model S machine calculator. Need operation manual. E. Christofferson, 303 Taylor St., N.W., Washington, D.C. 20011.

Webcor Model 300, transistor Model EP-2404-1 tape recorder. Need schematic. Byron Chamberlain, RFD-2, Box 166, Leesburg, VA 22075.

RCA Model WF-14A geiger counter. Need schematic and parts list. Don Foster, 10504 S.E. 2nd ST., Vancouver, WA 98664.

Dumont Model 401 oscilloscope. Need schematic and any information available. Wayne A. Kallunki, 1228 Belleview Blvd., Clearwater, FL 33516.

Mohawk Model 1925, type A-5 radio. Need any information available. Neil Walgenbach, 30W141 Wildwood Ct., Warrenville, IL 60555.

Sony Model TC-630 tape recorder. Need service manual and schematic. Rocky Starland, 1310 Wilson St., Bay City, MI 48706.

Heathkit Model T-3 signal tracer. Need operation and assembly manuals and schematic. Mark Alan, Box 2923, Greenville, NC 27834.

EMC Model 600 oscilloscope. Need schematic and operating manual. Robert N. Bishop, 18109 E. 27th St., Independence, MO 64057.

NRI Model 34 signal tracer. Need manual and schematic. Harvey L. Felber, 1508 Myerlee C.C. Blvd., Fort Myers, FL 33907.

Hallicrafters Model SX99 receiver. Need manual and schematic. Charles Boyd, 1237-170 St., Hammond, IN 46324.

Hy-Gain Models 16 and 20 CB. Need schematic and service manual. E. Joines, Miami Springs Senior High School, 751 Dove Avenue, Miami Springs, FL 33157.

Tennelec Model MS2 memory scanner. Need schematic, service manual and technical information. Carl J. Gray, 361 Spencer Ave., Lancaster, PA 17603.

Motorola Model TS-C9 television. Need owner's manual or any information available. Brian Douglas, 37220 Blacow Rd., Fremont, CA 94536.

Popular Electronics

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ELECTRONICS WORLD® Personal Electronics News

dbx NOISE REDUCTION will soon be available in portable stereos, according to dbx president, David Blackmer. In a joint venture, dbx and Matsushita have developed an extremely small IC chip that is designed to operate on two AA batteries (7V), or as little as 1.8V. Owners of car and Walkman-type stereos are said to be the main beneficiaries of this development, since it will enable them to play their dbx-encoded cassettes with less tape-hiss and greater dynamic range than had been previously possible. In addition, dbx believes that the new chips will be used universally when digital playback equipment becomes available for the mass market—since dbx is said to be uniquely suited to copying digital discs onto analog tape.

A COMPUTER TRAINING COURSE, called Computer Programming and Operations (COP), is being offered by the Control Data Institute. The course provides students with hands-on, interactive instruction in programming, debugging, and code creation. Emphasis is on standard programming languages and business systems analysis. No formal lectures are given, but individualized instruction is said to be provided through Control Data's PLATO computer-based education system, and by videotaped lessons and manuals. Instructors are also available should a student desire a human interface. After completing the 653 hours of course curriculum (during a period of six to ten months), students are reported to be qualified for entry-level positions as programmers, operators, assistant applications analysts, and customer service representatives. Applicants for the course must have completed at least two years of college and pass a standard admissions test. Cost is $4975 per student.

"VIDEO LETTER FROM JAPAN" is the name of a new series of video programs designed to give American children in grades 5 through 7 a candid look at various aspects of life in Japan. Funded by the TDK Electronics Co., and coordinated by the Asia Society of New York, each Video Letter contains two 25-minute segments (½" format in both VHS and Beta) that depict such topics as Japanese family life, education, economic structure, hobbies and sports, etc. The production takes the form of an audio-video profile in which a Japanese child shows and tells about a part of his life, which is interpreted for American children by an English language narration and professionally-developed teaching guides. Initial distribution of the Video Letter has begun in New York, California, and Georgia, with nationwide distribution to begin at the start of 1983.

THE TACOMA NARROWS BRIDGE COLLAPSE is the video disc feature of the newly launched Wiley Educational Software program from John Wiley & Sons. You might remember this famous disaster film from Physics 111, during the lectures on wave motion. The Wiley disc shows the actual collapse and provides a series of interactive investigations on the effects of wind speed, cable tension, and standing wave frequency. The disc offers three separate levels of presentation, depending on the user's background. It can be played on a programmed MCA DiscoVision 7820 or on a Pioneer VP-1000 player.

SOFTWARE DEVELOPERS FOR HOME COMPUTERS can now visit a center where they will have access to technical reference materials and instruction from a staff of trained professionals, according to Bruce W. Irvine, Vice President of Software for Atari's Home Computer Division. The center, located in the Crimson Galleria in Cambridge, MA, is the second of its kind—the first having been established in Sunnyvale, CA near Atari's corporate headquarters. Users of the facility will be assisted in developing software for entertainment, education, and home management, which will then be marketed by Atari. The center will also offer assistance in converting programs written for other computers to an Atari-compatible format.

TECHNICAL INFORMATION is available to electronics dealers via computer terminal as a result of an agreement between the National Electronics Service Dealers Association (NESDA) and Compu-Tips (formerly Compu-tel). The Compu-Tips National Network consists of a data base of technical tips imputed by the group of service dealers who formed the company last year. Servicing information for TV, VCR, video discs, TV games, and audio products is said to be added to the system at a rate of 500 tips per week. Other data will eventually include parts pricing and service contract management. At this writing, the system has over ten-thousand tips accessible in over 600 U.S. cities via a local phone call. For more information, contact J.W. Williams, NESDA, 2708 W. Berry, Ft. Worth, TX 76109.

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