Computers & Electronics

MARCH 1983

formerly Popular Electronics

$1.25

How Video Recordists Tap Cable TV Programs

A PRACTICAL GUIDE:

"Working" the Computer Networks

Learning 16-Bit Microcomputer Technology

The British Are Coming!

First-hand examination of BBC and Torch Micro-computers

Tested in This Issue:

- Zenith "System 3" Color TV Receiver
- going and incoming wireless telephone control)
- Marantz 46 watts/channel Stereo FM/AM Receiver

THE LEADING EDGE IN PRINTERS

ONE GREAT LINE. ONE GREAT WARRANTY.

Finally, there's one full family of printers that covers every business or word processing application—all from C. Itoh, a company known for packing more product into less price; and all distributed exclusively by Leading Edge, a company known for searching out and providing that very thing. Which means that one call to one source can get you any printer, any time you need it, for any purpose. All backed by a full years' warranty from Leading Edge. (Try *that* on any other line of printers.)

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The Prowriters: business printers—and more. The "more" is a dot-matrix process with more dots. It gives you denser, correspondence quality copy (as opposed to business quality copy, which looks like a bad job of spray-painting).
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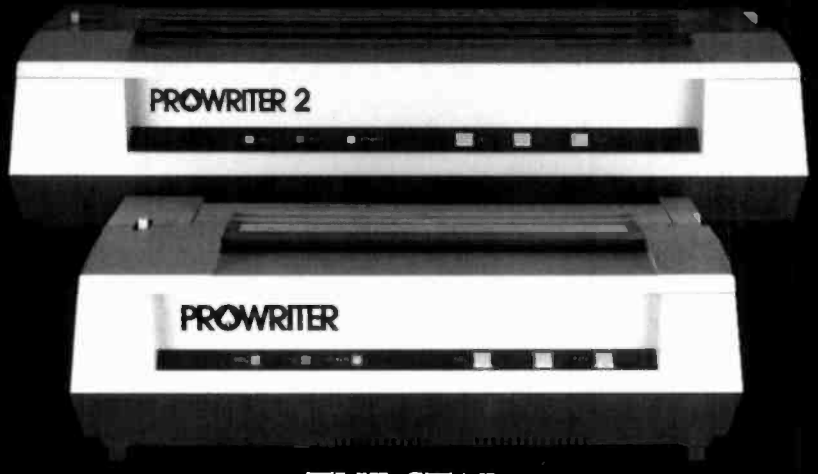

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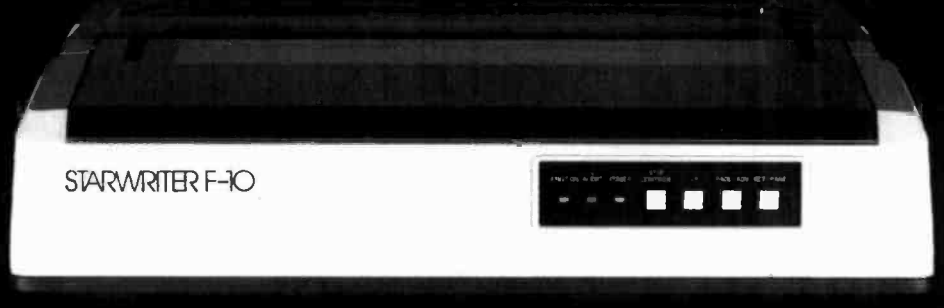
The Starwriter F-10. In short (or more precisely, in a sleek 6" high, 30-pound unit), it gives you more of just about everything—except bulk and noise—than any other printer in its price range. It's a 40 cps letter-quality daisy-wheel with a bunch of built-in functions to simplify and speed up word processing. It plugs into almost any micro on the market, serial or parallel.



THE MASTER.

The Printmaster F-10. Does all the same good stuff as the Starwriter except, at 55 cps, the Master does it faster.

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CIRCLE NO. 20 ON FREE INFORMATION CARD

The $7 Push Button Phone

Plug in and start pushing. Now you can have highly automated phones with no monthly service charges for just $7 each. But, there's a catch.

Send back your dumb phones. Now instead of paying monthly service charges you can have push button dialing, last number redial, mute, and ringer off.

You can forget big clunky phones. You can also forget dials. This phone works perfectly whether you now have rotary or push button phones.

Now for just $7 you'll have the latest technology at a price that'll let you have a phone in every room in your home. But, don't forget there's a catch.

NOTHING TO INSTALL

Simply plug this phone into any standard modular phone jack and start talking. If you don't already have jacks, call your phone company.

They may even put them in free for you. Due to the recent Supreme Court ruling, soon they'll probably be selling you your own phones anyway. And, at worst, there's just a small one time fee.

LAST NUMBER REDIAL PLUS

It's really neat. If you call a number and it's busy this phone will automatically redial the number for you each time you touch 'redial'. There's no need to keep dialing over and over again.

When you need to speak privately to someone with you, you don't have to cover the mouth piece. Just press the mute button and the person on the line will be cut off for privacy.

When you want to take a nap, just switch the ring off and the phone won't ring. There's never a need to take your phone off the hook again.

The quality is great. A high quality condenser microphone lets the person you talk to hear you loud and clear.

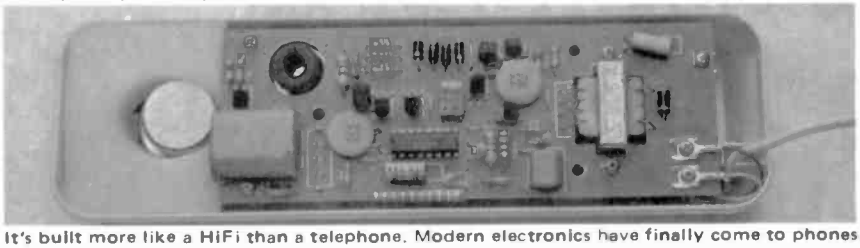
And you hear them through a high quality speaker instead of the old diaphragm 'thing' that's been in phones for 20 years. Even the electronic ring is new.

But, the nicest part of all are the push buttons. Once you've started using buttons you'll hate dialing the old way.

With this phone you can push the buttons as fast as you want. Then the phone sends out pulses on your line that work with virtually any phone system.

So this phone works anywhere. You can unplug it and move it from room to room or house to house in seconds.

The phone automatically hangs up when you set it down or you can push its 'hang up' button. It comes complete with an 8 foot cord, coiled at the phone end, and a limited warranty.



It's built more like a HiFi than a telephone. Modern electronics have finally come to phones.

THE CATCH

Frankly we are losing our shirts on the automated phone, but we're looking for audiophiles who use audio cassettes.

If you buy top name TDK and Maxell cassettes, you probably pay $3.50 to $4.50 each for a 90 minute cassette.

We want you to try DAK's new Gold Label MLX ultra high energy, normal bias cassettes. Not at $4.50 or even at $3.50 each, but at a factory direct price of just $2.49 for a 90 minute cassette.

We challenge you to compare the frequency response, dynamic range and signal to noise ratio of our new Gold Label MLX to Maxell UDXL or TDK SA. If they win, we'll not only give you back your money, we'll give you a free gift for your trouble. And, DAK's come with a deluxe hard plastic box, index insert card and a limited 1 year warranty.

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NOT A BAD CATCH

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Now our new Gold Label MLX is second to none. We have a frequency response to 19,500hz and we'll go head to head against any tape on the market.

TRY NEW DAK MLX90 CASSETTES RISK FREE

To get the automated phone for just $7, try 10 MLX high energy cassettes. If you aren't 100% satisfied, return only 9 of the 10 cassettes and the phone in its original box within 30 days for a refund. The 10th cassette is a gift for your time.

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An automated Phone for $7 and DAK's new improved MLX. Time to stock up.

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CIRCLE NO. 67 ON FREE INFORMATION CARD

The new HX-20 Notebook Computer. Where was it when I was a kid?

Epson.

The new Epson HX-20 Notebook Computer is perfect for kids. But it's not just for kids.

The HX-20 has as much total memory as most popular desktop computers. And, like a desktop, you can connect it to a monitor, add extra memory, use a cassette or microcassette to load and store programs, play games, even interface with other computers through a telephone modem.

But that's where the similarity ends. Because, unlike a desktop, the HX-20 has the hardware you need to do word and data processing anywhere. Built in. It has enough internal power to run for 50-plus hours, a full-size keyboard, a scrollable LCD screen, even a handy little microprinter.

But more importantly, it has something that no comparable personal computer can match: a price tag of under $800. You can have *everything* you need to do real computing for a lot less than the cost of most desktop computers. A lot less.

The new Epson HX-20 Notebook Computer. It's perfect for kids, salespeople, business executives, students — anyone who's looking for an affordable way into serious computing.

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Try it out. After all, why should kids have all the fun?

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CIRCLE NO. 25 ON FREE INFORMATION CARD

Computers & Electronics

MARCH 1983 VOLUME 21, NUMBER 3

FEATURE ARTICLES

39 **THE BRITISH ARE COMING!**
Stan Veit/Evaluation of the BBC and Torch microcomputers.

59 **CROSSED SIGNALS**
B.K. Roberts/A logic quiz.

60 **THE COMPUTER NETWORK MAZE, Part 1**
Stan Veit/How to use the various communication networks available on your microcomputer.

69 **THE VIDEO CONNECTION**
Dave Trowbridge/An equipment and hook-up guide for cable-TV viewers and VCR recordists.

81 **16-BIT MICROCOMPUTER TECHNOLOGY**
George Meyerle/Part 1: The first in a series on learning about an 8088-based computer.

CONSTRUCTION ARTICLES

52 **MICROCOMPUTER JOYSTICK INTERFACING METHODS**
Randy Carlstrom and Ralph Tenny/Two ways to interface a joystick or paddle to your computer.

92 **A PSEUDO CURSOR FOR OSCILLOSCOPES**
D.E. Patrick/Add a calibrated time base to dual-trace scopes.

95 **USE A TRIPLE-THREAT IC**
Sami A. Shakir/Versatile uses of the CD4040 CMOS IC.

98 **AUTOMOBILE IDIOT LIGHTS**
Richard M. Hilbert/Circuit monitors your car's electrical system

EQUIPMENT REVIEWS

16 **ZENITH SYSTEM 3 MODEL SY1963W 19" COLOR TV RECEIVER**

22 **MARANTZ SR620CX AM/FM STEREO RECEIVER**

COLUMNS

31 **LES SOLOMON ON COMPUTER HARDWARE**
Adding a Video Monitor To Your Sinclair ZX81.

35 **STAN VEIT ON COMPUTER SOFTWARE**
Software for Mass Markets and Integrated Packages.

100 **PROGRAMMER'S NOTEBOOK**/*Jim Keogh*
How to Use Subroutines.

102 **COMPUTER VIDEO GAMES**

103 **SOLID-STATE DEVELOPMENTS**/*Forrest M. Mims*
New Peripheral Transforms Apple II into a Computerized Oscilloscope.

107 **COMPUTER HOTLINE**

109 **DX LISTENING**/*Glenn Hauser*
Around the World.

111 **EXPERIMENTER'S CORNER**/*Forrest M. Mims*
Experimenting with VMOS Power Transistors.

114 **PROJECT OF THE MONTH**/*Forrest M. Mims*
A Digitally Programmable VMOS Variable Resistor.

DEPARTMENTS

6 **EDITORIAL**/*Art Salsberg*
The Calculator Connection.

7 **LETTERS**

12 **NEW PRODUCTS**

99 **LITERATURE**

106 **OPERATION ASSIST**

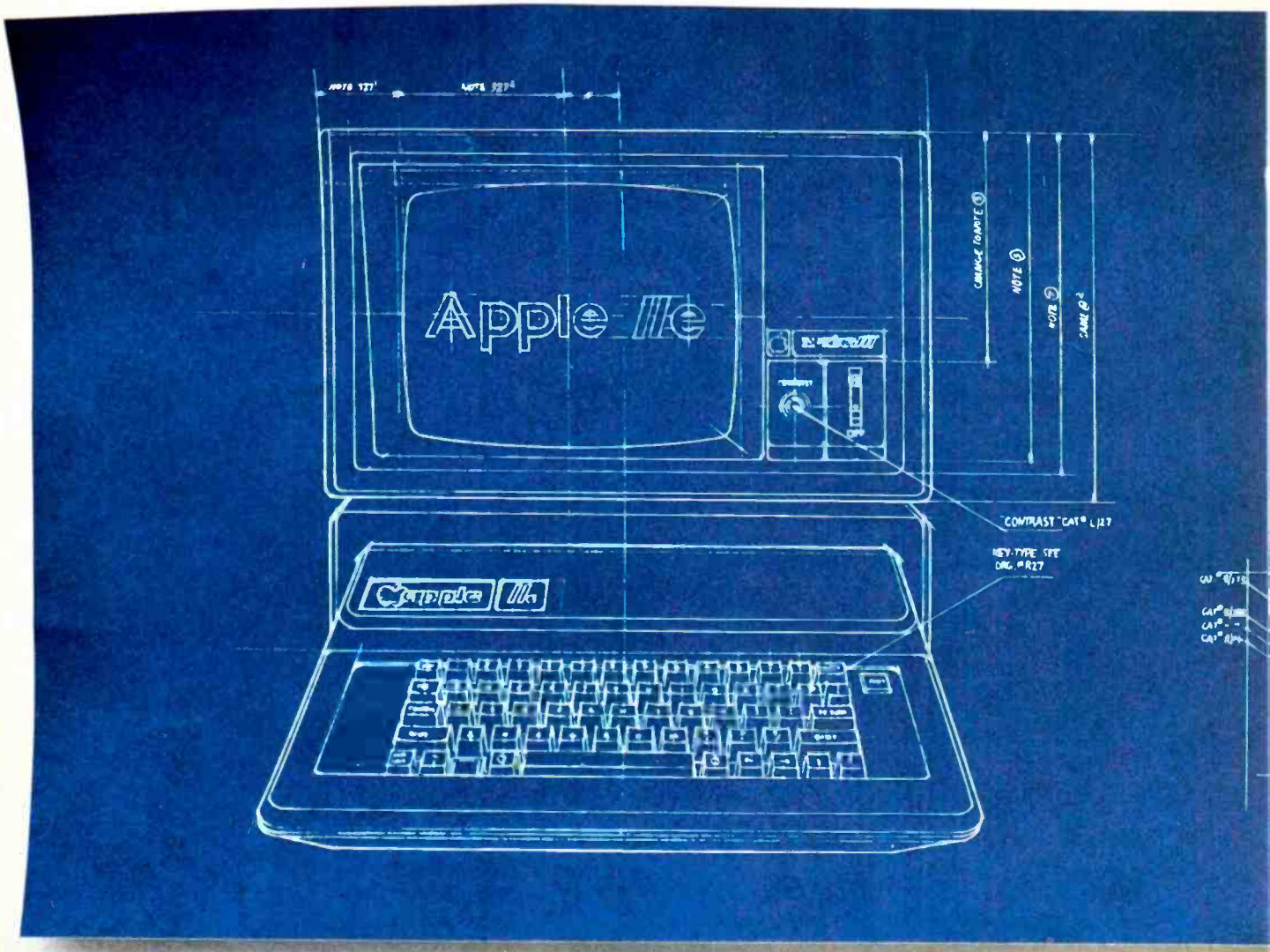
115 **ADVERTISERS' INDEX**

128 **COMPUTER MART/ELECTRONICS CLASSIFIED**

COVER PHOTO BY JAY BRENNER

 Computers & Electronics (ISSN 0032 4485) March 1983 Volume 21 Number 3 Published monthly by Ziff Davis Publishing Co., at One Park Ave New York, NY 10016 Richard P Friese President Selwyn Taubman, Treasurer, Bertram A Abrams, Secretary One year subscription rate for U S and Possessions $15 97 Canada $20 97 all other countries $23 97 (cash orders only payable in U.S currency) Second Class Postage Paid at New York, N Y 10016 and at additional mailing offices Authorized as second class mail by the Post Office Dept Ottawa Canada, and for payment of postage in cash POPULAR ELECTRONICS including ELECTRONICS WORLD trademark registered Indexed in the Reader's Guide to Periodical Literature Ziff-Davis also publishes Boating Car and Driver, Cycle, Flying, Popular Photography, Skiing, Stereo Review Electronic Experimenter's Handbook, and Tape Recording & Buying Guide **POSTMASTER:** Send address changes to COMPUTERS & ELECTRONICS Circulation Dept P O Box 2774 Boulder CO 80302 Please allow at least eight weeks for change of address, enclosing, if possible an address label from a recent issue

It's the same old Apple II.



For years, people have been trying to build a better Apple® II.

It finally happened.

Meet the Apple IIe, an impressive new version of a most impressive machine.

The "e" means enhanced. Which means a bundle of new features:

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A new, improved keyboard, with a complete set of ASCII standard characters. Plus full cursor controls, programmable function keys, and a rapid auto-repeat feature built into every key on the board.

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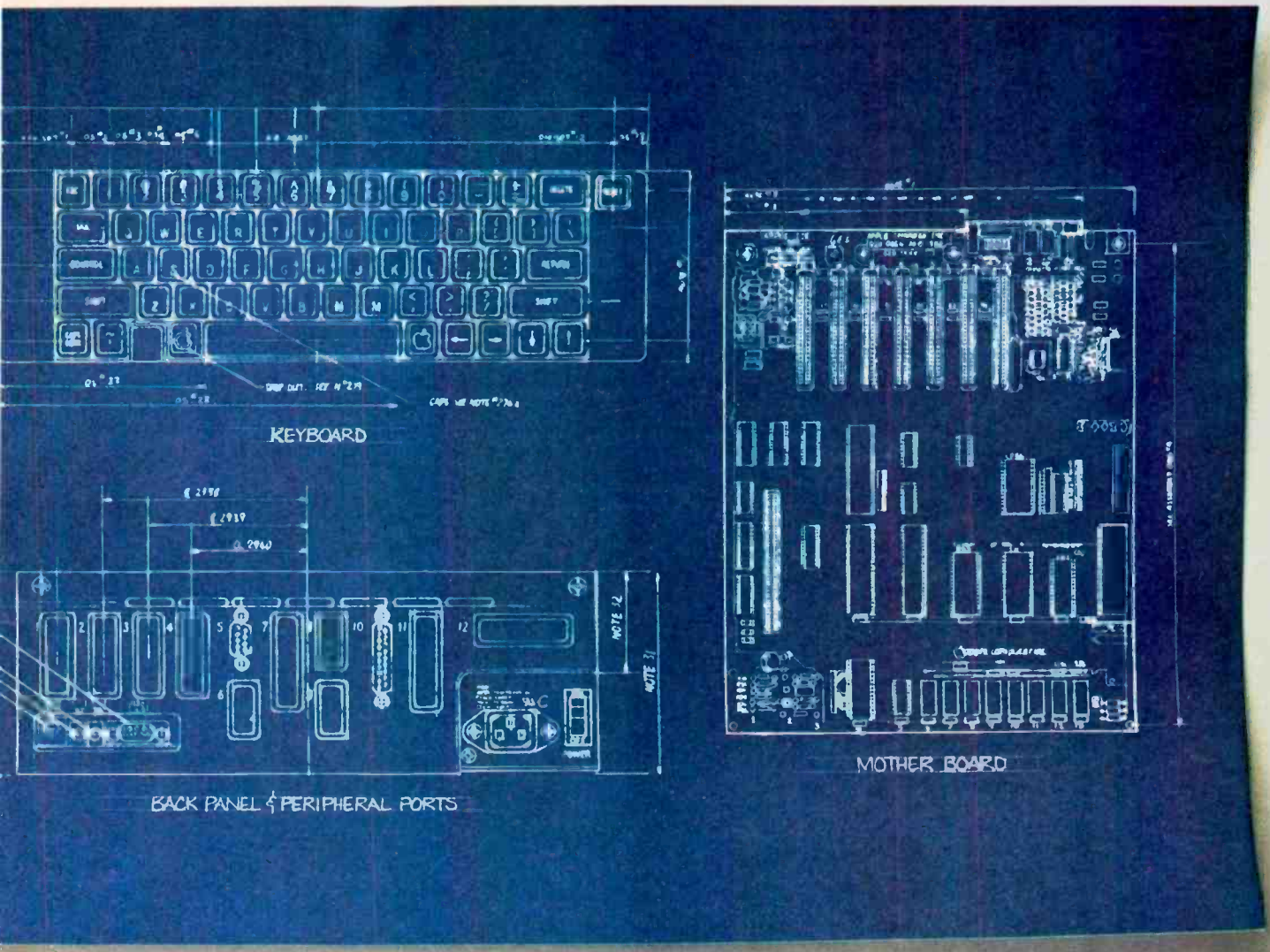
Improved peripheral ports. Which make it a lot easier to connect and disconnect game controllers, printers and all those other wonderful things that go with an Apple Personal Computer.

Except for the front, back and inside.



Self-diagnostics. That's a special feature that makes it easy to give your computer a thorough check-up.

Plus an even more reliable design. Achieved by reducing the number of components—which is to say, the number of things that could go wrong.

And bear in mind, the IIe still has all those other virtues that made the Apple II so very popular. Including access to more accessories, peripheral devices and software than any other personal computer you can buy.

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CIRCLE NO. 35 ON FREE INFORMATION CARD

EDITORIAL

The Calculator Connection

About 14 years ago a new company, Intel (a contraction of INTegrated ELectronics), got a contract from a Japanese firm to produce integrated circuits for a new calculator. It called for almost a dozen ICs. The project head, Ted Hoff, combined this need with Yankee savvy into a monolithic chip called the Intel 4004, which was the first microprocessor.

The world hasn't been the same since.

A few years later Intel introduced the first 8-bit microprocessor, aptly named the 8008. The pMOS CPU was superseded rather quickly owing to its limited instruction set and an inability to address more than 16K bytes by the nMOS 8080. This 8-bit device was able to access 65K of memory and had over 50% more instructions.

Again, a calculator maker came into the picture: MITS. The company's calculator business was in a nose dive, together with a host of others, and the owner, Ed Roberts, sought to enter the computer field using Intel's new device. The new computer, named Altair, was introduced to the world in our January 1975 issue. The calculator connection was made once again. A byproduct of the new computer was a bus with 100 connections, called the standard-100 or S-100 for short, which served as the impetus for a host of manufacturers to latch onto it with various peripherals and to establish a sort of mini (micro?) universal system that was recently standardized as the IEEE-696 bus.

Other companies developed and marketed their own microprocessors, including Motorola with its 6800 CPU, MOS Technology with its 6502, and Zilog with its Z80 (an improved outgrowth of the 8080 that spurred Intel to develop its 8085 CPU), among others.

The horsepower race continues today with the introduction of a number of 16-bit microprocessors. Actually, a 16-bit microprocessor from National Semiconductor was on the market before an 8-bit one was, but 16-bitters did not come into prominence until a later time. Even the early Texas Instruments 16-bit TMS-9900 didn't gain popularity, perhaps owing to its uniqueness. It really took Intel's 8088 16-bit CPU to dramatize the effectiveness of 16-bit devices for small computers. This "chip" is actually a modified 8086 that uses an 8-bit data bus instead of 16-bits, and programs written for it are upward compatible with the earlier 8080 CPU. Moreover, it is incorporated into the popular IBM-PC personal computer.

Furthermore, support chips must draw from the 8088 in order to work. Given all this, COMPUTERS & ELECTRONICS has choosen the 8088 as the heart of a microcomputer course initiated in this issue. As the course unfolds, you'll doubtlessly observe that it isn't pure electronics; nor is it software. It's logic-oriented, with the "electronics" in black-box devices that essentially consist of solid-state on-off switches that are often packaged as thousands to a device.

The final calculator connection here appears to have been made recently when IBM, which had a hand in developing an early general-purpose calculator, the Harvard Mark I, bought a piece of the (silicon) rock—Intel.

Art Salsberg

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LETTERS

PARALLEL PAIRS

The "Calculating Parallel Resistance Pairs" article in the December 1982 issue gives a simple shortcut for finding two or more resistance values to substitute for one that is not available. However, it should have been pointed out that the choice of the number used as the multiplier for finding the values of *R1* and *R2* is a random choice. The author used 4—it could have been 8 or 9. However, once the number is chosen for the multiplier, then the number used for the divisor must be one less, or 3 in the example—*Mack D. Baxter, Granite Shoals, TX.*

LINE SPIKES SET OFF ALARM

I built the "New, Effective Anti-Burglary System" (June 1982) and found that sometimes disturbances (spikes) on the power line will set off the alarm. The problem can be corrected to an extent by placing capacitors across the power transformer leads. However, in some cases, a capacitor must be applied across the source of the disturbance—refrigerator, fluorescent light, etc.—*David Crotty, Highland Park, MI.*

PRINTING COLOR GRAPHICS

With regard to the article "Printing Computer Graphics" (November, 1982), please note the following concerning the TRS-80 Color Computer. The early versions of the Color Computer had 7-bit printer drivers, limiting the values transmitted to 127. A cassette 8-bit driver program is available free to bring the machine to 8 bits out. Machines manufactured after April 1981, (Ver. 1.1) have had 8-bit drives built-in, and can transmit the 8-bit values needed for graphic printing. The screen print program (26-3021), which dumps a high-resolution screen to TRS-80 graphic printers also has an 8-bit output driver. The TRS-LP VIII also includes graphic capabilities.—*Roy J. Irvine, Radio Shack, Fort Worth, TX.*

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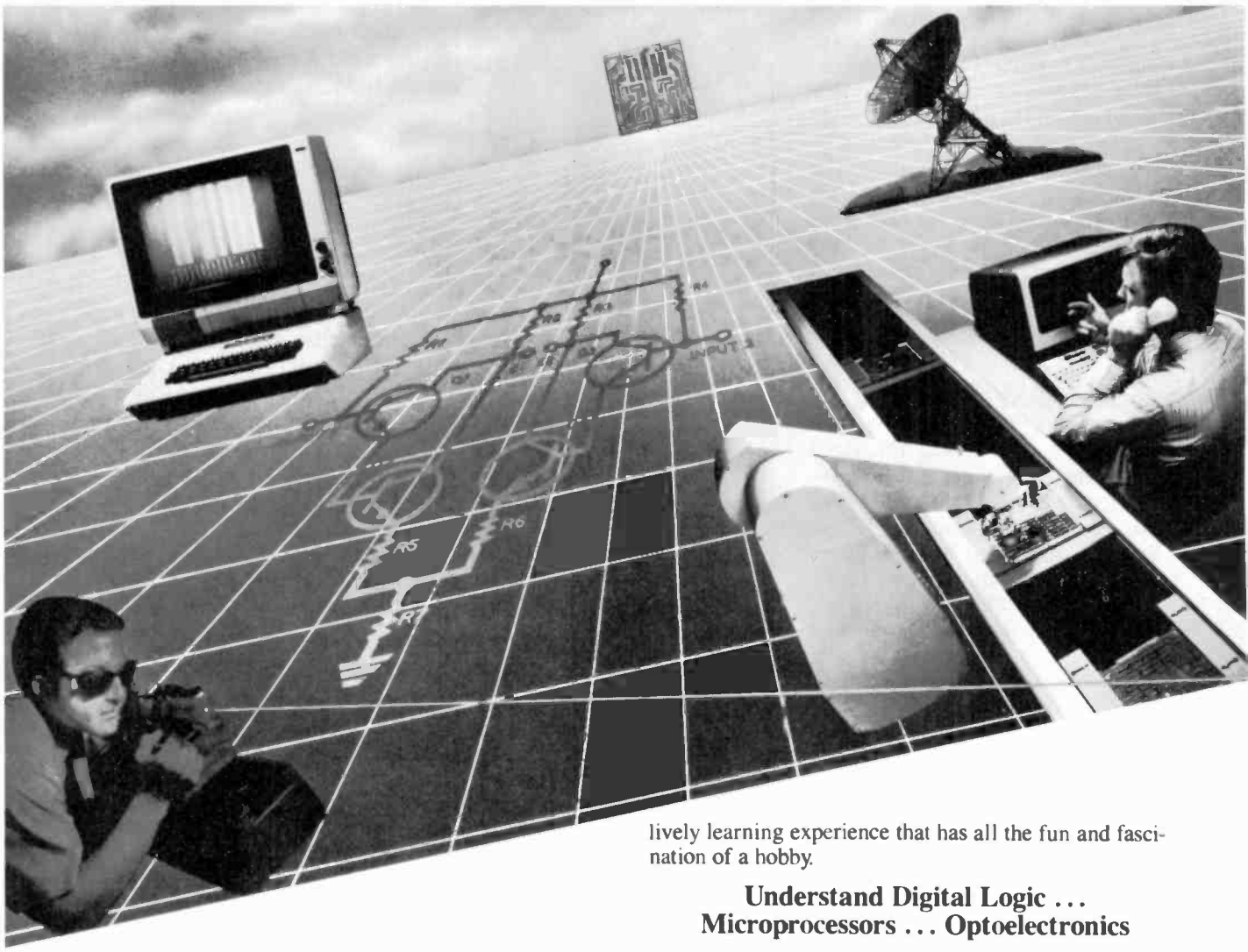

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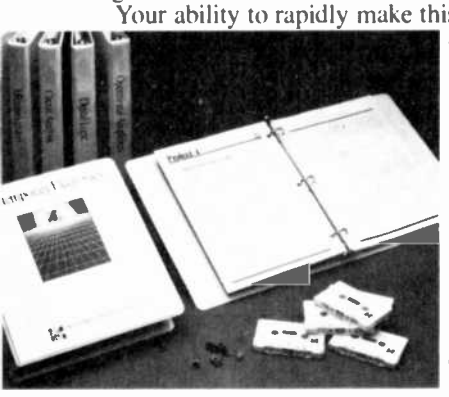

Update Your Knowledge of the New Electronics

This program is for you whether you're a scientist who can use electronics to improve or speed up your investigations... a teacher who'd benefit from a refresher in contemporary components, circuits and applications ... a manager or supervisor in an electronics related industry or business... an engineer in another field who finds electronics playing an ever more important role in your work... someone looking to find new direction in this wide open field... or the kind of person who wants to understand what's going on in the world around you.

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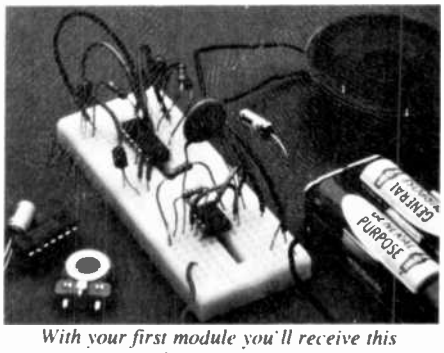

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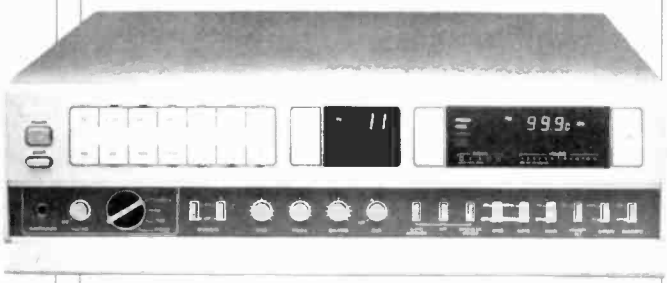
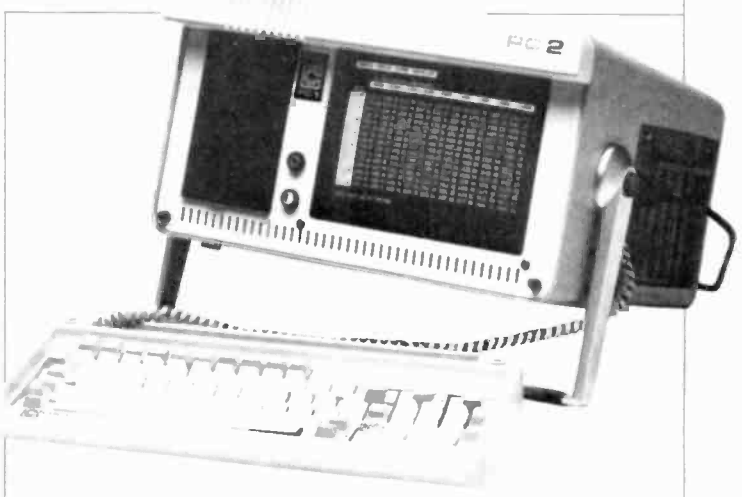


AUDIO/VIDEO RECEIVER

Combined in Jensen's Model AVS-1500 receiver are a synthesizer AM/FM tuner, 50-W/ch amplifier, cable-ready 133-channel video tuner, and microprocessor-controlled input/output switcher. The receiver can simulate stereo sound from mono video sources and has Dynamic Noise Reduction to enhance audio performance. Headphone listening to audio is possible while the main outputs are used for listening to video programs. $990.

Circle No. 92 on Free Information Card



IBM-PC COMPUTER GOES PORTABLE

Colby Computer's Model PC-1 kit allows the IBM-PC to go portable. It consists of a 9" high-resolution video monitor, switching power supply, wiring harness, and interface boards in a 17" × 15" × 8½" Cycolac® carrying case with room for IBM-PC elements. It's specifically designed to work with IBM-PC disk drive, system and plug-in boards, and keyboard. Total system weight is 26 lb. $899.

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HANDHELD DMM

The Model LX-306 is a new Hickok 3½-digit handheld multimeter with LCD display and "Vari-Pitch" tone. In addition to measuring and displaying up to 1000 V dc (750 V ac to 5 kHz), to 10 A ac/dc, and from 200 ohms to 20 megohms, the meter's tone frequency varies proportionally with signal input. Basic instrument accuracy is 0.25%. A diode test function is included. $139.

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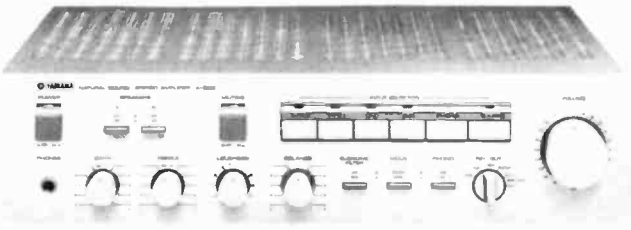

DIGITAL AUDIO STEREO AMPLIFIER

Yamaha has just released a stereo amplifier designed to meet the demanding requirements of digital audio discs. Rated at 70 W/ch, the Model A-500 features Zero Distortion Rule (ZDR) circuitry for super-low distortion, moving-coil head amp, digital input, independent record out/source in to permit recording from one source while listening to another, variable loudness control, and −20-dB mute switch. $300.

Circle No. 100 on Free Information Card

COMMUNICATIONS RECEIVER

The Model R-200 communications receiver from Trio-Kenwood covers 150 kHz to 30 MHz on AM/SSB/CW/FM in 30 bands. Features include: fluorescent frequency display; digital vfo's; 10 memories (store frequency, band, and mode); memory and programmable band scan modes; switchable i-f filters; S meter; noise blanker; r-f attenuator; dual 24-hour clock; with ac or battery operation. A lithium battery provides memory backup. $600.

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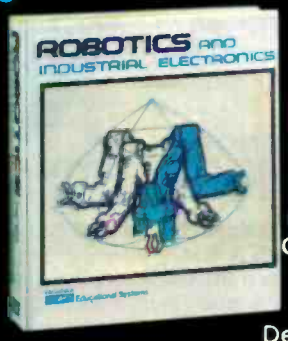
(More on page 14)

INTRODUCING the world's first, affordable teaching robot...

HERO 1 the most sophisticated microprocessor-controlled device since the microcomputer.

HERO 1 is a completely self-contained, electro-mechanical robot capable of interacting with its environment. Controlled by an on-board, programmable computer, it has electronic sensors to detect light, sound, motion and obstruction in its path.

Capable of seven axes of motion, the robot can be programmed to pick up small objects with its arm. It will also speak in comp ete sentences, using its voice synthesizer.



Remarkable though the robot is, its companion Robotics Education Course is an even more significant "first." It provides a thorough understanding of robot technologies, including robotics programming. Course features self-test unit reviews, experiments and final exam. Designed to be used with HERO 1, this 1200 page course is the most complete introduction to robotics available today.

HERO 1 is a computer on wheels. HERO 1 uses a 6808 microprocessor that controls 13 functions and sense boards. Its on-board processor can take it through complex maneuvers. The programming process is straightforward with provision for step-by-step debugging, enhancement and other corrections.

HERO 1 senses include: sound detection (frequency range 200-5000 Hz); light detection; ultrasonic ranging; ultrasonic motion detection; speech synthesis; and real time, four year calendar clock.

A completely mobile platform robot, HERO 1's motion abilities permit head rotation and arm rotation of 350°, shoulder rotation of 150°, arm extension of 5 inches, wrist pivot of 180° and wrist rotation of 350°. Gripper will open to a maximum of 3½ inches and rotate 90° at extreme extension. Payload capacity of arm is 8 oz. at maximum extension and 16 oz. at normal.

The remarkable HERO 1 robot is in production now, ready for you. Buy assembled or build it from a kit. Kit price is $1500 and the assembled robot is $2500, FOB Benton Harbor, or through your nearest Heathkit Electronic Center.

For full information on HERO 1 call 800-253-0570 toll-free. (In Alaska, Hawaii and Michigan, call 616-982-3411.) We'll give you the address of the nearest Heathkit Electronic Center and send you a booklet that gives details about the robot, the content of this course, and other information.

Please send details on the HERO 1 robot and robotics course.

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...NEW PRODUCTS (from p. 12)

PANASONIC HOME COMPUTER

Panasonic's new Model JR-200 8-color/3-tone (in five octaves) home computer comes with 32K bytes of user RAM and 16K bytes of ROM with BASIC and can be used with color TV receivers or RGB monitors. It features typewriter keyboard, ac power supply, r-f modulator, cassette I/O, Atari-compatible joystick and printer interfaces.

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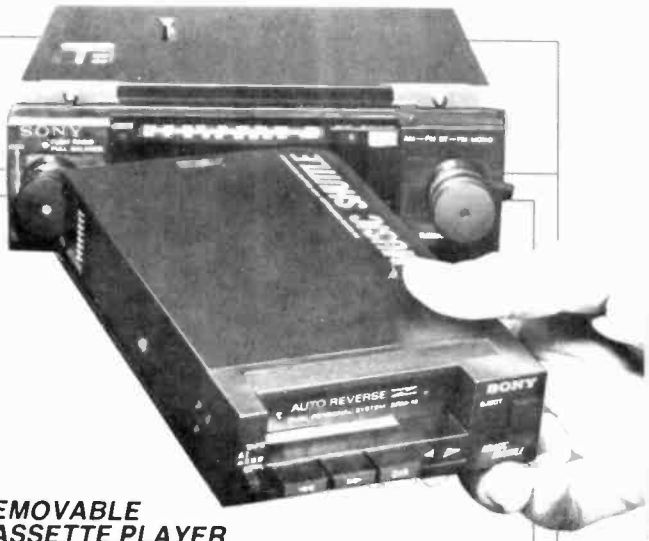

REMOVABLE CASSETTE PLAYER CAR STEREO

"Music Shuttle" Model XRM-10 from Sony Autosound is an in-dash AM/FM-stereo receiver with removable cassette player that can double as a carry-along personal stereo player. A battery pack, headphones, and carrying case are provided for Walkman-like operation of the cassette player. The system has outputs for two and four speakers, built-in fader control, metal-tape capability, and variable tape bias. System price is $380.

Circle No. 94 on Free Information Card

OLIVETTI TYPEWRITER COMPUTER INTERFACES

Olivetti Praxis series electronic portable typewriters can be used as letter-quality computer printers with "Micro-Type" interface kits from Computer Products Division of Selectone. Available are separate RS232C serial (Model OP-140S) and Centronics parallel (Model OP-150P) versions for interfacing with most personal microcomputers. Interface kits install inside the Praxis typewriters and have no effect on normal typewriter-only operation. Supplied with each kit are step-by-step instruction manual, application notes with connect points for configuration, and operating tips for many popular personal computers. $195 for each model.

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NEW HOME COMPUTER FROM ATARI

Now at the top of Atari's line of home computers is the Model 1200XL, with 64K bytes of user RAM and an improved typewriter keyboard. It can be used with existing Atari software and peripherals and includes 256 colors and four sound "voices" that cover 2½ octaves. Provided are HELP and four user-definable function keys, one applications/games cartridge slot, two controller and one serial I/O port, and an operating system compatible with previous Atari systems but modified to take advantage of the 64K memory. A built-in r-f modulator allows output to be displayed on TV channel 2 or 3. Under $1200.

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COMPUTER BOOKS FOR BEGINNERS

Everything you need to get started programming your own personal computer. These handy books of programs, and about programming, are loaded with easy-to-understand info for beginners. The books include hundreds of ready-to-type-and-run programs as well as hundreds of program-writing tips, tricks, hints, shortcuts, secrets, techniques. We offer books covering the most popular computers for beginners: TRS-80 Color Computer, Atari 400, Atari 800, Apple II, Sinclair ZX-81, Timex 1000, Micro Ace, IBM Personal Computer, Casio FX-702P pocket computer, Sharp PC-1211 and PC-1500 pocket computers and TRS-80 PC-1 and PC-2 pocket computers, TI-99/4A, VIC-20, and Commodore 64.

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101 TIMEX 1000/Sinclair ZX-81 Programming Tips & Tricks, secrets, hints, shortcuts, learn-by-doing instruction, techniques for the ZX-81, MicroAce and Timex 1000 computers, includes 101 ready-to-run programs, 128 pages **$7.95**

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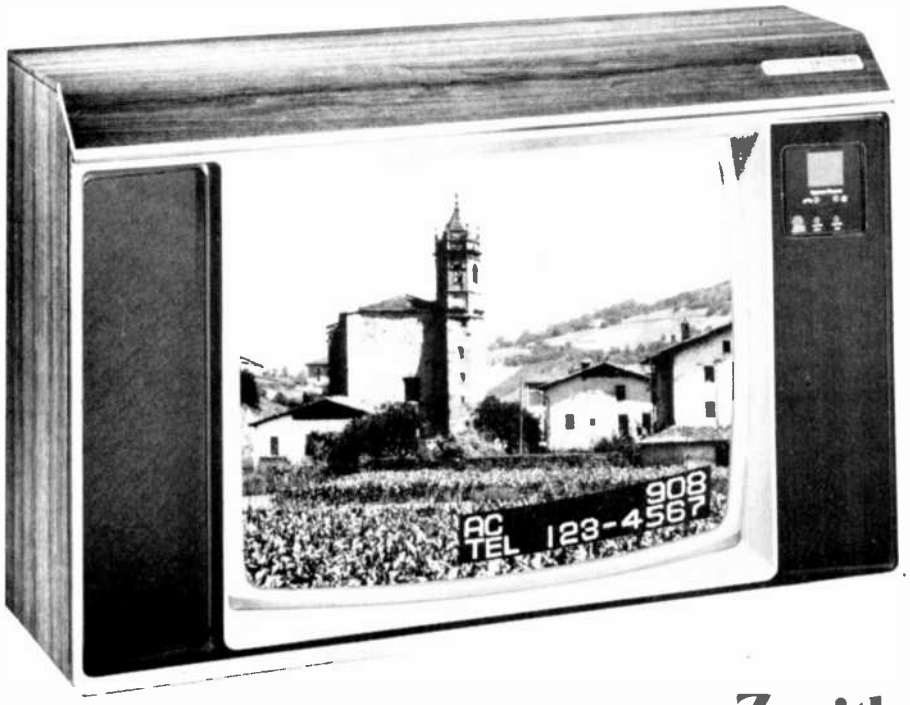

Zenith System 3 Model SY1963W 19" Color TV Receiver

In 1980, Zenith introduced an "answer-only" telephone as part of a TV receiver, following this "first" with a digital "dial-out" phone in 1981. In some of its latest sets, such as the Zenith System 3 Model SY1963W 19" color TV receiver examined here, an "Advanced Space Phone" is incorporated (Computer Space Phone Model 4100) that stores two phone numbers in memory and can automatically dial them through the TV receiver. Interestingly, the cost is only $30 more than Zenith's comparable model (Model SY161) that does not include this function.

This high-quality 19-incher features electronic tuning, remote control, 112-channel tuning capability, an on-off timer, and a number of worthwhile technical features. The new receiver utilizes the company's familiar modular construction with highly reliable "key-lock" connectors. Dimensions are 18" H × 27" W × 17" D, and weight is 56 lb.

General Description. The all-electronic, crystal-controlled, microprocessor operated vhf and uhf tuner covers 42 cable channels, including midband, superband and hyperband, as well as vhf and uhf channels. With the afc (automatic frequency control) switch in the NORMAL position the electronic fine-tuning circuit locks in on standard broadcast station signals, but when the switch is set to "special," the phase-lock loop (PLL) control voltage pulls in slightly off-frequency signals, such as those that might come from some video games, computers, VCRs, or master antenna systems.

Zenith's Computer Space Command 4100 remote control system uses infrared, digital signalling that includes not only channel selection, picture and volume control, but also the telephone operation. Channel selection is by up/down scanning of pre-programmed TV channels or by pressing the buttons representing the selected channel number. On-screen display of the TV channel, together with the time-of-day, persists for about five seconds, but pressing the "recall" button or selecting another channel brings the display back. A time control programmer can turn the set on or off once every 24 hours.

For Advanced Space Phone operation, a standard phone cable with snap-in plug is provided. When the phone rings, the viewer simply depresses the "phone" button on the remote control and the caller's voice comes from the TV receiver's two 5" oval speakers. A sensitive microphone mounted in the receiver lets anyone in the room answer, but if you want to discuss something without the caller hearing it, you press the "mute/privacy" button on the remote control. Pressing that button again restores microphone operation.

To dial out, there are a number of options. You can simply press the "phone" button, hear the dial tone over the TV speakers, and dial the number by pressing buttons on the remote control, just as on any pushbutton phone. As numbers are dialed, they appear superimposed on the TV screen. If you dial a 7-digit number, the display will just read

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"TEL 123-4567," but if you dial an area code, say 201, the display will run two lines, with the top reading "AC 201" and the bottom the same as before. Up to 13 digits can be displayed, and the display is on-screen for about 30 seconds. After the dial-tone, you will hear the ring-back, busy, or voice over the speakers. If you want to repeat the call, just press the "phone" button for the dial tone and then press the "enter" key on the remote control. This automatically redials the last phone number. In addition to the nonvolatile memory for the last number dialed, the Space Phone has memory for automatic dialing of two preprogrammed 13-digit numbers. The "autodial" mode is programmed by pressing the "autodial" button on the remote control and numbers are stored by means of the "enter" key. When "autodial" is used, the on-screen display will show AUTODIAL 1 (or 2), together with the number that has been programmed into that location.

The heart of the auto dial/dial-out system is a microprocessor, combined with a character generator and MNOS memory. As the transmitter's digit keys are pressed for dialing, the microprocessor decodes IR signals received and causes a relay to open and close on the Space Phone module in accordance with the signals. Sound is muted automatically to eliminate audio "clicks" when this occurs. There's a 90-ms delay between digits to compensate for slower phone equipment in some areas. To assure valid entry of signals, digits should not be "dialed" faster than three digits per second.

The i-f section of the Zenith SY1963W contains a SAW (Surface Acoustic Wave) filter and, as a special feature, Zenith's PRP (Peak Resolution Picture) circuit. It consists of a ceramic filter in the fourth stage of the i-f amplifier that is controlled by the agc (automatic gain control). When weak TV signals are received, this circuit changes the i-f response curve so that the video carrier, normally 6 dB below the top of the curve, moves to the top. In other words, on weak signals, the video carrier gets an extra 6-dB gain, but the high-frequency portion of the video signal loses about 4 dB.

As in most modern, high-performance color TV sets, the horizontal and vertical sync are counted down from a crystal-controlled, PLL oscillator. When the special circuit in the sync section detects at least nine serrated horizontal pulses during the vertical sync interval, standard, interlaced operation is assumed. When six consecutive noncoincidences are detected during the vertical sync interval, nonstandard sync is assumed and, instead of the count-down system, a conventional sync system takes over.

Zenith's "Color Sentry" consists of eight different, well-established, automatic circuits for color correction, flesh-tone, brightness, color sync, etc.

The sweep and high voltage sections of the Model SY1963W are very similar to most recent color TV sets. Most of the voltages are rectified from taps on the flyback transformer, with filtering and regulation done at the horizontal sweep frequency. This means that only the well-regulated B+ power to the horizontal sweep comes from the line, with the chassis "hot" and requiring an isolation transformer for all trouble-shooting or testing.

The audio portion of this receiver has a tone control and includes an output jack for connection to an external hi-fi system.

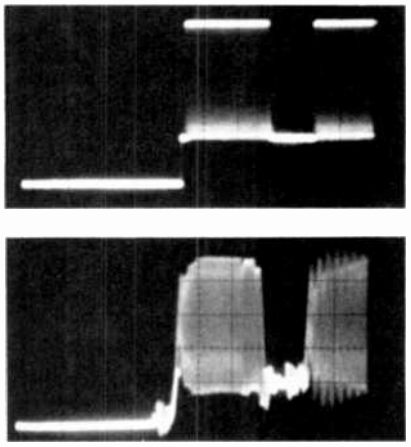
Laboratory Measurements. The r-f/i-f performance of the SY1963W was quite satisfactory, even without the special PRP circuit in the fourth i-f stage. By monitoring the signal down to a vhf input of −54 dBm, we obtained full bandwidth. At that point the age voltage switched the ceramic filter and we were able to get another 3 dBm of sensitivity. As indicated in the table of test results, the same increase was obtained in the uhf band. The noise figure in both vhf and uhf certainly recommends this set for deep fringe area reception. The video bandwidth (luminance bandwidth) measured an excellent 3.90 MHz, but when we activated the PRP ceramic filter in the fourth i-f stage, the overall bandwidth dropped to 3.50 MHz. This was obviously due to the shift in the i-f response curve.

The scope pictures show the overall response to the color bar signal. The frequency of the sine wave comprising each color bar is that of the color subcarrier at 3.58 MHz. If the video bandwidth were less, the color bar output would be reduced greatly.

R-f oscillator stability and frequency error were typical of other crystal-controlled, microprocessor-operated, electronic tuners we have tested When we set the switch to "special"—simulating reception of an inaccurate r-f signal from a TV game, computer or VCR—we measured a capture range of 1.2 MHz on channel 3, certainly adequate for all but grossly mistuned r-f signal sources.

Agc dynamic range and dc restoration were good and typical of most of our previously tested '82 and '83 color sets. In the specific unit that we tested the horizontal linearity was off at both sides, but the vertical sweep was almost perfectly linear. A slight misconvergence at the right side and a clearly visible pin-cushion effect on all four edges was found when using the grid test pattern. However, none of these relatively minor problems could be observed on a normal TV picture. Regulation of both B+ and high voltage were adequate and typical of recent color TVs.

Comments. From the test results, the Zenith model SY1963W emerges as a very good color receiver



Scope photos show color bar signal response: input (top) and output.

ZENITH MODEL SY1963W 19" COLOR TV LABORATORY MEASUREMENTS

Parameter	Measurement
Sensitivity, vhf (Ch. 3):	−54 dBm (−57 dBm*)
Sensitivity, uhf (Ch. 20):	−50 dB, (−53 dBm*)
Noise figure, vhf (Ch. 3):	8 dB
Noise figure, uhf (Ch. 20):	15 dB
Video bandwidth to CRT (−6 dB):	3.90 MHz (3.50 MHz*)
Oscillator stability (Ch. 3): (105 to 130 V ac, 2 hr)	0.05 MHz
Oscillator error (Ch. 3):	0.05 MHz
Afc pull-in range (Ch.3):	1.20 MHz
Agc dynamic range:	64 dB
Dc restoration:	95%
Horizontal linearity:	95% left, 95% right
Vertical linearity:	98% top, 100% bottom
Convergence:	95% at worst
Pin-cushion effect:	5% at worst
Voltage regulation, B+: (105 to 130 V ac)	96%
High-voltage regulation: (105 to 130 V ac)	95%
Power rating:	70 W

*Effect of Peak Resolution Picture (PRP) circuit.

with a host of desirable, advanced features. Color reproduction was very good, but when we asked the same observers who had been so enthusiastic over the Sony Profeel TV monitor and the RCA VGM 2023 monitor/TV set, they agreed unanimously that these two units had a degree of "naturalness"—a "true" pastel color reproduction—that was lacking in the Zenith set; color bar patterns were reproduced very well, faces appeared reasonably natural, but landscapes seemed to suffer from overemphasis of the primary colors (RGB). Zenith has an excellent, long-standing reputation, an active, nationwide network of service centers and parts suppliers, and enjoys a following of loyal customers. If you do buy the model SY1963W, you should consider the following.

In theory, any direct video connection can provide better resolution and color fidelity than a connection via an r-f signal that must be demodulated into a video signal (with the attendant possibility for degradation). If you plan to use your color TV set as a display for TV games, computers, VCR and video camera outputs, you might consider purchasing either a video monitor or a TV set that has direct video input capabilities. (Zenith, like other manufacturers, offers several 19-inch and 25-inch receivers that include video input jacks and can operate as video monitors.)

If, however, you are primarily looking for a color TV set for broadcast and cable reception (with the use of video accessories as a secondary consideration) you will find the SY1963W most satisfactory. The set provides many advanced features, such as the Computer Space Command 4100 remote control system, very well designed electronic tuning, SAW filter, etc. In addition, it has two circuits specially designed to improve operation with the inexpensive r-f modulators found in TV games, computers, VCR and video camera outputs. Automatic switchover between standard TV broadcast 525-line interlaced sync, and nonstandard sync helps greatly in this respect. Also, switching from the normal, crystal-controlled operation for broadcast channels to the special "pull-in" tuner often overcomes the lack of an accurate carrier frequency from inexpensive r-f modulators.

In short, the Zenith SY1963W is a very good, 19" table-model color set, well worth considering for your home, including use with various video accessories. The Advanced Space Phone is an additional attraction. —*Walter Buchsbaum.*

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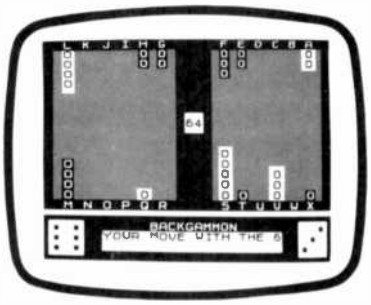
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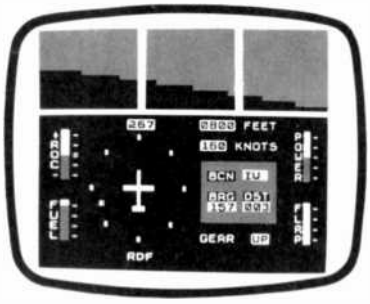
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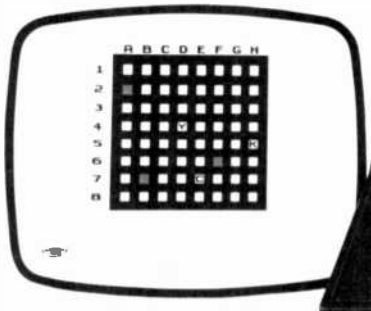
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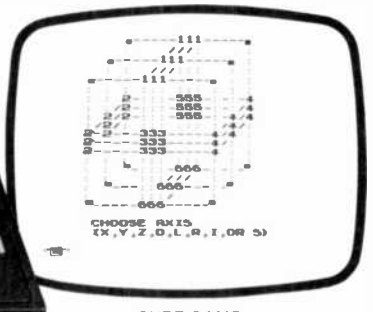
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The Timex/Sinclair 1000* is a fully programmable computer with a powerful BASIC language and complete instruction manual, all for only $79.95. The moment you sit down with the TS1000 you can learn how to program your own games. Maybe you want to create a stock market game, a word game, a mathematical game. The challenges are endless.

For this one low price, the TS1000 comes with everything you need for connecting the computer to your color or black-and-white TV.

Of course, you might also want pre-programmed software cassettes for your $79.95 computer. You'll have a wide choice with our free software catalog which comes with the TS1000. And the software cassettes play in any cassette recorder.

The 16K Memory Module. More power to you.

Let's say you want to go one step further. The 16K Memory Module allows you and your family to be challenged by even more sophisticated games. Not mindless arcade games, but serious, intellectually stimulating games which are both fun and educational.

The Memory Module costs only $49.95 and plugs onto the back of the TS1000 for 8 times more memory capacity. A whole new world of software is available to those with the 16K Memory Module.

The Serious Games Package. A $75 value for only $50.

For those who want a lot of serious 16K games, Sinclair announces a special software offering with a $25 savings! Now, for the first time, you can receive all five games shown above at the reduced price of only $50.

Chess: You can play with another opponent or you can match wits with the computer.

Flight Simulator: Maneuver and land a light aircraft with full cockpit controls, instrumentation and navigational aids. You have to allow for wind velocity and direction, rate of descent and mountainous terrain.

Cube Game: Every bit as mind-baffling as Rubik's Cube.

Backgammon: Everyone's favorite. Again, you can play against another opponent or against the computer. Complete with a doubling cube.

Mixed Game Bag: A series of memory and concentration tests including Robot Wars, a version of "Master Mind."

There's never been a better value on a serious games package. And to think it all starts on a $79.95 computer!

Why order today?

In addition to saving $25 on software, there are other reasons to buy your TS1000 today. Computers costing hundreds and even thousands of dollars rarely offer you games this serious or challenging.

Another reason to order today is convenience, by toll-free phone. No crowds, no waiting lines, no parking worries. It's never been easier to get started in the world of computers. Or more worthwhile.

How to order today!

Just call our toll-free number and use your MasterCard or VISA. Or send the coupon with a check or money order. Then try out the Timex/Sinclair 1000 for 10 days at no risk. If you're not entirely satisfied, we will refund your money. It's as easy as that. (Sorry, no refunds on software.)

Call toll-free: 800-543-3000. Ask for operator 509. In Ohio call: 800-582-1364. Ask for operator 509. In Canada call 513-729-4300, operator 509. Have your MasterCard or VISA ready when calling. Phones open 24 hours a day, 7 days a week. These numbers are for *orders only.*

If you simply want information, please don't call, write Sinclair Research, Ltd., 2 Sinclair Plaza, Nashua, NH 03061.

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Ad code: B3PE

Mail to: Sinclair Research, Ltd.
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☐ Check or Money Order enclosed

	Price **	Qty.	Amount
TS1000	$79.95		
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16K Cassettes	$15.00 each		
Special Serious Games Package (5 games valued at $75.00)	$50.00		
Shipping/Handling	$ 5.00		$ 5.00
**U.S. Dollars		Total:	

Cassettes for 16K Memory Module: $15.00 each.
Check the boxes of all the cassettes you want.

☐ Flight Simulator #6
☐ Chess #7
☐ Backgammon #8
☐ Cube Game #9
☐ Mixed Game Bag #26
☐ I'll take all 5 cassettes included in Sinclair's Special Serious Games Package.

Name

Street

City

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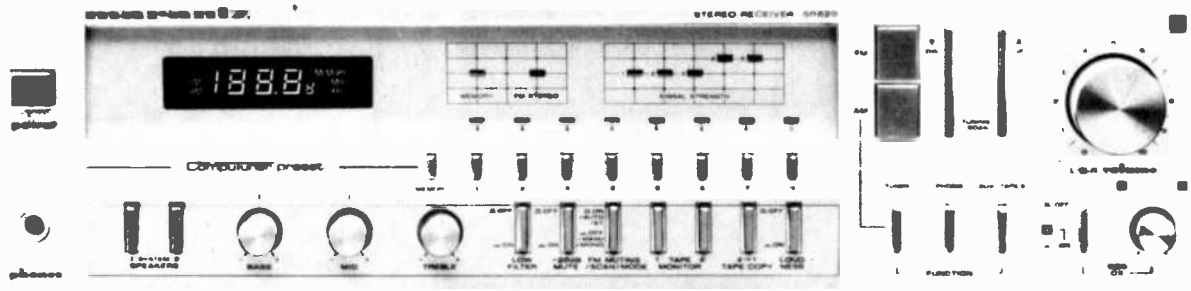
*Sinclair technology is the heart of both the ZX81 and the Timex/Sinclair 1000 computer.

sinclair

Marantz SR620CX AM/FM Stereo Receiver



THE new SR620CX stereo receiver is part of the Marantz "Solid Gold" line of stereo components. Although the exterior finish of the products in this line (a pale satin gold for all visible metal surfaces, including knobs and pushbuttons) would seem to justify the name, there is actually a more substantial basis for the choice than mere color. According to Marantz, the 24-karat gold plating on the input and output phono jacks on the rear apron ensures corrosion-free contacts.

The Marantz SR620CX contains a PLL (phase locked loop) synthesized AM/FM tuner, covering those bands in steps of 10 and 100 kHz, respectively (switchable to 9 and 50 kHz for use in other parts of the world). Its phono preamplifier, designed for use with a moving magnet cartridge, includes a CX decoder that provides a 20-dB noise reduction when playing CX-encoded records. The audio power amplifier is rated to deliver 46 watts per channel to 8-ohm loads, from 20 to 20,000 Hz, with no more than 0.03% total harmonic distortion. It also carries a 4-ohm output rating of 55 watts per channel, with no more than 0.06% distortion.

The Marantz SR620CX is 16⅜" W × 12" D × 4" H, and it weighs 13¾ lb. The suggested retail price is $495.

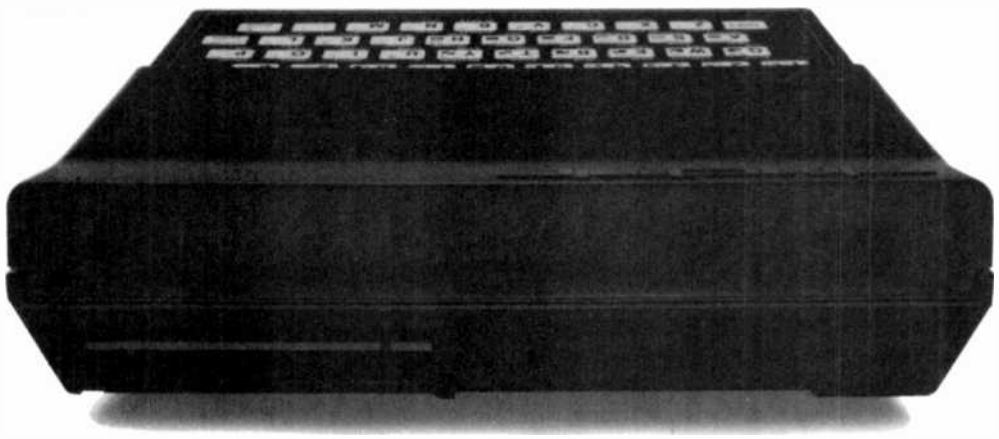
General Description. Most of the operating controls of the Marantz SR620CX are pushbuttons, with small knobs being used for the three tone controls and the CX calibration. A large knob controls the volume. To match the threshold level of the decoder to the output of the cartridge, the CX calibration is adjusted until the two red LEDs above it flash alternately when playing a CX-encoded record. A more accurate calibration can be made with the aid of a special record supplied with the receiver. This has 1000-Hz tones recorded at the standard level of 3.54 cm/s. When playing it, the control is set so that both of the LEDs are extinguished. However, proper operation of the CX system does not require a critical adjustment.

The SR620CX has 8 buttons for instant recall of station frequencies previously stored in its memories. Each button can serve for an FM and AM channel, for a total of 16 stored frequencies. A long-life lithium battery in the receiver retains the memories for as long as 7 years. In normal operation, a touch on one of the narrow scanning buttons causes the tuner to step up or down in frequency until it comes to a signal whose strength exceeds the muting threshold. At this point, tuning stops and the receiver unmutes. Mono/stereo operation is automatically determined by the presence or absence of a pilot carrier in the received signal. Pressing one of the control buttons on the front panel simultaneously switches the receiver to mono, disables the muting, and changes the tuning mode so that it advances by one frequency interval each time the scanning button is pressed. However, pressing a button for more than a couple of seconds causes the tuner to scan rapidly until it is released (regardless of the presence of a signal on the tuned frequency).

. . . CX decoding provides 20-dB noise reduction

The display window on the panel contains the numerical frequency readout, LEDs that show relative signal strength (in five steps) and the presence of a stereo pilot carrier, and other LEDs that identify the selected memory and when the MEMORY button has been pressed in preparation for storing a received frequency.

The rear apron of the Marantz SR620CX contains the gold-plated phono jacks for the inputs, a single high-level input identified as VIDEO/CD/TAPE 3/AUX, and input and output jacks for two tape decks. There are insulated spring connectors for two sets of speakers and binding post terminals for 300- or 75-ohm FM antennas and an external AM wire antenna. The pivoted AM loop antenna that normally connects to the AM antenna terminals can be removed and positioned or oriented for best AM reception. The scan step selector slide switch is also on the rear of the receiver (its setting is retained by a plastic strip to prevent accidental changes). One of the two ac outlets is switched.



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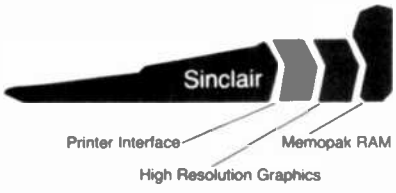

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Centronics Parallel Printer Interface	104.95		
RS232 Printer Interface	139.95		
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		Total	

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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 commands 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 Memopak Centronics Parallel or RS232 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.

Laboratory Measurements. The Marantz SR620CX, though a receiver of moderate power, is quite compact. For that reason it became warm over the output transistor heat sinks (which are inside the cabinet) as a result of the one hour preconditioning operation at one-third rated power. This was followed by five minutes at full power, and, finally, the actual measurements. In normal operation, however, the receiver remained quite cool to the touch.

The output waveform clipped at 60.5 watts per channel when both channels were driving 8-ohm loads. The 4-ohm clipping power was 61.6 watts, and the 2-ohm power was 65 watts per channel. (The receiver is not rated for 2-ohm operation, but it withstood this severe treatment without shutting off, overheating, or even distorting significantly.) The Clipping Headroom rating was 1.19 dB at 8 ohms and 0.49 dB at 4 ohms. Using the pulsed (tone burst) 20-millisecond test signals of the Dynamic Headroom measurement, we measured maximum power outputs of 79 W, 78 W, and 90 W for load impedances of 8, 4, and 2 ohms. The corresponding Dynamic Headroom ratings (for 8 and 4 ohms) were 2.34 dB and 1.52 dB.

Since the maximum power output was very nearly the same for all three load impedances, the most obvious difference between them was the distortion, which increased slightly as the load impedance was reduced. With 8-ohm loads, the total harmonic distortion was a constant 0.0028% from 1 to 50 W, rising steeply as the clipping point was approached. With 4 ohms, the distortion was a constant 0.004% at most power outputs, and with 2 ohms it was typically 0.008 to 0.009%.

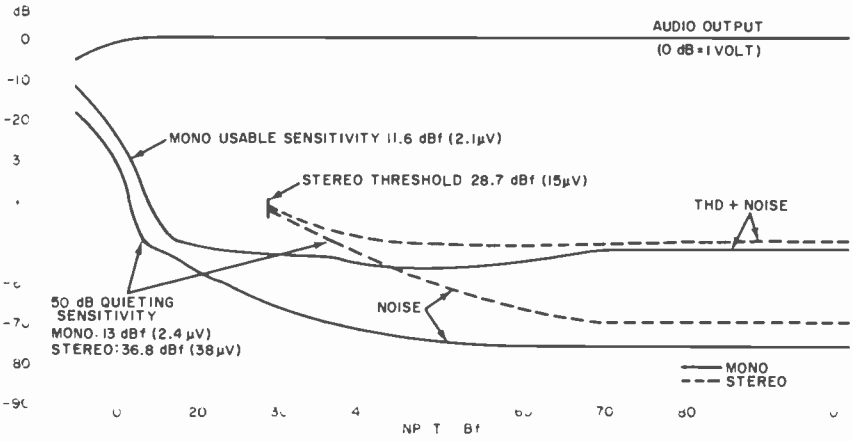
At rated power (8 ohms) or less, the distortion was less than 0.002% in the midrange, increasing to 0.01 to 0.02% at the extremes of 20 and 20,000 Hz. The IHF-IM distortion (using two equal-amplitude input signals at 18 and 19 kHz, whose peak amplitude was equal to that of a 46-watt sine-wave signal) produced a second order component at 1000 Hz with an amplitude of −78 dB, and third-order distortion at 17 and 20 kHz at a −82-dB level.

Input sensitivity for a reference output of 1 watt was 83 mV at the high-level AUX input, and 0.43 mV at the PHONO input. The respective A-weighted S/N measurements were 81.4 and 77.2 dB. The PHONO input overloaded at levels between 147 and 157 mV over the 20-to-20,000-Hz range. The amplifier was stable with reactive simulated speakers loads, its IHF Reactive Load Factor was 1.03 dB at 63 Hz. (This is a measure of an amplifier's ability to develop at least its rated output into the complex impedance of a loudspeaker woofer near its resonance frequency.) The amplifier Slew Factor was 3.8. (A full-power sine wave developed a triangular shape at 76 kHz.) This measurement shows that the amplifier of the SR620CX can deliver its rated output power with low distortion at frequencies well above the audio range.

Tone controls of the Marantz SR620CX had conventional response characteristics, with the bass turnover frequency shifting between about 200 Hz and 400 to 500 Hz as the control knob was turned from its center. The bass control range was about ±10 dB at 100 Hz. The treble curves were hinged at about 3500 Hz. The midrange control action affected most frequencies between 100 and 4000 Hz, with a maximum boost or cut of about 5 dB, which is adequate for most conditions without undue risk of excessive modification of the tonal balance.

The loudness contours boosted both low and high frequencies at control settings below −10 dB. (The amount of boost did not change over most of the range of volume control movement, below −20 dB.) The LOW filter had a good cutoff slope of 12 dB per octave, with a −3 dB response frequency of about 35 Hz. The RIAA phono equalization was very accurate, almost perfectly flat from 100 to 20,000 Hz, rising to +1.5 dB in the 20-to-40-Hz octave. It was not affected significantly by the inductance of a phono cartridge connected to the input jacks.

The FM tuner section had a mono usable sensitivity of 11.6 dBf (2.1 μV). Stereo sensitivity was set by the stereo switching/muting threshold of 28.7 dBf (15 μV). The 50-dB quieting sensitivity was 13 dBf (2.4 μV) in mono and 36.8 dBf (38 μV) in stereo. The distortion at a 65-dBf (1000 μV) input was 0.22% in mono and 0.28% in stereo, and the respective S/N measurements were 76 dB and 70 dB. The mono IHF-IM distortion (with the signal generator modulated by equal amplitude signals at 14 and 15 kHz, whose combined peak level corresponded to 100% modulation) was −48 dB for second order (1000



Noise and sensitivity curves for FM section of the SR620CX.

Bionic "Ears"

Tiny, powerful electronic sensors give you superhearing — through walls, up to 1/2 mile away.

The **Dyna-Mike Transmitter**

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

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

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

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

Choose Your Model

New Horizons is introducing three models of the DYNA-MIKE supersensitive broadcast microphone Model AR-7 is the world's smallest microphone. It's a miracle of electronic miniature power, with a range of 750 feet and a battery life of 90 hours. Introductory price is $129 95 (two for $119.95 each)

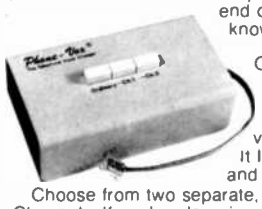
Model 9-DX is a long-range microphone, broadcasting an unbelievable half-mile distance. This miniaturized wonder is $149 95 (two for only $139 95 each). Normal battery life is 25 hours, or you can have the special Power-Pak, which operates 200 hours, for $19.95

The AR-7 and 9-DX are sensitive They'll pick up sounds from 40 feet away. But for super-sensitivity, nothing beats the A-5

The A-5 will pick up a whisper from more than 60 feet away and broadcast it to a receiver 750 feet distant The A-5 comes with a special 200-hour long-life battery and is introductory-priced at $99 95 (two for only $89.95 each)

The **Telephone Voice Changer**

It's right out of James Bond! Push a button and the VOICE CHANGER gives your voice completely different characteristics. The person on the other end of the phone won't know it's you



The VOICE CHANGER is more than an "electronic handkerchief" — it doesn't cause your voice to sound filtered. It literally changes tone and timber.

Choose from two separate, distinct Changer Channels. If you're alone in a business office, it'll sound like an employee answering. If you live alone, you can get rid of pesky calls by pushing Channel 1 or Channel 2 and saying, "Sorry, that person isn't in."

How It Works

The VOICE CHANGER is powered by two ordinary penlight batteries. One set of lead-in wires connects to your telephone base; the other clips to the wires leading to the handset.

Pushing the button labeled "Ordinary" puts your normal voice through the line. Pushing "Channel 1" changes timber and texture Pushing "Channel 2" creates different characteristics from Channel 1 Thus you have three voice options — your own, plus two changed voices.

MAKE NO MISTAKE! THE VOICE CHANGER DOESN'T MUFFLE YOUR VOICE OR MAKE IT UNINTELLIGIBLE. It literally changes the quality of sound — space-age electronics at work

Use the VOICE CHANGER to reach that doctor, lawyer, or business executive whose secretary knows your voice and who always is "out" when you call Use it to screen your own incoming calls Use it for just plain fun. Any time you like, during a conversation, push the "Ordinary" button and your regular voice returns to the wire.

The VOICE CHANGER is yours for $99.95 — two for $89 95 each (plus $2.50 shipping per total order) When you consider the many uses of this brilliant electronic instrument, it's a real bargain Of course it has the standard New Horizons guarantee

The **Super Ear**

You'll hear it all.

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

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

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

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

It Works Anywhere!

Ever put your ear to a railroad track to try to hear the train? Try it with SUPER-EAR You'll hear that train many miles away. Use it as a powerful stethoscope on yourself, a friend, or a pet You can even hear a bird's breathing.

The only source for SUPER-EAR is New Horizons Choose from two models — Model SB-5, with ultrasensitive microphone, $139.95 (two for only $129.95 each); or Model SB-1, with suction-type microphone, $99.95 (two for only $89.95 each)

The **Private Transmitter/Receiver**

The NCZ-10 broadcasts on a special radio band No one without equipment can hear your transmitted messages. The reception is unbelievably clear and bright — commercial broadcast quality.

Your receiver clicks into any of three separate channels In the suburbs the range is up to 2000 feet, and in the city 850 feet.

With your special receiver is an inconspicuous high fidelity earphone. You can put three transmitters in three locations and then switch back and forth, monitoring all three. Someone with an FM or police band receiver can tune his dial all day, but he won't pick up these signals.

With two receivers, you can have a complete two-way system without the inconvenience and annoyance of the semi-public CB channels. The NCZ-10 channels are private.

This professional-quality electronic miracle is easy to use and completely dependable. Monitor your baby's room Leave a transmitter in an inconspicuous place in your office or your home, and you'll hear anything going on in that room.

One NCZ-10 receiver with one transmitter is $279 95, with two transmitters (two separate bands), it's $379 95 with three transmitters (three separate bands), it's $479 95.

For a complete private communications system, order two receivers, each with a transmitter (we'll send them with different bands). Special high-performance batteries enable you to operate the receiver for 40 hours continuously, the transmitter for 35 hours

We Absolutely Guarantee!

Use any electronic instrument acquired from us for up to 30 days. If you decide for any reason you don't want to keep it, return it for a 100% refund.

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Or send check or money order. Please add $2 50 per total order for shipping. Order any or all these state-of-the-art electronic instruments:

- Dyna-Mike AR-7, $129 95 (two for $119 95 each)
- Dyna-Mike 9-DX, $149 95 (two for $139.95 each)
- 9-DX rechargeable power-pak, $19.95
- Dyna-Mike A-5, $99 95 (two for $89.95 each)
- Super-Ear Model SB-5 microphone, $139.95 (two for $129 95 each)
- Super-Ear Model SB-1 microphone, $99.95 (two for $89.95 each)
- Voice Changer, $99.95 (two for $89.95 each)
- NCZ-10 transmitter and receiver, $279.95 (two transmitters, one receiver, $379.95) (three transmitters, one receiver $479.95)

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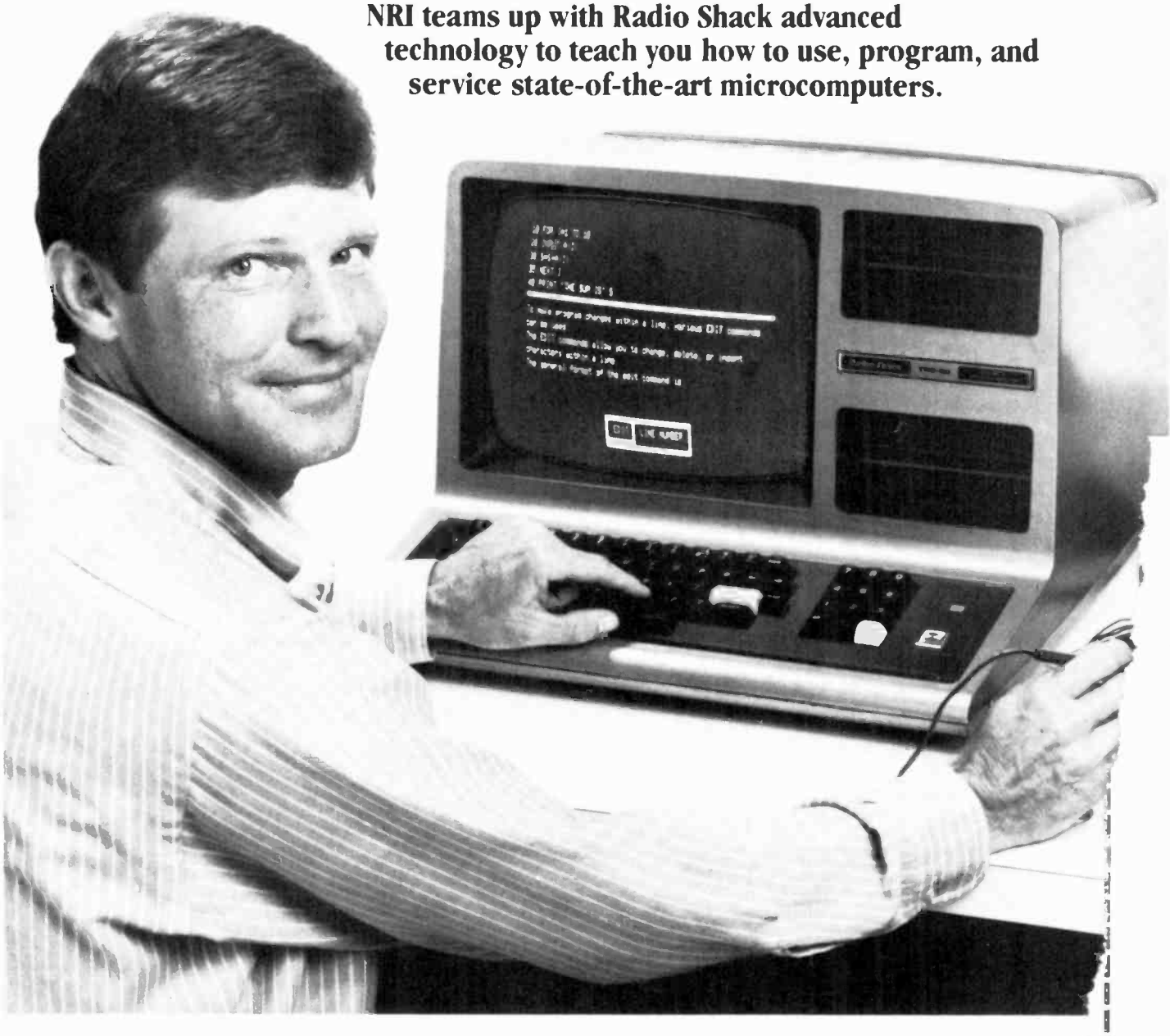

It's no longer enough to be just a programmer or a technician. With microcomputers moving into the fabric of our lives (over 250,000 of the TRS-80™ alone have been sold), interdisciplinary skills are demanded. And NRI can prepare you with the first course of its kind, covering the complete world of the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

Learn at Home in Your Spare Time

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.

Only NRI gives you both kinds of training with the convenience of home study. No classroom pressures, no night school, no gasoline wasted. You learn at your convenience, at your own pace. Yet you're always backed by the NRI staff and your instructor, answering questions, giving you guidance, and available for special help if you need it.

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gain a real insight into its nature.

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As part of your training, NRI sends you the new, state-of-the-art TRS-80 Model III microcomputer. This functional unit is complete with 65-key keyboard and 12" display in one desk-top unit. It features high-speed cassette loading, built-in interface for parallel printer, and provisions for optional disk drive. Its 16K RAM is internally expandable to 48K and its BASIC language is compatible with most Model I software.

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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(TRS-80 is a trademark of the Radio Shack division of Tandy Corp.)

Comparing the SR620CX to Marantz's Costliest Model

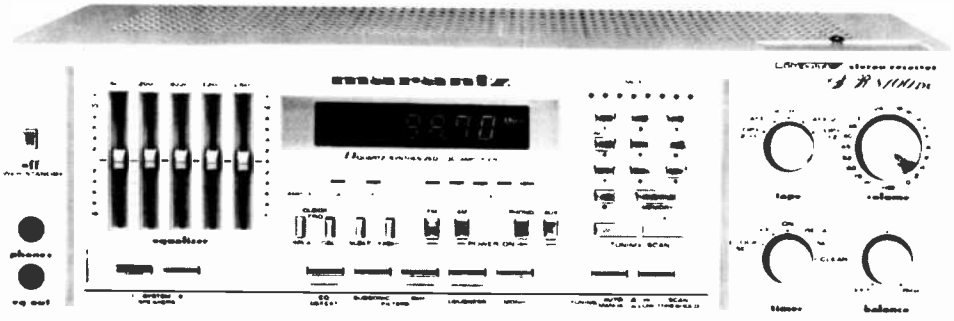
THE SR620CX is approximately in the middle of the Marantz receiver lineup. Having also examined its top receiver, the SR8100DC, we found it interesting to compare the two, both with respect to their audio specifications (rated and tested), and to their various features.

The SR8100DC is 50% more expensive than the SR620CX (about $750 versus $500). It is quite similar in styling and general features, with the additional power one would expect from a high-end receiver (rated 75 and 90 watts for 8 and 4 ohms, respectively). But the power difference, it must be realized, is only about 2 dB, and hardly likely to be noticed by a listener. In fact the major difference between the receivers in this regard was the superior current delivering capability of the SR620CX, which can actually deliver more power to 2 ohms than its larger relative.

The SR8100DC has considerably higher amplifier gain, roughly the same distortion (negligible in both cases), and a Slew Factor of 1.7 compared to the 3.8 of the SR620CX. (Neither is exceptional, but both are adequate.)

The FM tuners of both receivers have identical features, and very nearly the same performance ratings. For the most part, both met their ratings; and in fact, the SR620 had marginally better sensitivity and S/N performance than the SR8100. (The differences were in all probability due to sample-to-sample variations).

All in all, we would judge the two to be equivalent in performance, leaving the real differences to be in their features. The SR8100DC has a five-band graphic equalizer instead of the three tone controls of the SR620CX. Instead of the CX decoder of the SR620, it has a built-in digital clock (24-hour) that controls a number of timing functions for the receiver. It can be set to turn it on and off at preset times over a 24-hour cycle, repetitively if one desires. Aside from that convenience feature, we would have to say that the lower-priced SR620CX offers about the same listening performance, plus the ability to decode CX records. ◇



The Marantz top-of-the line Model SR8100DC.

Hz) and −51 dB for third order (13 and 16 kHz). In stereo, the corresponding readings were −50 and −41 dB.

The FM frequency response was within ±0.5 dB from 30 to 15,000 Hz, and the stereo channel separation was between 45 and 52 dB from 80 to 8000 Hz, reducing to 39 dB at 30 Hz and 35 dB at 15,000 Hz. The FM capture ratio was an exceptionally good (low) 0.92 dB at 45 dBf (100 μV) input. The AM rejection was 61 dB at the same signal level. Image rejection was a fairly good 56 dB, as was the alternate channel selectivity of 60 dB and the adjacent channel selectivity of 4 dB. The 19-kHz pilot carrier in the audio output was at a −65-dB level, and the power line hum in the tuner output was extremely low at −78 dB. The five signal-strength lights came on at input levels of 17.7 to 48.7 dBf (4.2 to 150 μV), indicating that one cannot expect to realize full performance of the FM tuner unless all the lights are lit. The only measurement made of the AM tuner section was of its frequency response, which was down 6 dB at 20 and 3100 Hz, relative to the 1000 Hz output.

User Comment. The Marantz SR620CX was a very easy receiver to use, with all of its controls marked logically and operating smoothly.

The sound, from either FM or records, was excellent. It had no difficulty driving low-efficiency speakers to the highest levels we find enjoyable. The gain of the audio amplifier is somewhat lower than that of most receivers we have tested, though; and, as a result, it may be necessary to set the volume control a bit higher than usual in some cases. The CX decoder worked very well, and the dual LED calibration indicator, used with the supplied test record, made it possible to calibrate in a matter of seconds. (It has to be repeated only if the cartridge, is changed.) We found, however, that proper calibration was possible only with cartridges delivering at least 2 mV from a 3.54 cm/s recorded velocity, but this covers almost all moving-magnet cartridges currently available. Some high output moving-coil types, otherwise suitable for use with this amplifier, may not be fully compatible with its CX decoder. Even though the CX system may operate satisfactorily without the proper input level, it normally reduces the overall gain of the phono system (at least in this receiver) and did not produce sufficient listening level with moving-coil cartridges whose rated outputs were in the 2-mV range.

All things considered, the Marantz SR620CX proved to be a highly attractive combination of an excellent audio section, a reasonably good AM tuner, and an FM tuner whose performance, if not quite "state of the art" in some respects, is nonetheless a competent performer and more than equal to the task of extracting the full program quality from any broadcast it is likely to be called upon to receive. —*Julian D. Hirsch*

CIRCLE NO. 101 ON FREE INFORMATION CARD

Adding a Video Monitor to your Sinclair ZX81

LIKE some other computers, a large "cottage industry" has grown up around the low-cost Sinclair ZX81 and its American cousin, the Timex 1000.

Almost every kind of peripheral imaginable—from disk systems to printers—is currently available for this small computer. However, the only type of video output from this import is r-f switch selectable between channels 3 or 4.

The problem with using a TV receiver as the video monitor for a computer is the lack of sufficient bandwidth to display good-quality alphanumerics and graphics. Also, adjacent-channel interference produces disturbing moire patterns that can cause more eyestrain than the program is worth.

There is no question that a video monitor is far superior to a TV receiver, and such a monitor may be used with the ZX81 by the simple addition of a short length of coaxial cable. If the addition is made, the warranty is likely voided. If you do make it, though, the ZX81 will have both r-f and direct video output. Here's how it's done.

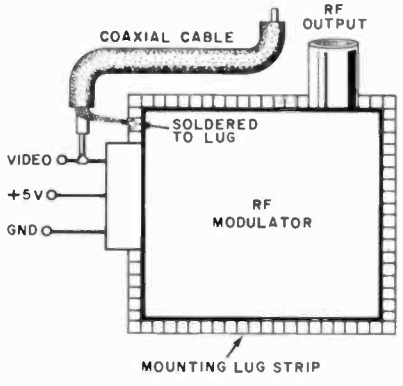
Turn the ZX81 upside down, and remove the five Philips-head screws securing the bottom half of the computer to the top half. Gently remove the bottom half, taking care not to lose the screws. Just as gently, remove the two screws securing the pc board to the top half of the assembly, noting which holes contained the mounting screws.

Carefully turn the pc board over to expose the metal enclosure that surrounds the r-f modulator as shown in the diagram. Note that there are three bare leads coming from the pc board to a plastic grommet on the side of the metal enclosure. The lead nearest the edge of the pc board carries the baseband video used to modulate the carrier; the other two leads carry +5 volts and ground. If desired, a scope can be used to observe the video, which is at TTL level.

Trim the end of a length of slender coaxial cable, exposing both the outer braid and the center conductor. Carefully solder the inner conductor to the bare video lead, and the braid to the metal enclosure (the bottom grips can be used as the enclosure is solder-proof aluminum). Make sure that there are no solder bridges, then carefully re-assemble the pc board to the top half of the assembly.

Using a sharp knife, carefully enlarge the hole in the plastic case that surrounds the RCA r-f connector. Press the slender coaxial cable into this slot. Carefully re-assemble the bottom half of the case to the top half, using the five Philips-head screws. Affix a suitable connector to the loose end of the slender coaxial cable (it should mate with the cable coming from the video monitor).

Connect the r-f connector, as usual, to the antenna inputs of a monochrome TV receiver, then connect the new coaxial cable connector to the video monitor. Turn all power on. Note that no matter how well you can tune the TV receiver, the display on the video monitor is considerably better.



Connecting a monitor to your ZX81.

New HP Computers. A couple of new computers are now available from Hewlett Packard. The first is the Series 200 Model 16, a 16-bit machine based on a MC68000 operating at 8 MHz. The Series 200 also includes the Model 26 and Model 36 desktop computers, formerly called the HP 9826 and 9836. Its features include a 9-inch CRT, a detached ASCII keyboard, and a choice of single or dual 3.5" microfloppies (Sony approach). These provide 270K bytes of storage per diskette. A single 3.5" microfloppy also is available with a 4.6M-byte Winchester disk. The standard 128K bytes of main memory can be increased to 768K bytes and with an external expander to as much as 4.6M. The Model 16 has built-in graphics and has an 80 column by 25 line display with each character formed by a 9 × 15 matrix. Resolution is 300 by 400 pixels.

The keyboard includes 5 user-definable keys (10 with shift), and a special rotary control knob for fast editing of programs, cursor positioning, analog control of instruments, and other applications requiring a linear input.

Interfaces include the HP-IB (IEEE-488) and RS232C for serial communications.

Software includes BASIC, HPL, and Pascal. The BASIC includes enhancements of some powerful languages like FORTRAN or ALGOL including subprograms, multi-dimensional arrays, unified I/O and mass storage, labelled COMMON blocks, and external program control. HP is investigating the possibility of offering CP/M and an HP version of Unix.

(Continued on p. 34)

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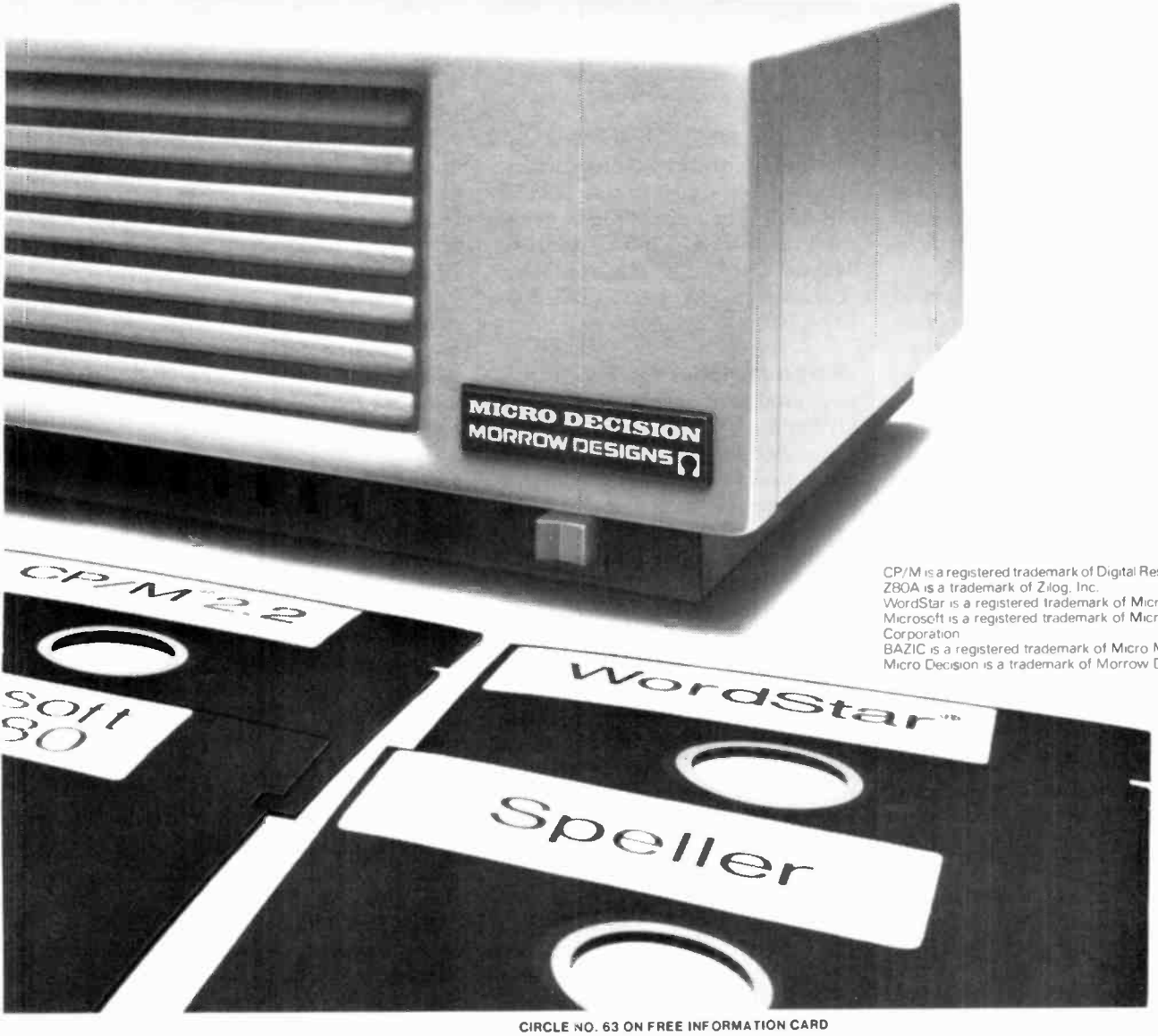

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Microsoft is a registered trademark of Microsoft Corporation
BAZIC is a registered trademark of Micro Mike's, Inc.
Micro Decision is a trademark of Morrow Designs

CIRCLE NO. 63 ON FREE INFORMATION CARD

(Continued from p. 31)

Other software packages include computer-aided engineering tools, mathematics modules, and a broad variety of business aids including VisiCalc.

Several Model 16's can be linked together to share disc drives and printers in what is called Shared Resource Management. The SRM network can also incorporate other HP computers including Series 200 and HP9845 that includes color graphics.

The second computer, the Series 100 Model 120 is a personal office computer that includes word processing, decision support, presentation graphics, programming and accounting. It has all the computing power of the HP 125 in a smaller package (1.7 square feet of desk space), and can be used as an intelligent terminal when the demand requires.

The Series 100 uses dual Z80A CPU's and have 64K bytes of main memory, 16K bytes of screen display memory, and 32K bytes of ROM. The operating system is CP/M.

The 9-inch video monitor can be mounted on a tilt-and-swivel option to locate the screen as the user desires. It features the same high-resolution display as the HP 125 including true descenders in lower case. Character format is on a 9 × 15 matrix.

Each Series 100 computer has an IEEE-488 connector allowing as many as 14 peripherals to be attached, and a pair of RS232C ports. Single or dual 3.5-inch disc drives are available with each providing 248K bytes of formatted storage. A single 3.5-inch and a companion 4.6M byte Winchester are also available, although 5.25 and 8 inch floppies continue to be offered.

Software includes WordStar (with companions SpellStar and MailMerge), VisiCalc and CONDOR database and report generators, and BPI payroll packages. Because of the CP/M, program packages from third-party suppliers are also available.

140M-byte 5¼" Drive. The MX-1000 family of 5¼" Winchester drives now includes an 8-disk, 140M byte 5¼" drive. Average access time is 30 milliseconds, and the drive is compatible with standard ST506/412 interface, and has a data transfer rate of 5M bytes/s. The drives use plated media for storage

Maxtor's new 5¼" Winchester has 140M bytes on eight plated disks.

capacities of 9.57M-bytes/disk surface and 918 tracks per disk surface. Recording density is 11,155 bits/inch. The price in OEM quantities is about $2600. **Address:** Maxtor Corp., 5201 Lafayette St., Santa Clara, CA 95050 (Tel. 408-748-7740).

VIC-20 Peripherals. This firm is now producing four new peripherals for the VIC-20. The first is the Video Pak cartridge that plugs into the expansion port and produces a 24-line display with a choice of 40 or 80 upper/lower case characters, at the same time increasing the memory from 5K to 20 or even 70K. It also includes a terminal emulator and has screen print feature. Price is $299.95 for 16K, and $399.95 with 64K.

The second add-on is a Printer Interface that adapts the VIC-20 to most printers and has continuous visual monitoring of the data transfer functions via two LEDs. These status monitors indicate if the printer is hooked up, if the buffer is full, and if data is being transmitted. $69.95.

The third item is an Expansion Chassis that allows use of any four compatible cartridges simultaneously. These can be memory, software, or games. It plugs into the 22-pin edge connector and has its own protective fuse. $64.95.

The fourth item is a 16K Memory Cartridge that increases the VIC-20 memory to 20K, and uses 200-nanosecond RAMs. $99.95. **Address:** Data 20 Corp., 20311 Moulton Parkway, Suite B10, Laguna Hills, CA 92653 (Tel: 714-770-2366).

Hitachi 16-Bit Personal Computer. Due in the very near future is the 16-bit Personal Computer from Hitachi. This three-piece—keyboard, video display, and disk system—office computer, features an 8088 processor, 64K bytes of RAM (with parity) expandable to 256K, and a video display of 80 by 25 or 40 by 25 in a choice of 15 colors or monochrome. In the graphics mode, 640 × 200 (noninterlaced) or 640 × 400 (interlaced) pixels in eight different colors are provided. Text and graphics can be overlaid with each having their own colors. A double-sided, double-density mini floppy is built in and can be supported by external drives. Interfaces that can connect with CRT displays, printers, light pens, and RS232 are also built in. Five expansion slots having an IBM-style structure are provided. Software includes MS-DOS (Microsoft) and a BASIC interpreter, FORTRAN, COBOL, PASCAL, and an assembler are optional.

Timex Add-Ons. VOTEM is a package of hardware and software that enables a Timex/Sinclair to monitor almost any physical phenomena that can be represented by a dc voltage. It requires no modification to the computer and does not use the expansion port. Voltage measurements have resolution to 0.000044 V with an accuracy of 0.2%, and linearity of 0.1%. Temperature measurements can be made from −25 to +125°C with a resolution of better than 0.05%: and the power supply requirements are +8 to +15 V at 25 mA. Will also work on ZX80 with an 8K ROM. Kit is $39.95. **Address:** Down East Computers, POB 3096, Greenville, NC 27834. ◇

STAN VEIT ON COMPUTER SOFTWARE

Software for Mass Markets and Integrated Packages

As I walked through the aisles at Comdex, the big Fall computer industry show in Las Vegas, I was impressed by two trends in the software industry. First is the development of good, low-cost software systems designed for the mass market. The second is the offering of integrated packages by several companies. This trend was started by the Context MBA package and taken up by Lotus 1-2-3, previously reported on in this column. At Comdex, there were several new entries by both new and established companies.

Although these trends may seem to be opposites, they are both signs of the growing maturity of the software market.

Initially, let's consider the excellent low-cost software I saw at Comdex. The outstanding example of this was Wordvision from Bruce & James. This is a word-processing program designed for the IBM-PC and priced at $49.95! Jim Edlin, president of Bruce & James, is a long-time advocate of mass-market and "people literate" software. Wordvision is designed for the first-time user of word-processing software. It provides all the necessary features, but omits most of the "bells and whistles" that make a word processor difficult to learn and are therefore used only by a relatively small group of people. (Bruce & James, 4500 Tuller Road, Dublin, OH 43017. Tel: 614-766-0110. Compuserve Number, 71435,1040.)

Other low-cost software I noted was Budget Master for the Timex/Sinclair and the 6502 Professional Development System ($29.95) for the Commodore 64. (Human Engineered Software (HES), 71 Parl Lane, Brisbane, CA 94005. Tel: 415-468-4900.) The company also proffers Heswriter, a word processor for the VIC-20, and Heswriter 64, a word processor for the Commodore 64 at $44.95.

It should be noted that the IBM-PC owner has the best selection of low-cost software of any computer. The IBM-PC DOS costs $40 including the manuals and BASIC. Then there is the Freeware software, including PC-Talk for $25 and PC-File for $35. Now Wordvision for $49.95 extends the concept. In spite of this, we notice that some software publishers price their IBM-PC software above versions for other computers. We wonder about the reason for this practice.

The second trend toward integrated software systems was represented at Comdex by Context MBA, Lotus 1-2-3, and Visicorp's VisiOn. VisiOn, unlike Lotus 1-2-3 is not really a system, but an Operation Environment. With VisiOn, applications are displayed on a screen that corresponds to the desk of the user. Each application appears on the screen in a separate window. The user accesses one or more of them by moving a cursor controlled by a peripheral called a "Mouse." The Mouse cursor acts as if it were an extension of the user's arm. As a result, it is claimed that a new user can learn to employ the system in 30-minutes.

One may show a word-processing draft in one window, while a second may display an electronic spreadsheet calculation. A user can view both applications and, while working on one, move the Mouse to another and push the button. This opens the related window and its application. To open new windows, or close existing windows, the user moves the cursor to the command line located on the bottom of the screen. Multiple windows can be sized and re-located on the screen using the Frame command, and data can be moved from one window to another using the Mouse and the Transfer command.

Although VisiOn was shown at Comdex, operating on an IBM-PC, and was one of the most exciting software concepts there, it will not be ready for release until the summer of 1983. Visicorp announced that a contract had been signed to install the system into the Digital Equipment Corp. personal computers, and it is expected that VisiOn will also be installed on other memory-mapped video computers made by others.

Power Base from GMS Systems (12 West 37th St., New York, NY 10018. (Tel: 212-947-3500) is a relational data-base system that attracted a lot of attention at the show. This system is very simple to set up and operate, yet it is powerful, accommodating up to 65K records of 1760 bytes of length containing 32 fields each. Each field can be 80 bytes in length. Power Base was also shown on the IBM-PC, but will be extended to other computers.

The long-established Condor and dBase2 data bases were also represented at the show with new revisions of their proven software.

Not all of the new software systems were shown in the exhibit hall. At other areas around the convention site, we were greatly impressed by products such as MicroMate III, a complete business package from Megaware Systems (2581G Alicia Parkway, Laguna Hills, CA 92653. Tel: 714-855-4733). This package contained all of the usual business accounting modules, plus report programs.

What impressed us the most was the coordination between On-Line Helps and the manuals. *There were*

references to the exact manual pages with each help shown on the screen! It is just this type of user-friendly application that is needed to support first time computer users. The system sells for about $250 per module, bringing the complete system to a user for $1995, which is not an excessive price for high-grade business accounting software.

In the field of operating system software, Digital Research Inc. of CP/M fame announced "CP/M Plus," its new name for version 3 of CP/M-80. The company also will release its extensive Graphics Software to work with CP/M. There were many questions about the development of a CP/M for the M68000 microprocessor. DRI spokesman said that CP/M-68K was being written in the C-language to provide portability to the many different types of M68000 computers now appearing on the market. This is the first important announcement of a non-Unix operating environment for the M68000 computers. Heretofore, only RM Cobol and Unix were offered as M68000 operating systems. The use of a CP/M type of environment for the M68000 will please a lot of users who are accustomed to this system.

Two-Dimensional Graphics. The entry of Digital Research Inc. into the graphics field was one of the important trends announced at the fall session of Comdex in Las Vegas. The initial product from DRI that provides a base for CP/M Graphics is called "GSS-Kernel." This tool provides software authors with an established library of two-dimensional graphic primitives such as lines and coordinate points needed to include graphic routines into application packages. By using GSS-Kernel software, authors no longer have to write graphics application code from scratch. They can simply call the established primitive from within GSS-Kernel.

Its use requires installation of the GSX extension of graphics to the CP/M system. (GSX is a graphics system extension that gives CP/M the ability to interface with many graphics hardware devices, from plotters to CRTs.) Writing graphics programs with the GSS-Kernel linkable run-time library will provide source-code portability to all micros with CP/M operating systems that have been extended with GSX. GSS-Kernel can be used with several popular computer languages, such as FORTRAN, Pascal MT+, and PL/1-80.

While to some the announcements may make it seem as if DRI is only playing "catch-up" in the graphics field. But I think that incorporating graphics into CP/M will profoundly affect the way application software appears to the user. It is all part of the development of user friendly software that is necessary if it is to be widely accepted.

Attention Programmers. Osborne Computer Co. has a new promotion plan for software authors. They are looking for programs to run on their machine and are offering a liberal royalty to authors. For additional information, contact Bob Moody at Osborne Computer Co., 26500 Corporate Ave., Haywood, CA 94545 and ask for an Author's Pack. If your programs were originally written for another CP/M machine, they will do the translation for you. Since their installed base is about 70,000 and they expect 200,000 by the end of next year, this sounds like a good deal for software authors.

C-Language Compiler for TRS-80. MISOSYS has developed LC, a C-compiler for TRS-80 Mod I and Mod III. Selling for $175, plus $4 shipping, the program produces ROM-able Z80 assembler source code compatible with EDAS IV, a full macro assembler that is included. LC supports I/O redirection, command line arguments, dynamic memory management and many C-statements. It is, however, an integer-only compiler. **Address:** MISOSYS, PO Box 4848, Alexandria, VA.

Apple Reference Cards. These pocket reference cards for the Apple II and Apple II Plus are accordion-foldup style on 80-pound Beckett antique cover stock. There are two cards, one for BASIC only, and one for BASIC and 6502 machine language. They are complete summaries of the Reference Manual, Integer BASIC Programming, Manual, Applesoft BASIC Programming Manual, and the 6502 programming manual. BASIC only is $3.95, BASIC + 6502 is $4.95. **Address:** Nanos Systems Corp., Post Office Box 24344, Speedway, IN 46224.

Slides From Apple II Disks. Visual Horizons has developed one of the most exciting services to be offered in a long time. Is is called Computer Slide Express, and it offers to convert the graphics from any Apple II diskette into a color slide.

The disk can have up to 35 graphic programs on it and the cost is $6 per slide. The turn-around time is said to be 48 hours from receipt of the disk. Once the slide is made, other photographic media can be produced, such as overhead projection transparencies and black-and-white prints. To start, the service is offered only from Apple II diskettes. Reportedly, the service will be extended later to IBM-PC and other computers with graphic capabilities. **Address:** Visual Horizons, 180 Metro Park, Rochester, NY 14623.

Condor Data Base. Condor Computer Corp. publishes the Condor Relational Data Base System which is a completely self-contained data language permitting users to define their own data storage and retrieval system. The Condor DMS is relational and easier to understand and use than network systems or hierarchical data bases. Condor DBMS has been adopted by most of the major microcomputer companies and is available on Digital Equipment Corp., IBM-PC, Hewlett-Packard 125, BMC Computer, Apple II, Zenith Data Systems, and NEC Computers. All of these will market and support the data base system for their respective computers. **Address:** Condor Computer Corp., 2051 S. State, Ann Arbor, MI 48104. ◇

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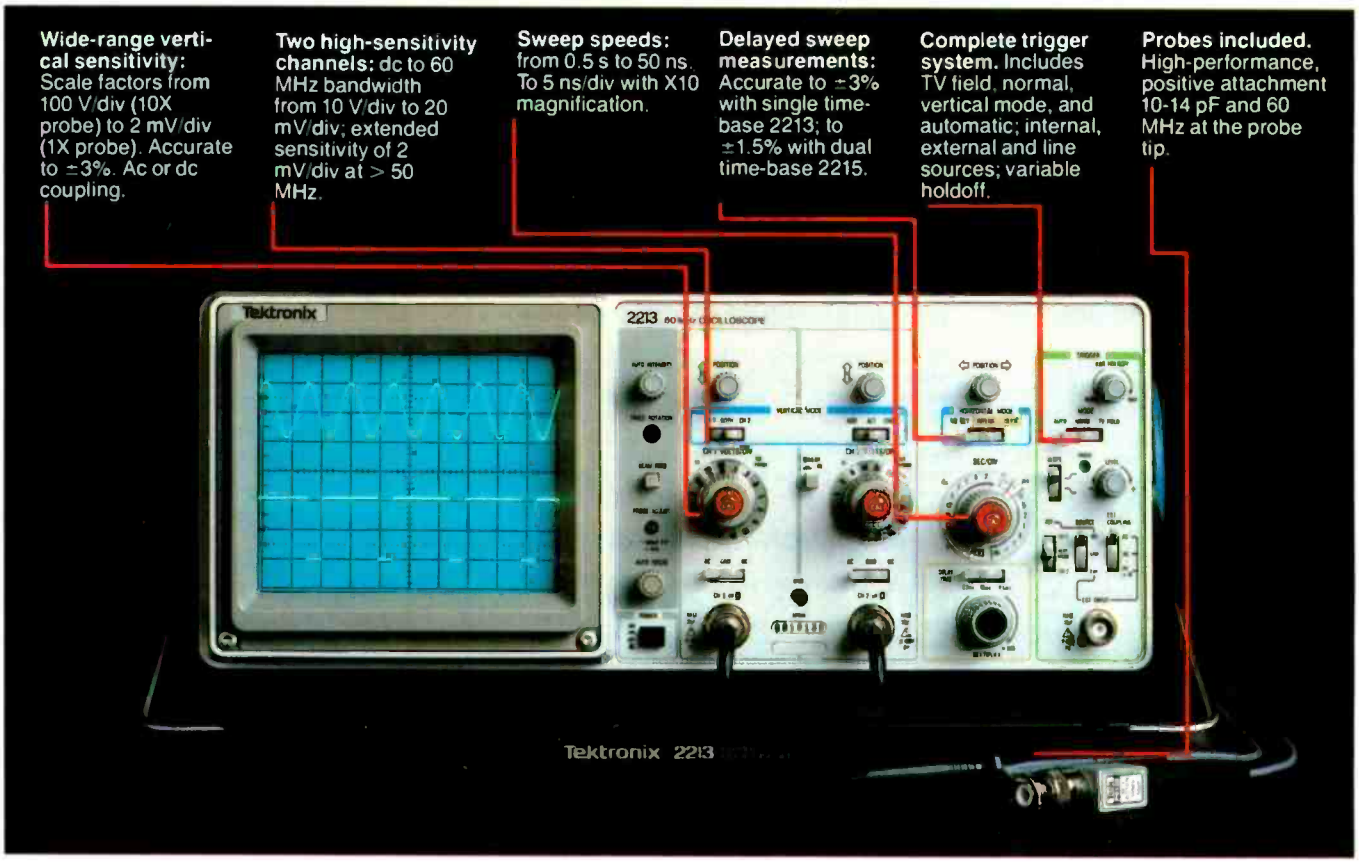

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THE BRITISH ARE COMING!

Hands-on evaluation of the BBC and Torch Microcomputers

By Stan Veit

THE British government has launched a campaign to encourage computer literacy among the country's children and young adults. The principal vehicles for this campaign are two Computer Literacy Programmes broadcast by the BBC. These are used by both individuals and schools throughout the United Kingdom. To support this program, a standard computer was specified. The resulting machine, called the BBC Computer (built by Acorn Computers) is the most versatile, small general-purpose computer I've seen.

The BBC micro is capable of having all kinds of enhancements and peripheral modules added to it until it grows into one of the most powerful microcomputers on the market. In fact, that is what the Torch Computer is: a BBC Computer with every possible hardware upgrade device and peripheral packaged in one cabinet and supported by a host of operating and application software.

Computers & Electronics
MARCH 1983

Since this review covers both the basic BBC and the Torch and the latter is an evolutionary product, let's examine the BBC Computer first. Then we'll cover expansion features that can be added. Finally, the complete Torch Computer and the hardware and software features that are unique to that machine will be discussed.

The BBC Computer. The basic BBC computer-keyboard package uses a 2-MHz, 6502 CPU and comes in two models: Model "A" (with 16K RAM) and Model "B" (with 32K RAM). Both models have the same case which is a plastic cabinet, 16" × 13" × 3" high. The power cord as well as video and cassette connections are made through the rear panel. Other connections are either on the rear panel or on a panel under the computer.

The keyboard is a standard QWERTY arrangement with 10 user-defined function keys. It has an excellent feel to it and seems well-built.

Model A is a simple machine suitable for beginners. All of the 16K bytes of RAM are available to the user because it also has additional Read Only Memory (ROM).

One 16K ROM contains the operating system. This is designed to interface with high-level languages and to operate a cassette data storage system.

An additional 16K ROM contains the powerful BASIC interpreter. This is somewhat like the *de facto* Microsoft standard BASIC, but it includes a 6502 Assembler, which permits BASIC statements to be intermixed with 6502 Assembly Language. There is provision for four additional ROMs to be plugged in at any time. These may contain additional language interpreters such as Pascal, LISP, and FORTH; or they may contain application firmware systems like word processors, computer-aided design programs, Teletext systems, electronic mail systems, or other enhancements. As the computer expands from Model A to Model B, you plug in additional ROMs to support the expansion with additional software systems.

The 32K Model B has additional video modes. In addition, there are interfaces that can only be used with the Model B, such as a floppy disk system; a serial interface to the new RS432 standard (interchangeable with RS-232C with extra capabilities such as improved data transfer rates and longer cable lengths); a parallel Centronics interface; an RGB video color interface; and four analog input channels, each with an input voltage range of 0 to 18 V. They are capable of converting from analog to digital data in 10 milliseconds and, when the conversion is complete, storing the data in memory for later access. These analog inputs are not only used for laboratory and process control, but to provide inputs for game joysticks, trackballs, and paddles.

A buffered extension bus is provided in Model B to permit connection to Prestel, Teletext or various other expansion units such as an extra 6502 processor with 64K of RAM, a Z80 second processor with 64K of RAM, and the CP/M 2.2 Operating System.

The video system on the BBC Microcomputer has many display modes and is one of the most adaptable parts of the computer system. Table I shows video capabilities of both models. Model B features resolution as high as 640 × 256 pixels with two-color graphics and 160 × 256 with 16-colors.

The standard television output is modulated composite video for a TV receiver. There is also an unmodulated video output for a monochrome monitor and an RGB color video output. Music output is through an internal speaker driven by a three-voice music synthesis circuit, with full sound-envelope control. There is also a noise channel for special effects.

In the U.K., where disposable income is not as available as in the United States, cassette mass data storage is much more widely used. Accordingly, the BBC Computer supports a full file system based upon the CUTS (Computer Users Tape System) method that can be used to record programs at either 300 or 1200 baud. The cassette recorder is under full automatic motor control (for start and stop). This system has not been used in the United States since the SOL computer went out of business in 1978. It was one of the fastest and most reliable of the cassette operating systems.

For those who use the BBC Micro for business or data-collection applications, the cassette data storage system is obviously not satisfactory. Therefore, a floppy-disk system is available as an expansion unit for Model B computers. The interface is installed inside the computer case and consists of an 8271 LSI controller chip, supporting circuits, and a ROM with the operating system firmware.

One of the interesting features of the BBC design is that most of the operating system is contained in ROM so that is does not take RAM memory space. The disk drives are mounted externally. They are slimline drives with two taking the space of one normal-sized drive. The assembly contains either two, single-density, single-sided drives with

100K bytes of data storage, or they are two double-sided, double-density drives of 400K bytes capacity each.

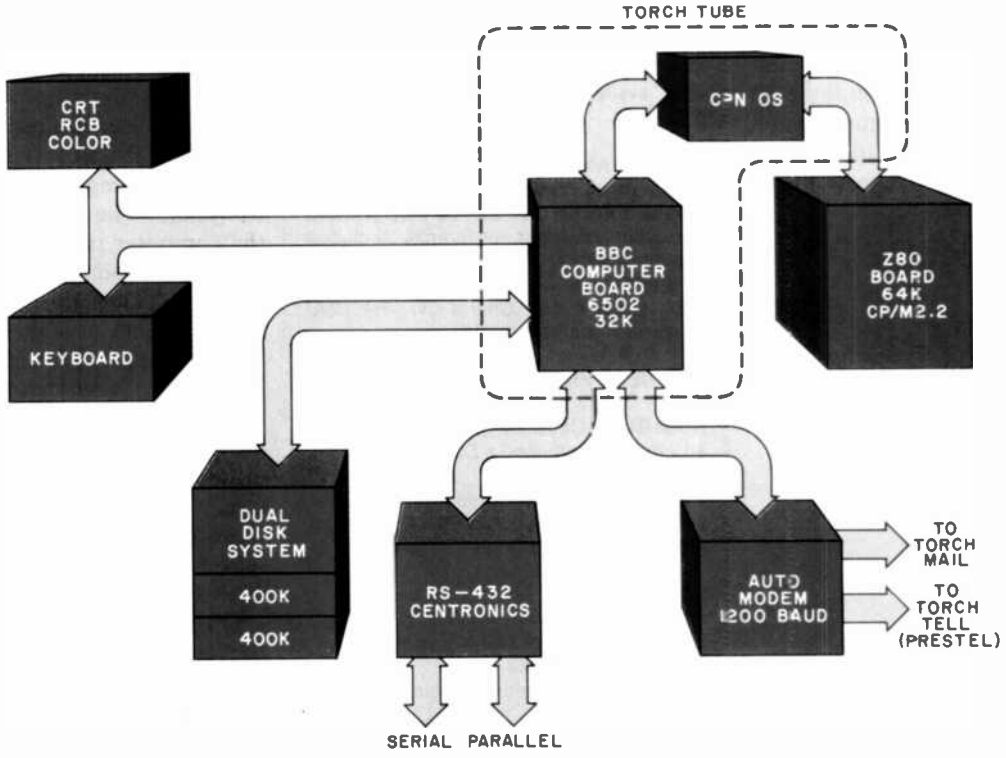
To provide extra room for expansion, several different peripheral expansion units are sold. They are all housed in the same type of case, designed to match the computer. One type of expansion unit may contain a 6502 second processor and an extra 64K of RAM. This allows the system to run CP/M Version 2.2. and turns the BBC machine into a business-capable computer. Only one second processor can be attached to the computer at one time.

The Teletext Unit is another identical-looking plug-in expansion unit that can be attached to the computer. This contains the Teletext circuits and 1K of additional RAM. In use, the system receives and decodes the teletext TV signal using a UHF tuner and converts it into a video signal for the video processor Teletext data, which is transmitted between picture lines on a television receiver, is stored in the 1K-RAM buffer and then sent to the BBC computer.

Another communications feature of the BBC Computer is the Prestel System, which is also housed in one of the expansion cases, and connected to the BBC Computer through cables and to the telephone system by a standard jack. This interface contains a 300/1200-baud approved modem, automatic dialing and receiving circuits, and the necessary software in a ROM. The Prestel System allows the user to access a central Prestel computer that stores thousands of pages of information in full color and with graphics. This system is just starting to operate in the United States, and it is possible to call an interface number in Boston, MA and be connected with the Prestel System in London. The Prestel expansion unit can also permit one BBC Computer to carry out a two-way communication with another BBC computer so equipped.

The BBC Computer enjoys extensive software support in the UK. However, most of the software supplied to us with the computer was games and video color demos. Using the BBC RGB Color Monitor, we can say that the graphics and color quality surpassed anything we have ever seen in a personal computer. It was as good as or approached what is seen in a video arcade.

The Torch. The Torch Microcomputer is simply an assembly of all the desirable options connected to a BBC Computer plus a high resolution RGB CRT, two double-density, double-sided, disk drives of 400K-byte capacity each, and a super keyboard detached from the computer case as required by the European standard. The Torch has a power supply for 220/110-volt, 50/60-Hz operation. (The BBC Computer we tested operates on 220-V, 50-Hz power and we used a step-up transformer. The use of 60 Hz instead of 50 produced only a slight flicker.) It features a steel desktop cabinet. All output connectors and switches are mounted either on the side or rear of the cabinet. The unit's design permits the computer to be used either as a desktop computer or mounted in a rack. The Torch is a completely self-contained unit. All you have to do is add a printer: everything else is provided, including a built-in modem. However, there are two-hard-disk options available. Both add an internal Winchester Technology hard disk with an external power



Block diagram of the Torch computer.

supply. One option stores 10M bytes of data, while the other stores 20M bytes. Both hard disks retain one floppy-disk drive for back-up and program loading purposes.

The multiprocessor system used in the Torch gives it remarkable speed and flexibility. The 32K BBC Computer board is used as a powerful peripheral controller handling the operating system, housekeeping chores, and communications with the outside world. This frees the Z80 processor for application program operation. It provides the user with 61K bytes of user program space out of a possible 64K bytes. This is 20% more space than any other CP/M compatible system. The operating system is called CPN and includes an exclusive "TUBE" design that provides a two-way channel between the BBC Computer and the Z80 processor board. It is this design that permits most of the CP/M operating system to reside in a ROM on the BBC Computer while it is actually used by the Z80 processor.

When the 6502 in the BBC Computer is handling communications, it does not interrupt the current mode of operations. This means that the user is not aware that the system is sending or receiving messages from another computer or network, although a message is printed on the screen to indicate that the transfer has been made.

There is also a speech synthesizer that uses phoneme encoding to speak to you and inform you that an electronic message awaits you, or that you have an appointment stored in its calendar!

The music system built into the computer includes three independent channels of sound over a three-octave range. It is capable of being programmed with very complex compositions. Both the music and speech synthesis systems are reproduced by a good-quality loudspeaker.

The detached keyboard contains both a numerical keypad, the standard QWERTY keys, and a special pad that permits one-stroke operation of wordprocessing systems. The keyboard is interrupt driven and permits type-ahead operation. All keys are sealed-wafer types to ensure dirt-free operation. This also gives them an excellent typing feel and reduces fatigue.

The normal display is a high-resolution RGB color monitor with a 12" CRT. It is capable of reproducing all of the BBC Computer video modes plus additional graphic displays such as DRAW LINE and FILL AREA used for making graphs and high-resolution graphics.

There is a built-in real-time clock with 10 millisecond resolution and a 100-year range.

The internal modem is capable of 1200-baud operation although it can be adjusted for operation for any lower baud rate through software selection.

Users Comments. In spite of the screen flicker caused by line-frequency differences, using the BBC Computer was fun. We were all enthralled by the graphics resolution and the color saturation provided by the RGB Color monitor and the increased lineage of the British video system. The processing speed of the computer is very fast, which is especially noticeable in animated graphics. The music quality and sound effects are about on a par with the Apple, TI, or Commodore. No serious application programs were supplied to us with the demo unit and we did not have the communications interface unit for testing. We did program some applications of our own. The BBC Basic is a well-designed language, about the same as Microsoft BASIC.

On the negative side, we found the floppy-disk operating system software of the BBC Computers to be primitive. It is slow and, in general, appeared to be an afterthought.

(Continued on p. 48)

TYPICAL PROGRAMS FOR THE BBC COMPUTER

EDUCATIONAL

Business Games: Stockmark 1 teaches how to buy and sell stock, and Telemark is based upon the buying and selling of TV sets.

Tree of Knowledge: An interactive program for children that teaches categories and games of deduction and logic.

Algebraic Manipulation: Four programs that teach mathematics.

Peeko-Computer: Simulates the operation of a microprocessor to teach the fundamentals of machine-language programming.

GRAPHICS PROGRAMS

Creative Graphics: 36 programs on cassette producing pictures and patterns in full color. Includes animated pictures, defined curves and rotated three-dimensional shapes. A full discussion on how to produce them. The book *Creative Graphics On The BBC Computer*, by John Cownie is also available to go with this set of programs.

GRAPHS AND CHARTS

Programs on cassette produce a series of graphic routines that can be incorporated into your business programs. Includes two-dimensional graphs, three-dimensional graphs, bar charts and pie charts. A book *Graphs And Charts On The BBC Computer*, is also available.

BUSINESS PROGRAMS

Desk Diary: Cassette-based programs for an Address Book and a Diary Planner.

View: A word processor for the BBC Computer. Supplied on a 16K ROM with complete teaching and reference manuals.

LANGUAGES

LISP: Language for artificial intelligence.
FORTH: On cassette.
BCPL: Compiler-writing language for the BBC Computer.

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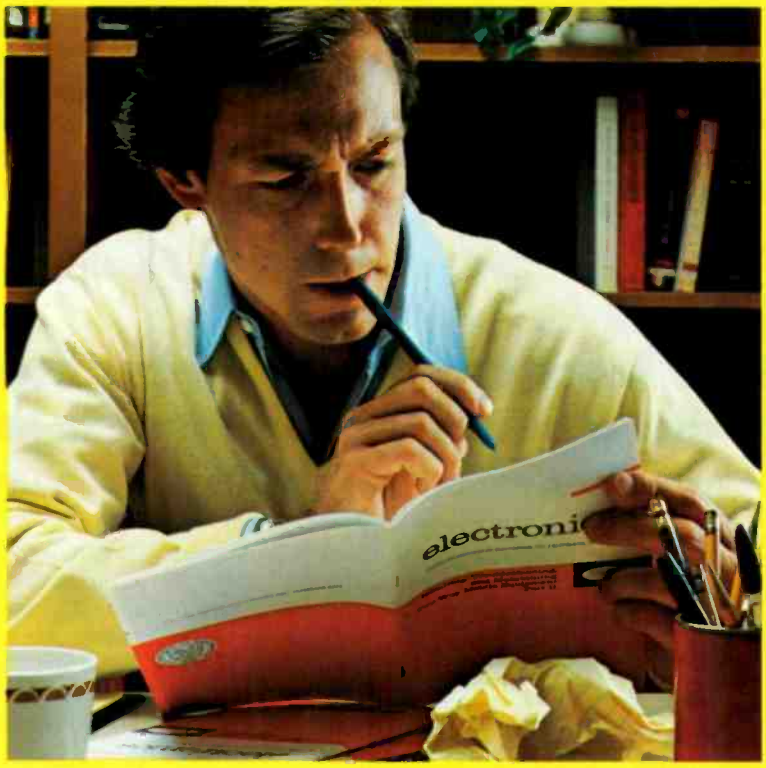

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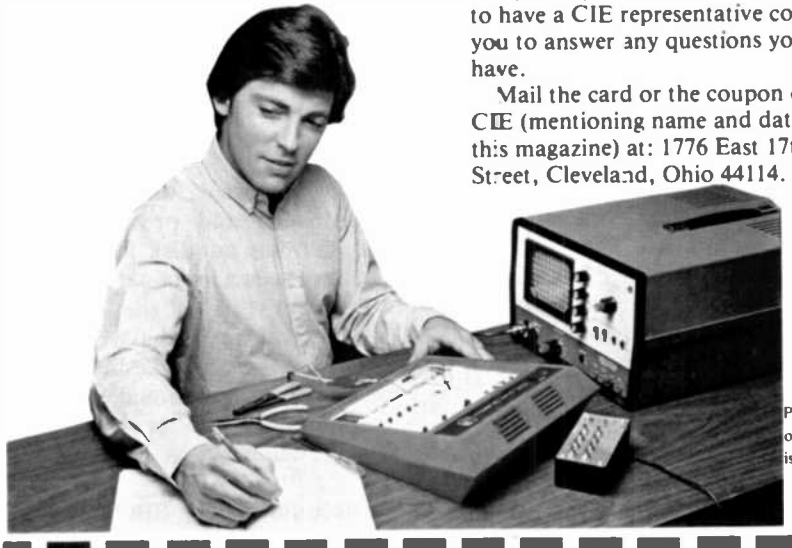

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(Continued from p. 42)

However, the disk drives are of the latest slim-line design. This represents the general situation in the UK, where most people who buy a moderately priced computer like the BBC Model "A" Computer will use cassette storage rather than disks. There is a huge amount of packaged software for the BBC Computer, but we were not supplied with anything but demos. The games we had are of Arcade quality though, and we are told that there are excellent business applications available.

The Torch is the best illustration of the BBC Computer's potential. It is truly a computer owner's dream. We ran WordStar, Supercalc, and the special Executive Aid System that contains the Typewriter Word Processor, Cardex Data Base, and Diary memo programs. This is a very friendly system, as is all the packaged software we used. Even in WordStar, the great speed of the system cut the time lost in changing menu screens so much that we forgot how annoying it can be on a slow computer. The recalculation time in Supercalc was dazzling! What really impressed us was the Prestel demonstration. We sat in our office in New York and selected items on a menu. The Torch automatically called the Prestel computer in Boston, made the connection, and in a few minutes we were looking at the Prestel pages in London, England! All in full color with graphics! We read all the post-Christmas ads for the London department stores and the Lonely Hearts Column. All our experience on the networks in this country had not prepared us for this technological wonder!

We also had a demo of the Torchmail system. In this electronic mail program, the Torch in New York automatically dialed the Torch in Boston, made the connection, announced it on the screen, and presented us with a menu.

TABLE I—BBC COMPUTER VIDEO DISPLAY MODES

Model B only:
Mode 0 640 × 256, 2-color graphics, 80 × 24 text
Mode 1 320 × 256, 4-color graphics, 40 × 32 text
Mode 2 160 × 256, 16-color graphics, 20 × 32 text
Mode 3 380 × 25, 2-color text

Models A & B:
Mode 4 320 × 256, 2-color graphics and 40 × 32 text
Mode 5 160 × 256, 4-color graphics and 20 × 32 text
Mode 6 40 × 25, 2-color text
Mode 7 40 × 25 Teletext display

We requested that a file be downloaded and presto, there it was, saved on our disk, forever ours. We have seen a lot of network operation, but this is the most-user friendly transfer we have ever experienced. A Torch spokesman told us that many international firms buy the computer just for this feature. We can believe it.

Conclusions. The BBC Computer is a wonder for the money in the UK. It costs about 300£ for the Model A and 400£ for the Model B. The disk drive costs 235£ for the single 100K unit and 389£ for the 200K double unit. The 14-inch RGB Monitor sells for 279£. (The exchange rate around the first of the year was about $1.63 to the pound.) These prices are for the British models. The BBC Computer will be imported into this country during 1983, but since there are technical modifications to be made because of the power and video differences, do not expect the price to be equivalent. Since this machine will have to compete with the same machines as it does in the UK, namely the Commodore, Apple, and TI Computers, the price will have to be competitive, though. With the price wars going on in the low-end computer industry, that will not be easy.

In any event, the design of the BBC Computer shows that original thought is going on in the UK at a time when so many of the American computer companies are building clones of one or another popular computers.

Some of the features of the BBC should be copied by our computer manufacturers. The idea of having different video modes, giving the owner a choice of display size, is certainly one that should be copied in this country. The option of NTSC or RGB color is another, and the built-in modem should also be considered. After all, it only requires a few extra chips added to existing circuits.

I predict that operating systems in ROM will become much more common in U.S. computers, thus providing more use of the complete RAM memory. As competition in price becomes sharper, we will likely see computers designed like the BBC. The initial purchase model will be inexpensive and there will be lots of add-on modules, increasing the power and cost of the computer to match the increasing skill of the user.

The Torch Computer is priced at $6,500 in this country which is not a high price for a machine with all its features. Nothing else in the market place offers the same kind of features for anywhere near this price. However, it is not everybody's computer.

While everyone will admire the Torch, not many people will find justification for the price. For those that need it, however, the Torch will find a welcome place in the market.

It certainly shows that the BBC Computer and all its expansion modules can be adapted for use in the U.S. No other computer for sale anywhere can match the Torch feature for feature in the same price range. It certainly gives U.S. designers a target to aim for. ◊

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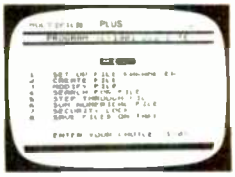

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ZXBUG is a powerful tool for machine language programming. It is 4K long and uses memory from 71EO to the top memory. ZX BUG works in hexa-decimal (base 16), not decimal, so all addresses are a maximum of 4 Hex bits long. Provides a total of 28 commands.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

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9 Powerful New Functions!

RENUMBER. This routine renumbers a program in any step and from any line up to 9999
DELETE. This command deletes a group of lines in a program.
MEMORY. Prints how much spare memory is available.
DUMP. Displays current values of string and numerical values, except arrays.
FIND. Will find any string of up to 255 characters and list each line containing that string.
REPLACE. Replaces any string of up to 255 characters by any other string.
SAVE. Transfers program in computer to below RAMTOP.
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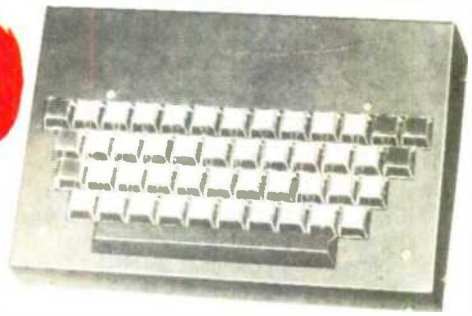
REMKILL. Removes all REM statements from a program, otherwise leaving it unchanged, preserving memory. **$14.95**



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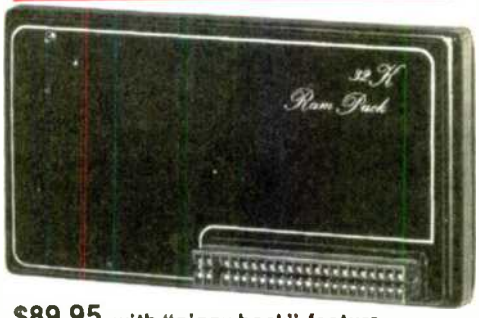

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Now we're introducing the HP-75 portable computer. And if press reaction is any indication, history is about to repeat itself.

As small as a book. As powerful as a personal.

Desktop-computer power in a handsome 26-ounce package. That's the HP-75. It's just 10 inches by 5 inches by 1¼ inches.

But don't let the compactness fool you. Inside its rugged case lies a 48K-byte, ROM-based operating system. With a comprehensive, 147-command instruction set that helps you write hard-working, memory-efficient BASIC programs.

Plug-in ROM ports let you add up to three 32K-byte software modules—modules that solve tough problems *without* sacrificing user memory.

And that user memory gives you up to 24K bytes of program and data storage.

It all adds up. A fully loaded HP-75 is a 168K-byte computing powerhouse in calculator clothing.

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Those keys, by the way, can be redefined with your favorite commands or programs. Up to 196 unique key combinations in all.

Immediate, convenient access to your most frequently used programs.

Thanks to the HP-75's multiple-file structure, programs, data and text can be named, simultaneously stored in memory, and programmed to interact with each other.

Add continuous memory, and you've got a computer that's designed to solve problems on the go. Simply load your favorite files and enjoy immediate access to any or all of them. The files are retained in memory until *you* decide to delete them—even when the machine is turned off.

Time and appointments to keep you on schedule.

The TIME key brings to display the day of the week, date and time to the nearest second.

The APPOINTMENT feature reminds you—an hour from now or a year from now—of things you have to do. You can have a silent message on the display, any one of six alarms, or a combination of both.

Even if the machine is turned off, it will "wake up" and alert you of an appointment. Or it will execute programs or control peripherals according to predetermined schedules.

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Software tailored to solve your specific problems.

HP-75 software is now available in areas such as math, engineering, finance, and statistics. With spreadsheet analysis* on the way.

Our plug-in math module,* for instance, solves polynomial roots, evaluates integrals, and performs finite Fourier transforms.

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In addition, our third-party software program assures you of ever-expanding software variety.

If you're a volume purchaser or OEM, give us a call. We can help you create custom HP-75 systems with special plug-in modules, magnetic cards, digital cassettes, and keyboard overlays.

Peripherals for a total computing package.

The HP-75 is equipped with the Hewlett-Packard Interface Loop, giving you a choice of 15 peripherals. (And that choice is expanding. The HP-75 *can* work simultaneously with up to 30.)

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In summary, the HP-75 is the heart of an extremely versatile system, in addition to its stand-alone capabilities.

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Chock-full of examples and helpful hints, our owner's manual will get you up and running in short order. And it's organized to help you access the information you need to get on with the job at hand.

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What is the price of all this power in this compact package? $995.**** A lot less than you might pay for a personal computer you can't take with you.

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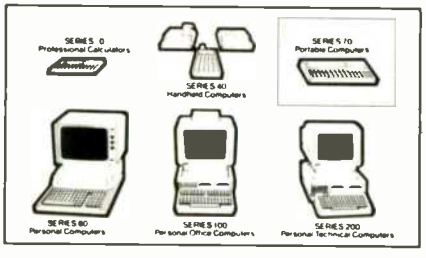

*Available May 1, 1983.
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****Suggested retail price. May vary outside U.S. Peripherals and software not included.

HEWLETT PACKARD

CIRCLE NO. 54 ON FREE INFORMATION CARD

HP-75 SPECIFICATIONS

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48K-byte, ROM-based operating system:
• 8-bit CMOS CPU • Multiple file structure in continuous memory • Instruction set: 52 system commands, 43 BASIC commands, 41 numeric functions, 7 string functions, 6 time-mode commands, 16 arithmetic/logical/relational operators
Numeric precision:
• Real—12 digits ($\pm 9.99999999999 \times 10^{\pm 499}$)
• Short—5 digits ($\pm 9.9999 \times 10^{\pm 99}$)
• Integer—5 digits (±99999)
Time/appointments:
• Perpetual clock/calendar • 12- or 24-hour format • Appointment control of command/program execution
Memory:
• User (RAM)—16K bytes, expandable to 24K bytes • Operating system (ROM)—48K bytes • Plug-in software (ROM)—up to 96K bytes (3 32K-byte modules)
Typewriter-like QWERTY keyboard:
• 65 keys • 194 redefinable key combinations • "Hidden" numeric keypad
Integral mass storage: hand-pulled card reader (1.3K bytes per card)
Built-in interface: HP-IL; choice of 15 peripherals
Power supply: 3 AA NiCad batteries (AC adapter/charger included)
Liquid-crystal display: 32-character window on 96-character line

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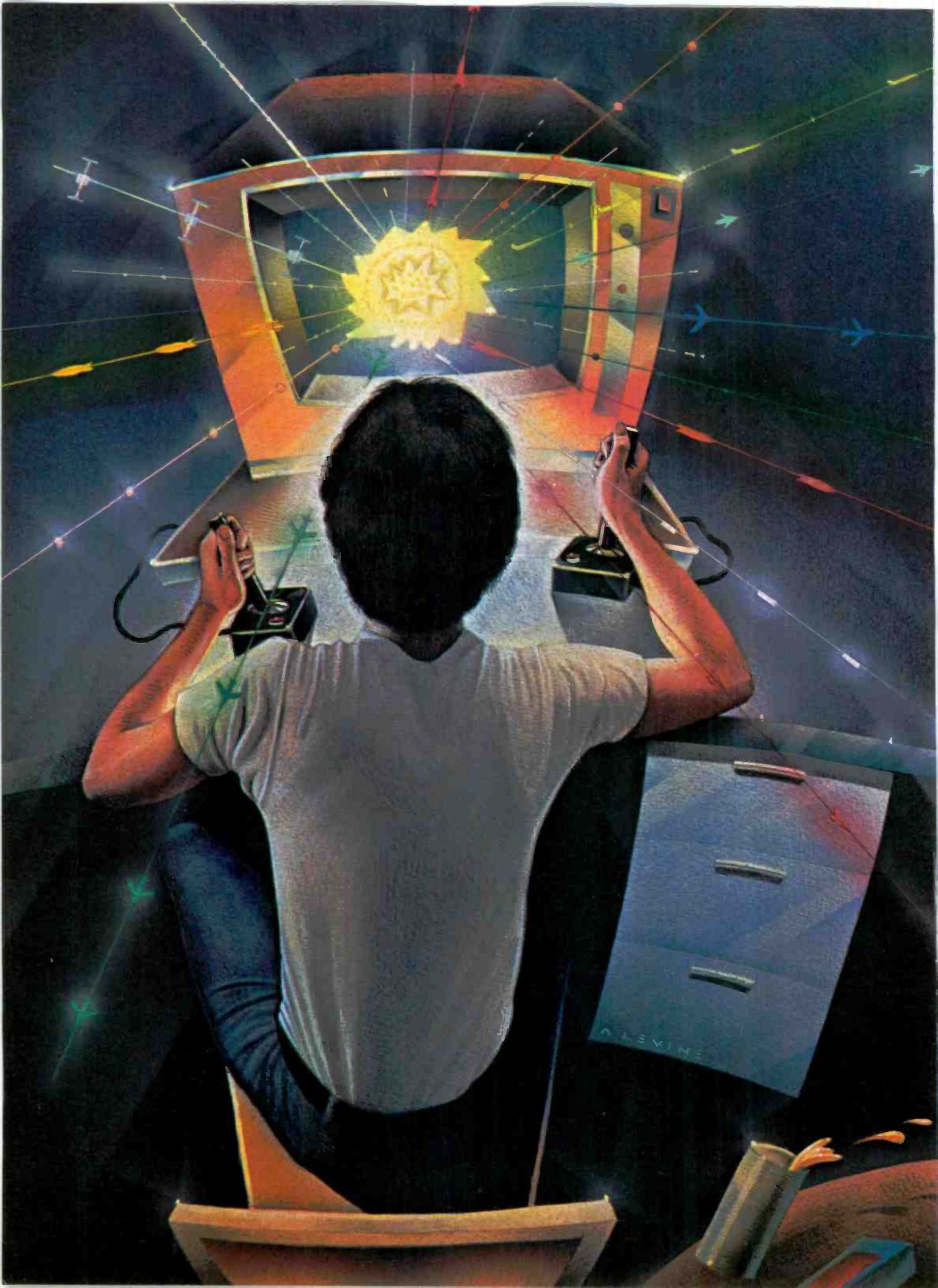
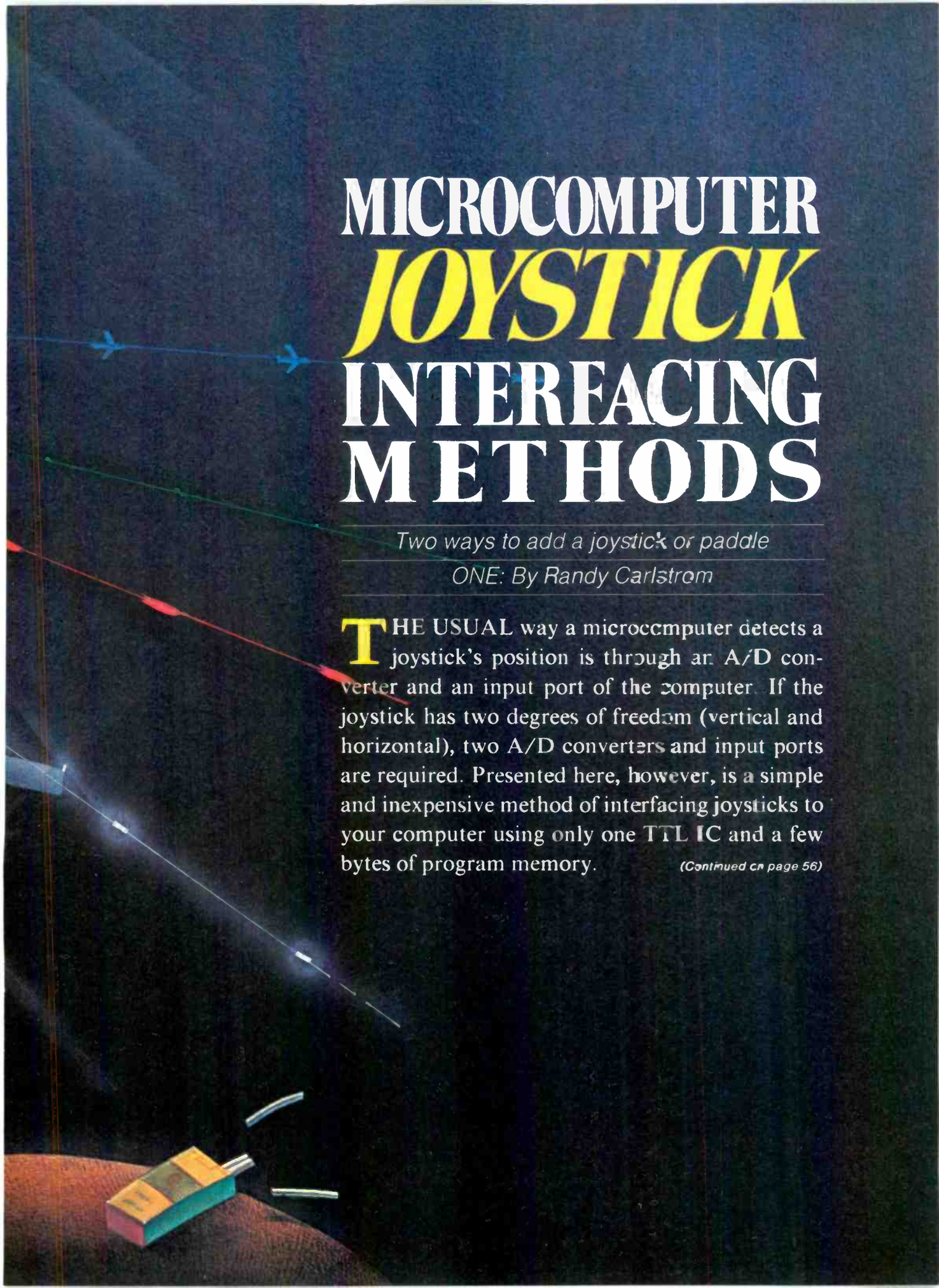

ALEXINE



MICROCOMPUTER *JOYSTICK* INTERFACING METHODS

Two ways to add a joystick or paddle

ONE: By Randy Carlstrom

THE USUAL way a microcomputer detects a joystick's position is through an A/D converter and an input port of the computer. If the joystick has two degrees of freedom (vertical and horizontal), two A/D converters and input ports are required. Presented here, however, is a simple and inexpensive method of interfacing joysticks to your computer using only one TTL IC and a few bytes of program memory.

(Continued on page 56)

"I built this 16-bit computer and saved money. Learned a lot, too."

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Save by building it yourself. You can save hundreds of dollars over assembled prices when you choose the new H-100 16-Bit/8-Bit Computer Kit – money you can use to buy the peripherals and software of your choice.

H-100 SERIES COMPUTER SPECIFICATIONS:

USER MEMORY:
128K-768K bytes

MICROPROCESSORS:
16-bit: 8088
8-bit: 8085

DISK STORAGE:
Built-in standard 5.25" disk drive, 320K bytes/disk

KEYBOARD:
Typewriter-style, 108 keys, 13 function keys, 18-key numeric pad

GRAPHICS:
Always in graphics mode. 640h/225v resolution; up to eight colors are available*

COMMUNICATIONS:
Two RS-232C Serial Interface Ports and one parallel port

DIAGNOSTICS:
Memory self-test on power-up

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CP/M-85
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Multiplan
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*128K bytes standard. Optional.

The H-100 is easy to build – the step-by-step Heathkit manual shows you how. And every step of the way, you have our pledge – "We won't let you fail." Help is as close as your phone, or the nearest Heathkit Electronic Center.

And what better way to learn state-of-the-art computing techniques than to build the world's only 16-bit/8-bit computer kit? To run today's higher-speed, higher-performance 16-bit software, you need an H-100. It makes a significant difference by processing more information at faster speeds.

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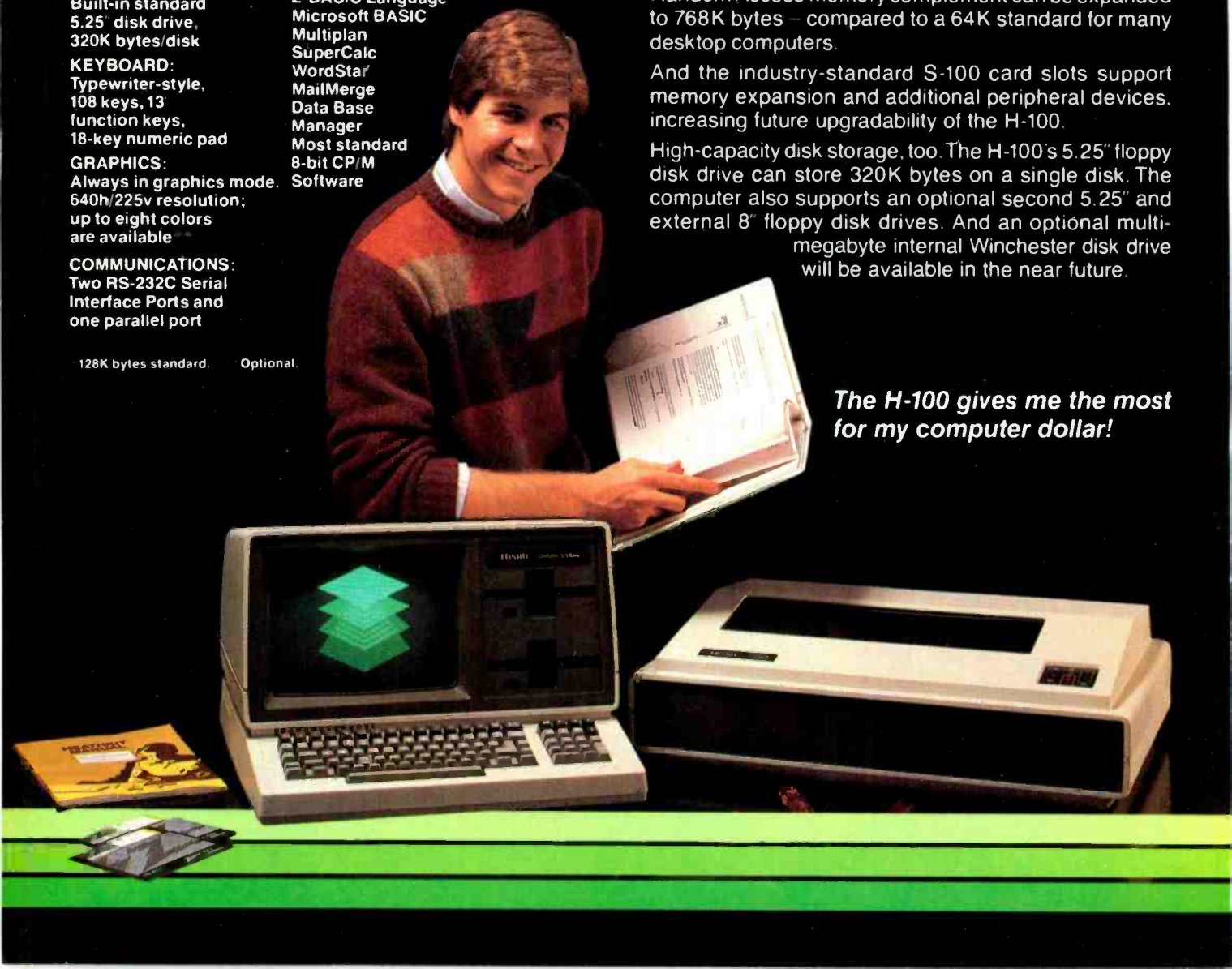

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Critical circuits are pre-assembled, making the H-100 easier and faster to build!

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The H-100 gives you total communications flexibility. Three interface ports let you plug in dot-matrix and letter-quality printers, as well as other peripherals.

Compare the H-100's exceptional capabilities with other desktop computers:

COMPUTER:	Heathkit H-100	IBM Personal Computer	Apple III
MICROPROCESSORS:			
16-bit:	8088	8088	–
8-bit:	8085	–	6502
RANDOM ACCESS MEMORY:			
Minimum:	128KB	16KB	128KB
Maximum:	768KB	576KB	256KB
FLOPPY DISK STORAGE:			
Per Diskette:	320KB	320KB	140KB
Maximum Internal:	640KB	640KB	280KB
3" Floppy Support:	Standard	—	—
EXPANSION SLOTS:	Five S-100 (four available)	Five (three available)	Eight
I/O PORTS:			
Parallel:	1	Optional	–
Serial:	2	Optional	1
VIDEO DISPLAY:			
Line Columns	25 x 80	25 x 80	24 x 80
Pixels Colors	640 x 225 (8 colors)	640 x 200 (2 colors) 320 x 200 (4 colors)	560 x 192 (16 colors)
OPERATING SYSTEMS:	CP/M-85, Z-DOS (MS-DOS),	CP/M-86 PC-DOS (MS-DOS) UCSD P-System	Apple SOS

Information current as of 8/31/82. *** External disk storage available soon.

Learn by building. When you build and operate the H-100, you learn more about this sophisticated computer system and its unique 16-bit/8-bit software capabilities.

Learn from outstanding documentation. One of the most important parts of any computer system is documentation – and Heathkit documentation is among the industry's best. Our instruction and operating manuals are fully detailed, in the world-famous Heathkit tradition.

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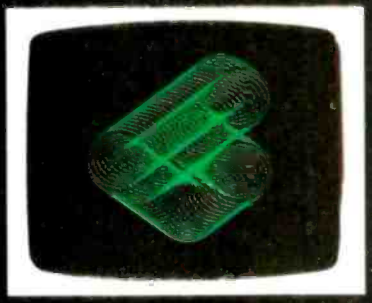

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CIRCLE NO. 61 ON FREE INFORMATION CARD

Circuit Operation. The circuit of Fig. 1 shows *IC1A*, which is one-half of a dual non-retriggerable monostable multivibrator ("one-shot"). The output pulse width is determined by the values of *C1*, *R1*, and *Rx*. The circuit is triggered at pin 1 of *IC1A* by an "input read" pulse. This pulse is generated from the system's input interface logic during the execution of an input instruction. Circuit details are omitted since the decoding circuitry is system and CPU dependent. The input read signal is usually found connected to an "enable" input of the input buffers of the interface. Pin 13 of *IC1A* should be connected to one bit of the input port for sampling by the CPU. This scheme allows up to eight joystick potentiometers to be interfaced to an 8-bit computer using only one parallel input port and very simple hardware.

When *IC1A* times out, *C2* begins charging through *R2*. Multivibrator *IC1A* is prevented from triggering again until *C2* charges to about 1 V which enables *IC1A*. This delay is necessary to provide sufficient "recovery time" for *IC1A*, to make sure its maximum rated duty cycle is not exceeded.

Software. The second half of the joystick interface is the driver software. Basically, a program measures the length of time one-shot *IC1A* is fired, which is a function of the joystick position (the setting of *Rx*). The pulse width, t_x, of *IC1A* can be calculated from the formula:

$$t_x = 0.7C1(R1+Rx).$$

In the 8080 implementation of the driver software shown in Table I, register B is used as a counter for measuring the pulse length. (The choice of register B is completely arbitrary.)

The value that will be returned in register B can be determined by the following method. The execution time for loop "XLOOP" is 18.5 μs for an 8080 CPU running at 2 MHz. (This can be calculated by adding up the individual execution times for each subroutine instruction, as

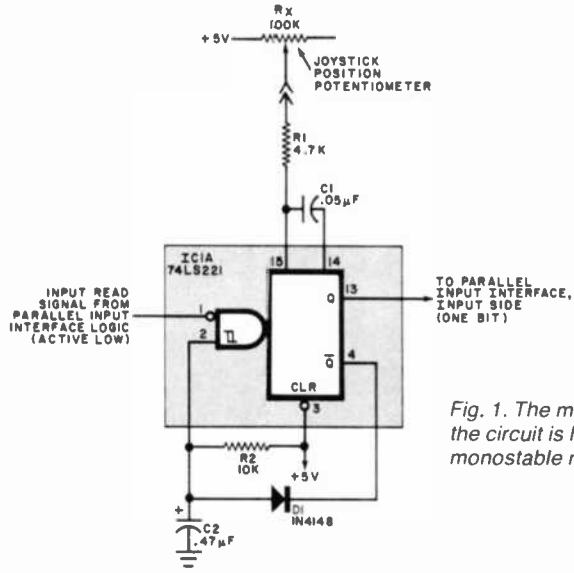


Fig. 1. The main part of the circuit is half of a dual monostable multivibrator.

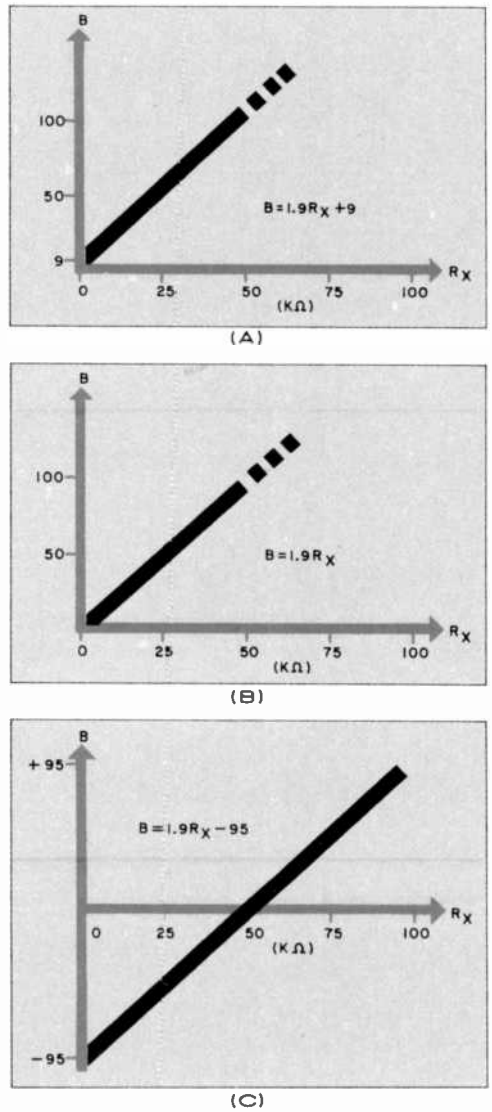


Fig. 2. Three plots of B vs R_x with different amounts of vertical offset.

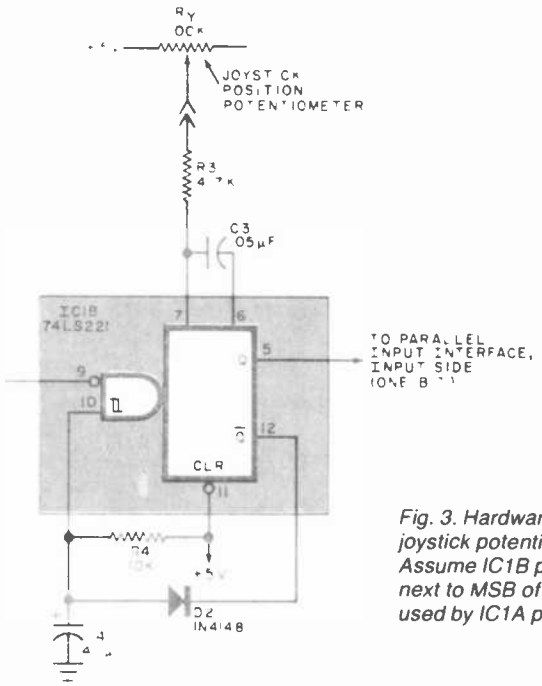


Fig. 3. Hardware for second joystick potentiometer interface. Assume IC1B pin 5 is connected next to MSB of same interface used by IC1A pin 13.

given in the 8080 data sheets.) Therefore, as long as the one-shot is fired, register B is incremented by one count every 18.5 μs. Clearly, then, the value returned in register B is

$$B = t_x/18.5\ \mu s$$
$$= 0.7C1(R1 + Rx)/18.5\ \mu s$$
$$= 0.7C1R1/18.5\ \mu s + 0.7C1Rx/18.5\ \mu s$$

Using
$C1 = 0.05\ \mu F$
and
$R1 = 4.7$ kilohms
from Fig. 1,
$B = 8.9 + 1.9Rx$ (*Rx* expressed in kilohms).

A plot of B vs. *Rx* would be a straight line of slope 1.9 and B-intercept of 9. (The value of B must be an integer; the closest integer to 8.9 is 9). See Fig. 2A. The experimental result of B vs. *Rx* is given in Table II.

If the program calling the subroutine in Table I required the register B count corresponding to $Rx = 0$ to be zero, the curve in Fig. 2 could be "shifted down" to make the B-intercept zero by subtracting nine from register B (Fig. 2B). Similarly, if joystick displacements to the left of the neutral (center) position were to represent negative displacements, and displacements to the right positive displacements, subtracting the B value corresponding to $Rx = 50$ kilohms (which corresponds to the joystick neutral position) will shift the curve by the appropriate amount (Fig. 2C). (This is assuming that *Rx* increases as the stick's position is moved from left to right).

It should be noted that, if the subroutine shown in Table I is called again before the one-shot's "recovery time" has elapsed, register B will be returned with a value of zero. Because of this, the calling program should check for this condition before it processes register B any further. (Register B = 0 may be interpreted as "hardware not ready" by the calling program.)

If the joystick has two degrees of freedom (and therefore two position potentiometers), the second potentiometer *Ry* may be interfaced as shown in Fig. 3. More joysticks may be interfaced to the input port in like manner.

If your CPU runs at a speed other than 2 MHz, *C1* should be scaled by the appropriate amount to keep the value returned in register B in the range 0 to 255. For instance, if your CPU is a Z80 running at 4 MHz and the subroutine in Table I is used, *C1* should be scaled by 1/2, or $C1 = 0.025\ \mu F$. Or, compensation can be provided by increasing the execution time of XLOOP by imbedding NOP instructions in the loop, each of which adds 1 μs to the execution time (for a Z80 running at 4 MHz). ◇

(Authors note: For more information on 8080 I/O interfacing and machine language programming, refer to "Designing with the 8080 Microprocessor," Parts 2 and 3, which appeared in POPULAR ELECTRONICS, *October and November, 1981.)*

(See next page for second interfacing method.)

TABLE I—8080 SUBROUTINE

```
START  MVI B,00     Initialize counter
       IN XCORD     Trigger one-shot
XLOOP  IN XCORD     Has one-shot
                    timed out?
       ANI 80H      (Mask one-shot
                    status)
       RZ           Yes: return with
                    count in register B
       INR B        No: bump count
                    in register B and
       JMP XLOOP    continue measur-
                    ing pulse length
```

Note: *Assumes IC1A pin 13 is connected to MSB of input interface. XCORD represents actual port number, dependent on system input interface hardware.*

TABLE II—EXPERIMENTAL RESULTS OF B VS. Rx

Rx (kilohms)	B Count	Calculated value
0	9	9
10	27	28
20	47	47
30	65	66
40	86	85
50	106	104
60	125	123
70	143	142
80	162	161
90	180	180
100	201	199

TWO: By Ralph Tenny

USING a new low-cost A/D (analog to digital) converter, you can design a joystick interface for your personal computer. Originally developed for automotive control circuits, the TL507 A/D converter offers features not even available in more costly ICs.

The internal logic for this IC is shown in Fig. 1. It features a counter driving a resistive ladder, a set of comparators, and an internal voltage regulator.

After a reset signal is applied to pin 8, the internal counter is set to zero. With the voltage being measured applied to pin 5, and a clock signal applied to pin 2, the internal counter begins counting. The voltage output of the resistive ladder is compared against the input voltage. When the ladder voltage equals the input voltage, the output at pin 4 switches low and remains low as long as the reference is high. The counter can then be reset to start again. If the clock signals continue, the counter will continue to count until it "wraps around" to zero. When it reaches this point, the output at pin 4 switches high. The internal voltage regulator generates +5 V at pin 7 if needed.

Joystick Interface. The TL507 can be used to create a joystick interface, as shown in the schematic of Fig. 2. The actual joystick potentiometer, *R2*, is connected in a voltage divider formed by *R1* and *R3* across the regulated output coming from pin 5 of *IC1*.

If the computer generates clock pulses while counting the pulses, then stores the count when the output (pin 4 of *IC1*) switches low, the count of pulses represents the input voltage at pin 4. When this circuit is driven from a computer port, a program using the flowchart shown in Fig. 3 will generate a binary number proportional to the joystick position. ◇

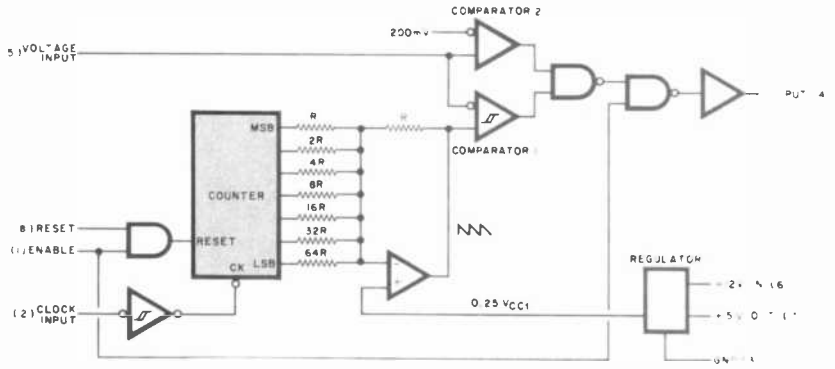


Fig. 1. Internal block diagram of the TL507.

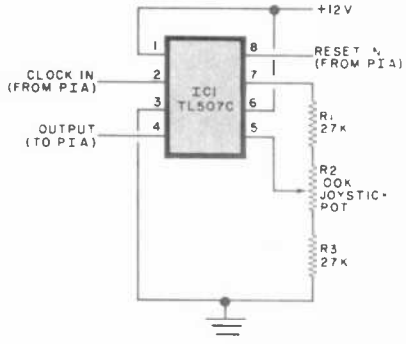


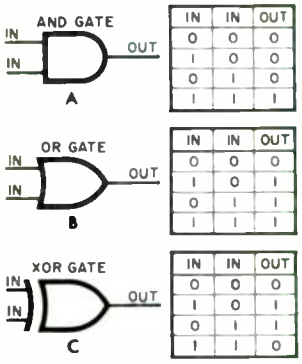
Fig. 2. Circuit used to create a joystick interface with TL507.

Fig. 3. A program using this flowchart will generate a binary number proportional to the joystick position.

CROSSED SIGNALS

By B. K. Roberts

ONE of the basic elements of computer circuitry and digital logic is the *gate*. There are three fundamental types of gates: (A) the AND gate, whose output is a 1 if and only if both inputs are 1 (Fig. 1A); (B) the OR gate (also known as an Inclusive OR), whose output is a 1 if either or both inputs are 1 (Fig. 1B); and the Exclusive OR gate, whose output is a 1 if either, but not both, inputs are 1 (Fig. 1C).



IN	IN	OUT
0	0	0
1	0	0
0	1	0
1	1	1

IN	IN	OUT
0	0	0
1	0	1
0	1	1
1	1	1

IN	IN	OUT
0	0	0
1	0	1
0	1	1
1	1	0

Fig. 1. Three types of gates.

To learn how to use these logic elements in designing a circuit, try the following quiz. Starting with the simple box layout in Fig. 2, connect X_{in} to X_{out} and Y_{in} to Y_{out} with logic gates so that the effect will be the same as if two simple wires had been used to make the connections. That is, a logic 1 applied to X_{in} should appear at X_{out} and a logic 1 at Y_{in} should appear at Y_{out}. The problem would be trivial except for one small consideration: *no lines may cross on the diagram.* You may use as many gates as you like—of any type. ◊

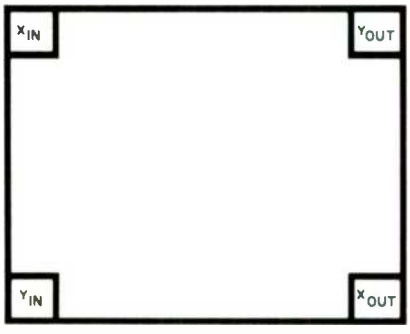
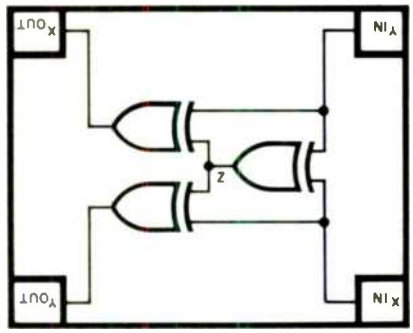


Fig. 2. Simple box layout.

ANSWER

The problem is solved by using three Exclusive OR gates, connected as shown here. The truth table shows what happens with any possible combination of inputs.



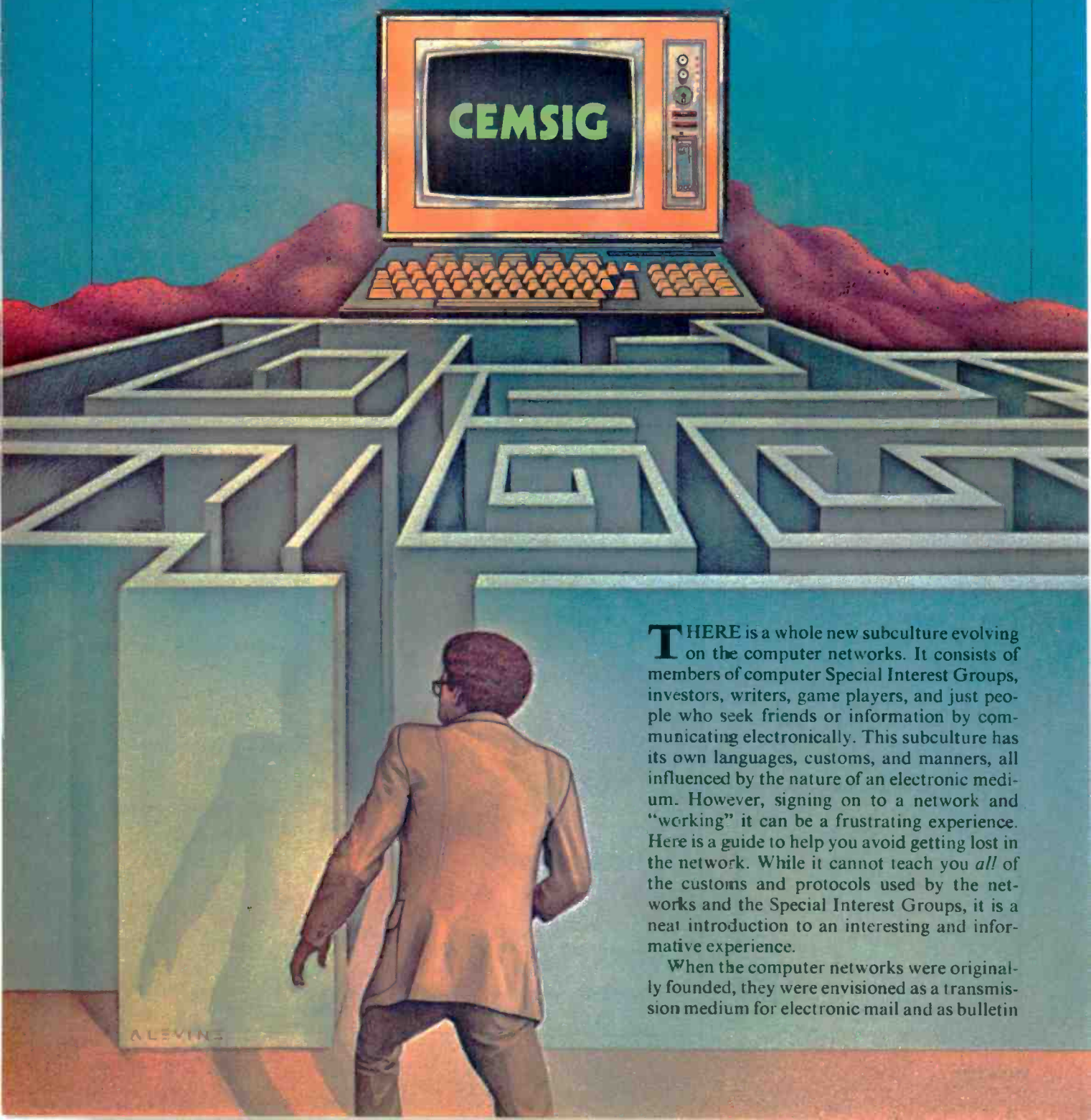
TRUTH TABLE

X_{IN}	Y_{IN}	Z	X_{OUT}	Y_{OUT}
0	0	0	0	0
0	1	1	0	1
1	0	1	1	0
1	1	0	1	1

The COMPUTER NETWORK MAZE

Part 1: Helpful hints on how to use the various communication networks that are available on your microcomputer

By Stan Veit



THERE is a whole new subculture evolving on the computer networks. It consists of members of computer Special Interest Groups, investors, writers, game players, and just people who seek friends or information by communicating electronically. This subculture has its own languages, customs, and manners, all influenced by the nature of an electronic medium. However, signing on to a network and "working" it can be a frustrating experience. Here is a guide to help you avoid getting lost in the network. While it cannot teach you *all* of the customs and protocols used by the networks and the Special Interest Groups, it is a neat introduction to an interesting and informative experience.

When the computer networks were originally founded, they were envisioned as a transmission medium for electronic mail and as bulletin

boards where people could post messages to each other. As they evolved, they became electronic newspapers, magazines, entertainment centers, and trading posts. Complete encyclopedias such as *The World Book* are available for reference, as well as theatre and travel reservations, current news, and financial information. In addition, a subscriber can send or receive electronic mail and participate in electronic conferences on every conceivable subject.

There are two principal general information networks available to the public. These are "The Source," owned by Reader's Digest, and "CompuServe Information Services," a division of H&R Block. In addition, there are several smaller services with specialized services, including the "Dow Jones News/Retrieval Service," Lockheed's "Dialog," and "BRS After Dark" from Biographical Research Service. The Source and CompuServe started out at the same time, but CompuServe has far outstripped The Source both in the number of members and the quality of the services offered. Since The Source was bought by Reader's Digest, it has a new computer center and is offering many new services and features to attract new customers.

In any event, before you can get on one of the networks and enjoy the host of features offered, you must learn how to sign on to the network and how to find your way through the maze of menus to your section of interest.

Most people communicate with the networks through the major common carriers such a Telenet and Tymnet. However, CompuServe has a growing number of direct-connect nodes where the user can dial a direct CompuServe access number. The Source only has such direct-connect facilities in the Washington, D.C. area. To sign on any of the networks you must have an ID number assigned by the network and a secret password, which you choose. Often, the network assigns you a password generated by random selection for your initial contact. Once you have signed on, you select a new password known only to yourself and the computer.

To start, you must buy a sign-on package from the network. These are sold by computer stores and other places where computer equipment is sold. In case you do not have such a facility available, you can call the network directly to sign up for the service. Dialog and BRS After Dark offer direct subcription service. For most of the networks there is an initiation fee and an hourly fee for the use of the service.

Some networks offer a special package in conjunction with the manufacturer of modems, computers or software. This special offer includes a sign-on contract package with the purchase of the equipment, and includes the initial fee plus a minimum number of hours on the network. Upon receipt, the new member fills out the papers so that he can charge future time to an approved credit card. By the time the sample hours are used up, the credit is approved and the normal membership starts. The Source charges a minimun charge each month if the service is used or not. CompuServe does not make this charge.

The equipment needed to use the networks varies from a "dumb terminal" with a modem to a personal computer with a modem and a videotext or communication program. The more elaborate equipment can print the conversations and record programs from the network to a disk storage system or from the personal computer disk to the network disk storage. Most communications over the telephone line to and from the networks are transmitted at 300 characters per second (300 baud). However, today's equipment often can work at speeds up to 1200 baud. Though this is four times as fast, the networks charge a much higher fee for this rapid communication facility.

Compuserve Information Service

TO illustrate connection to the networks I'll use the example of direct connect to CompuServe—the simplest case. The user turns on his computer and loads the communication program. If he is using a terminal, no special software is needed. The telephone number of the nearest access port is then dialed and, when a high-pitched tone is heard, the connection is made. If an acoustic coupler modem is being used, the telephone instrument is placed in the rubber cups on the coupler. The telephone cord end is usually marked on the acoustic modem. If a direct-connect modem is used, the connection is made automatically or a light goes on indicating that the user should throw a switch. Once the connection is made, the system prints out the word CONNECT, then the number of users on the node and the initials of the node. It then asks for the name of the host network.

CONNECT—Indicates that a connection has been made.

02NYC—Second person on the New York City node.

Host Name—The name of the host net is CompuServe Information Service so you enter CIS.

The request for the ID# appears on the screen. The user enters the number supplied by CompuServe and hits CARRIAGE RETURN. There is a short pause and a request for the user's password is made.

User ID—User enters his ID number

Password—User enters password which is invisible on screen.

If the password is accepted, the user is on the network and the following appears:

CompuServe Information Service
21:00 EST Tuesday 14-Dec-82

If the correct password is not accepted, the system asks for it several times and then signs off if it is not received.

Main Menu. What happens next is the result of a choice made by the user when he first joins the net. There are several options available, but most users choose to receive the top level menu of the service. Before the top level menu appears, there is a series of announcements called "Whats New." If a user wants additional information about any of the

announcement subjects, at the (!) prompt, he enters "Go New" and receives additional information.

As shown in Illustration I, the top menu lists the major sections of the network and allows a selection from them.

When you enter your selection number, you are transferred to the section you have selected and presented with another menu for subsections. The entire network is a tree structure of menus, each taking the user from the general classification to the specific information you are seeking.

The tree of menus, however, is only for the user who does not know where to go. Once you have been to a section of the network, you can directly return there by using the GO command at the ! prompt. For instance, type:

! GO CEM-450

This will take you directly to the Computers & Electronics Special Interest Groups, bypassing the hierarchical structure of menus usually needed to get there. When you use this method, the system will respond with "Request Recorded," and after a short pause you will be at page CEM-450.

Everything on CompuServe is divided into pages that are 32 characters wide by 12 lines long, plus a header line with the page identifier. This accommodates the personal computers with 32- or 40-character lines. If the information is longer than 12 lines, it is divided among as many pages as necessary to contain the information. On some pages you can enter an "S" in answer to a prompt. This will give you a screen as wide as you have indicated your terminal to be. You enter this information in a special terminal default section in the User section.

Electronic Mail. One of the most useful features of the networks is some type of electronic mail system. Each network has some version of electronic mail. In CompuServe, you can either send or receive mail from anyone who has a registered user number on the network. One of the options you make when you first sign on the network is to receive notice of any mail that is in your "mailbox" at the time you sign on the network. If you have made this option, you are informed, at the prompt, "You Have EMAIL Waiting." The system then automatically puts you into the EMAIL area. You have the option at the EMAIL prompt to:

1. Read Mail
2. Compose and send mail.

Last page menu page. Key digit or M for previous menu.

Suppose you prompt:

! 1

The following message might appear:

```
CompuServe                    Page EMA-5

14- DEC-82 00:22 FR (703421,4561)
Thanks for the information. I will act on it
soon.
Cheers.
Bill
```

Then, if you key ENTER to continue

!

Then:

```
CompuServe                    EMA-5

1. File this message, then delete it from
   mailbox
2. Delete from mailbox
3. Display the message again

Last menu page. Key digit or M for
   previous page.
!2

CompuServe                    EMA-10

Message Deleted.
Last page. Key M for menu.
```

The user selects one of the options, and the system either files or deletes the message. If the message is filed, it is recorded on the user's personal block of data storage allocated by the system.

If the person receiving the message wants to send a message in response, he enters an M and is returned to the main EMAIL menu. He can then select the option of composing an EMAIL message. All messages must be composed using one of the system Editor programs and then sent via the EMAIL Menu by selecting it from the file. Instruction on use of the System Editor programs can be obtained from manuals purchased from CompuServe, or from Help screens.

Using the Menus. Once sign-on procedures are completed and the EMAIL messages have been read and answered, the user is returned or sent to the main menu.

From this main menu the user can move through the network by following the chain of menus. Help messages are available at almost any point to aid the user. In addition, there are human guides called System Operators or SYSOPS available to help users on the Special Interest Groups that exist on the network.

Though the SYSOPS may not be on-line at the time the user needs aid beyond that provided by the normal help messages, a confused person can leave a message addressed to the SYSOP in the appropriate Special Interest Group (SIG) area (Illustration II). It will be answered by a message referenced by number to the questioning message. If the question is deemed to be of general interest to the membership by the SYSOP, it will be left on the bulletin board for all to read. Other members may also answer the question and the result will become a general discussion based on the question. Most of the SYSOPS are specialists in the area they manage, in addition to being experts in the management of the network.

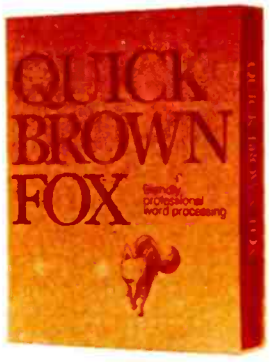
CB on the Network. No discussion of the CompuServe network would be complete without covering the "CB" channels, which is part of the Communications menu under Home Services (Illustration III). This is a simulation of citizens band radio on the network. It works about the same way except instead of being limited to an area of 5 to 20 miles (the range of CB transceivers) the CBers can talk with others across the United States and Canada. The interest range of CBers is wide and the conversations sometimes can become heated. CompuServe only requires that the CBers observe the same kind of rules that the FCC requires for CB radio.

(Text continues on page 68)

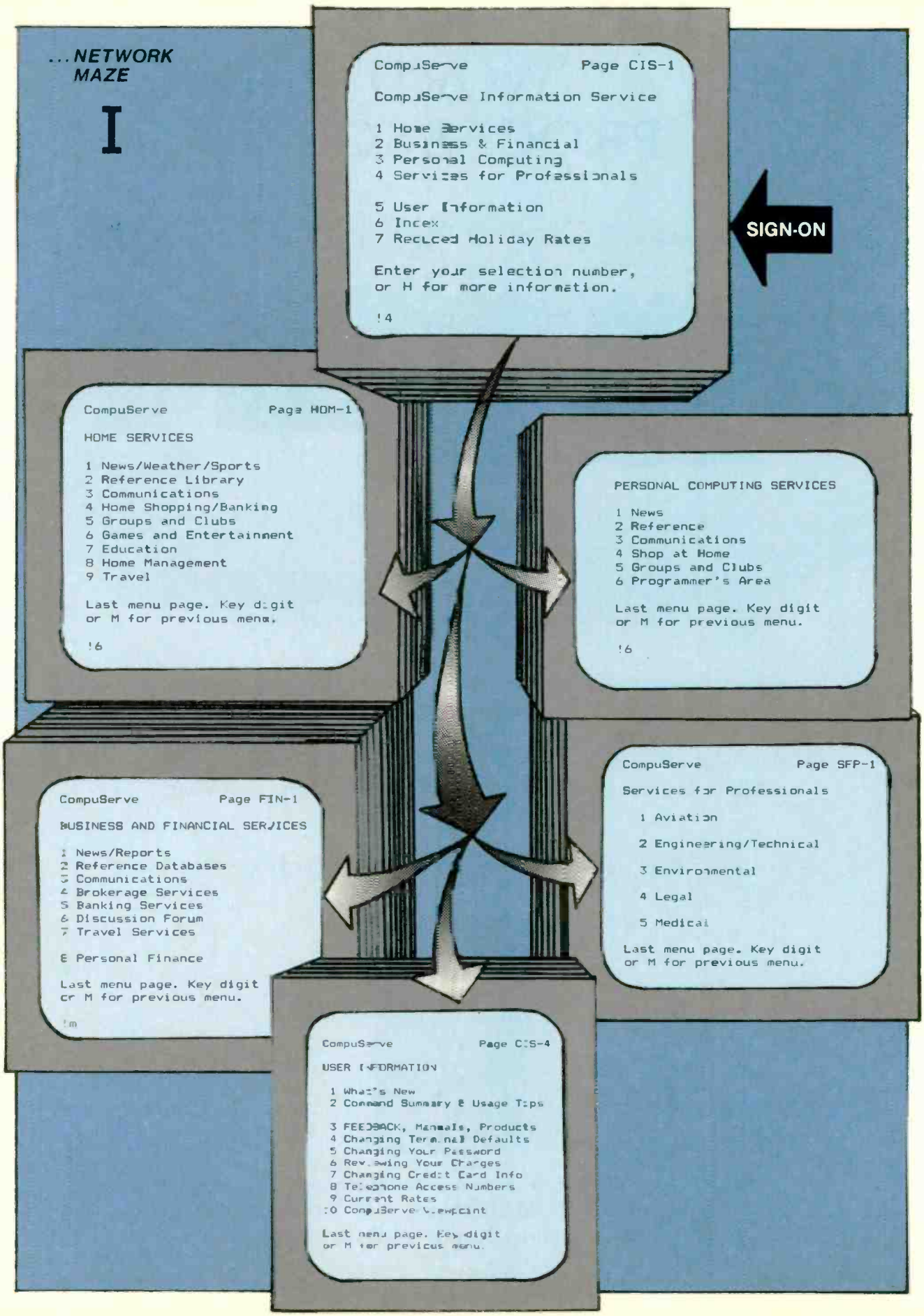
WORD PROCESSOR?

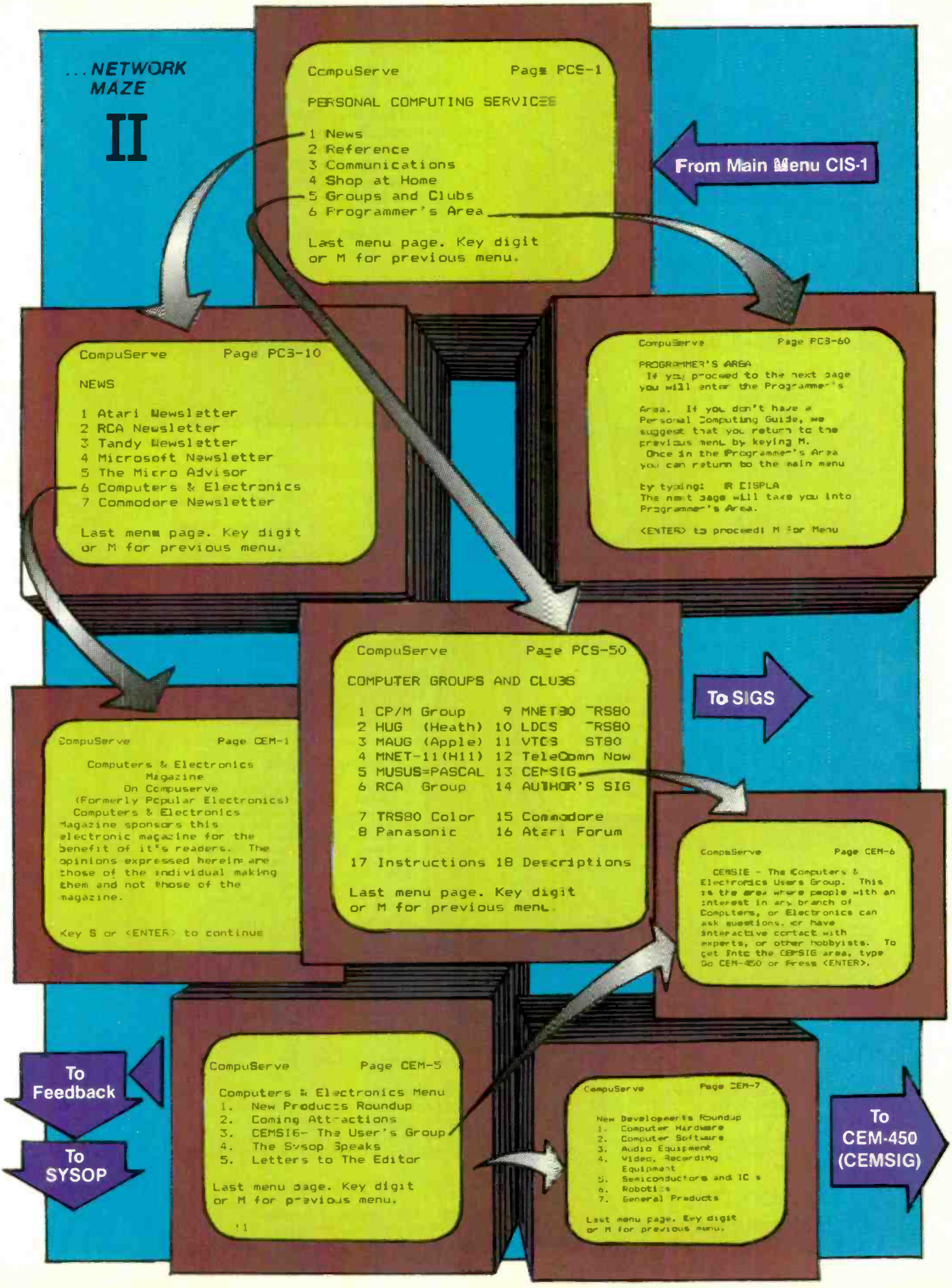
You bet! Quick Brown Fox word processing software has more features than Word Star and runs on your VIC or Commodore 64. And it can grow and grow. Add memory, 80 column display, disks, even a letter quality printer. We'll show you how a 1st-class word processor can be yours for less than $2000! You can even have a "student" system for less than $700!

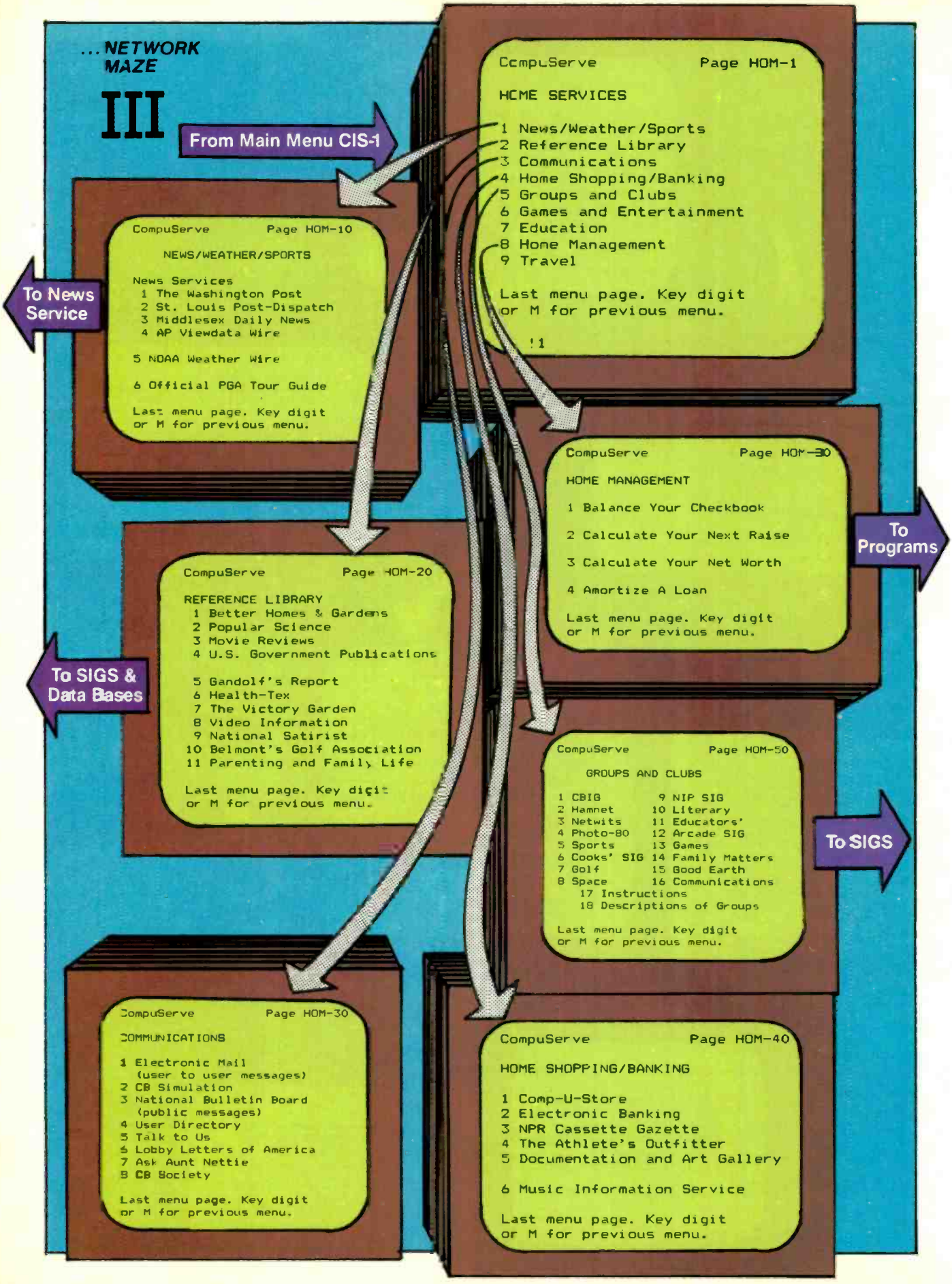
It all starts with the Quick Brown Fox at $65.

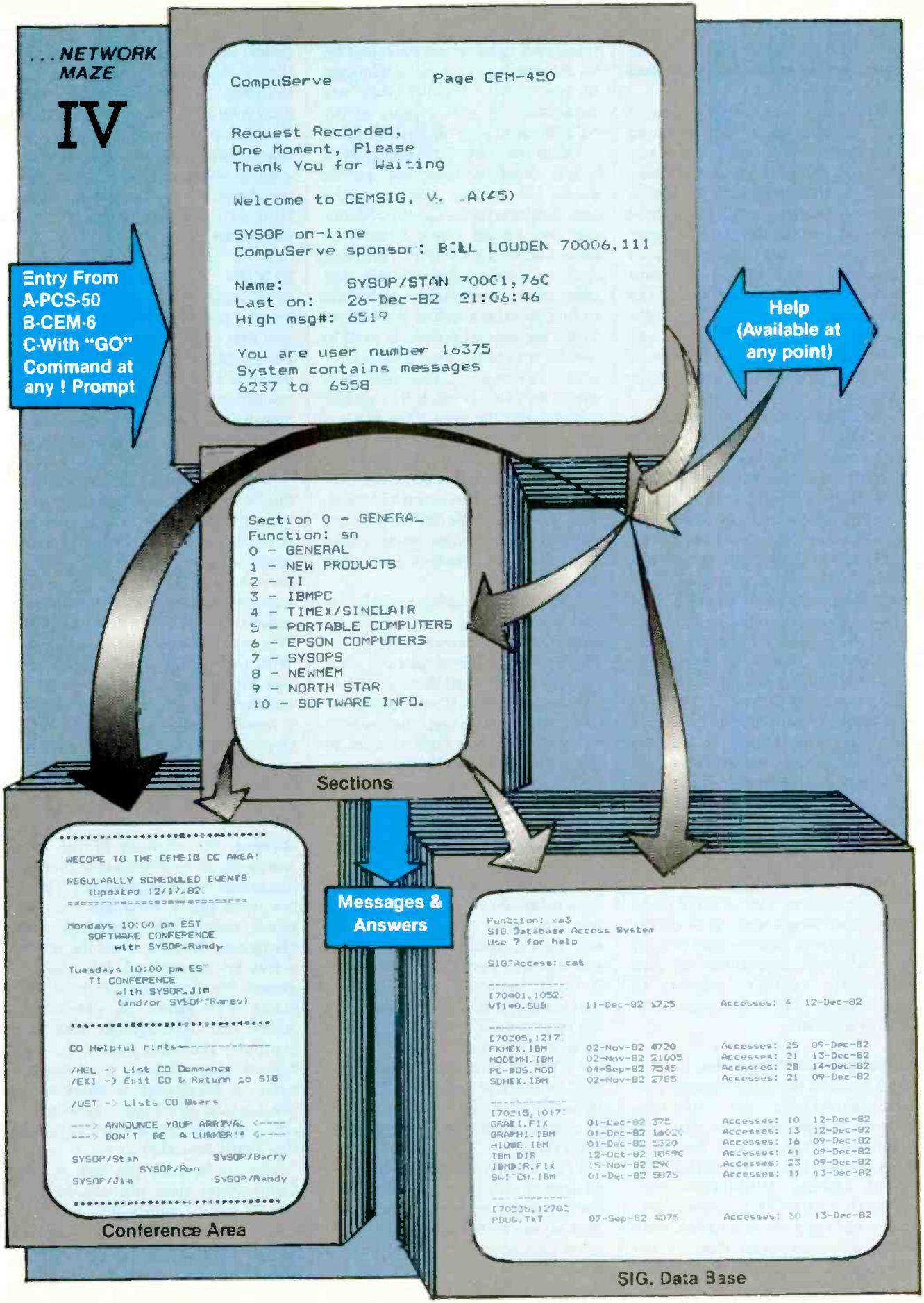


Call or write for our free brochure
Quick Brown Fox 548 Broadway New York NY 10012
Dealer Inquiries Invited (212) 925-8290


...NETWORK MAZE
I
CompuServe Page CIS-1
CompuServe Information Service
1 Home Services
2 Business & Financial
3 Personal Computing
4 Services for Professionals
5 User Information
6 Index
7 Reduced Holiday Rates
Enter your selection number, or H for more information.
!4
SIGN-ON
CompuServe Page HOM-1
HOME SERVICES
1 News/Weather/Sports
2 Reference Library
3 Communications
4 Home Shopping/Banking
5 Groups and Clubs
6 Games and Entertainment
7 Education
8 Home Management
9 Travel
Last menu page. Key digit or M for previous menu.
!6
PERSONAL COMPUTING SERVICES
1 News
2 Reference
3 Communications
4 Shop at Home
5 Groups and Clubs
6 Programmer's Area
Last menu page. Key digit or M for previous menu.
!6
CompuServe Page FIN-1
BUSINESS AND FINANCIAL SERVICES
1 News/Reports
2 Reference Databases
3 Communications
4 Brokerage Services
5 Banking Services
6 Discussion Forum
7 Travel Services
8 Personal Finance
Last menu page. Key digit or M for previous menu.
!m
CompuServe Page SFP-1
Services for Professionals
1 Aviation
2 Engineering/Technical
3 Environmental
4 Legal
5 Medical
Last menu page. Key digit or M for previous menu.
CompuServe Page CIS-4
USER INFORMATION
1 What's New
2 Command Summary & Usage Tips
3 FEEDBACK, Manuals, Products
4 Changing Terminal Defaults
5 Changing Your Password
6 Reviewing Your Charges
7 Changing Credit Card Info
8 Telephone Access Numbers
9 Current Rates
10 CompuServe Viewpoint
Last menu page. Key digit or M for previous menu.


...NETWORK MAZE
II
CompuServe Page PCS-1
PERSONAL COMPUTING SERVICES
1 News
2 Reference
3 Communications
4 Shop at Home
5 Groups and Clubs
6 Programmer's Area
Last menu page. Key digit or M for previous menu.
From Main Menu CIS-1
CompuServe Page PC3-10
NEWS
1 Atari Newsletter
2 RCA Newsletter
3 Tandy Newsletter
4 Microsoft Newsletter
5 The Micro Advisor
6 Computers & Electronics
7 Commodore Newsletter
Last menu page. Key digit or M for previous menu.
CompuServe Page PC3-60
PROGRAMMER'S AREA
If you proceed to the next page you will enter the Programmer's
Area. If you don't have a Personal Computing Guide, we suggest that you return to the previous menu by keying M.
Once in the Programmer's Area you can return to the main menu
by typing: M DISPLA
The next page will take you into Programmer's Area.
<ENTER> to proceed; M for Menu
CompuServe Page PCS-50
COMPUTER GROUPS AND CLUBS
1 CP/M Group
2 HUG (Heath)
3 MAUG (Apple)
4 MNET-11(H11)
5 MUSUS=PASCAL
6 RCA Group
7 TRS80 Color
8 Panasonic
9 MNET80 TRS80
10 LDOS TRS80
11 VTOS ST80
12 TeleComm Now
13 CEMSIG
14 AUTHOR'S SIG
15 Commodore
16 Atari Forum
17 Instructions
18 Descriptions
Last menu page. Key digit or M for previous menu.
To SIGS
CompuServe Page CEM-1
Computers & Electronics Magazine
On Compuserve
(Formerly Popular Electronics)
Computers & Electronics Magazine sponsors this electronic magazine for the benefit of it's readers. The opinions expressed herein are those of the individual making them and not those of the magazine.
Key S or <ENTER> to continue
CompuServe Page CEM-6
CEMSIG - The Computers & Electronics Users Group. This is the area where people with an interest in any branch of Computers, or Electronics can ask questions, or have interactive contact with experts, or other hobbyists. To get into the CEMSIG area, type Go CEM-450 or Press <ENTER>.
CompuServe Page CEM-5
Computers & Electronics Menu
1. New Products Roundup
2. Coming Attractions
3. CEMSIG- The User's Group
4. The Sysop Speaks
5. Letters to The Editor
Last menu page. Key digit or M for previous menu.
CompuServe Page CEM-7
New Developments Roundup
1. Computer Hardware
2. Computer Software
3. Audio Equipment
4. Video, Recording Equipment
5. Semiconductors and IC's
6. Robotics
7. General Products
Last menu page. Key digit or M for previous menu.
To Feedback
To SYSOP
To CEM-450 (CEMSIG)


...NETWORK MAZE
III
From Main Menu CIS-1
CompuServe Page HOM-1
HOME SERVICES
1 News/Weather/Sports
2 Reference Library
3 Communications
4 Home Shopping/Banking
5 Groups and Clubs
6 Games and Entertainment
7 Education
8 Home Management
9 Travel
Last menu page. Key digit or M for previous menu.
!1
To News Service
CompuServe Page HOM-10
NEWS/WEATHER/SPORTS
News Services
1 The Washington Post
2 St. Louis Post-Dispatch
3 Middlesex Daily News
4 AP Viewdata Wire
5 NOAA Weather Wire
6 Official PGA Tour Guide
Last menu page. Key digit or M for previous menu.
CompuServe Page HOM-30
HOME MANAGEMENT
1 Balance Your Checkbook
2 Calculate Your Next Raise
3 Calculate Your Net Worth
4 Amortize A Loan
Last menu page. Key digit or M for previous menu.
To Programs
To SIGS & Data Bases
CompuServe Page HOM-20
REFERENCE LIBRARY
1 Better Homes & Gardens
2 Popular Science
3 Movie Reviews
4 U.S. Government Publications
5 Gandolf's Report
6 Health-Tex
7 The Victory Garden
8 Video Information
9 National Satirist
10 Belmont's Golf Association
11 Parenting and Family Life
Last menu page. Key digit or M for previous menu.
CompuServe Page HOM-50
GROUPS AND CLUBS
1 CBIG
2 Hamnet
3 Netwits
4 Photo-80
5 Sports
6 Cooks' SIG
7 Golf
8 Space
9 NIP SIG
10 Literary
11 Educators'
12 Arcade SIG
13 Games
14 Family Matters
15 Good Earth
16 Communications
17 Instructions
18 Descriptions of Groups
Last menu page. Key digit or M for previous menu.
To SIGS
CompuServe Page HOM-30
COMMUNICATIONS
1 Electronic Mail (user to user messages)
2 CB Simulation
3 National Bulletin Board (public messages)
4 User Directory
5 Talk to Us
6 Lobby Letters of America
7 Ask Aunt Nettie
8 CB Society
Last menu page. Key digit or M for previous menu.
CompuServe Page HOM-40
HOME SHOPPING/BANKING
1 Comp-U-Store
2 Electronic Banking
3 NPR Cassette Gazette
4 The Athlete's Outfitter
5 Documentation and Art Gallery
6 Music Information Service
Last menu page. Key digit or M for previous menu.


. . . NETWORK MAZE
IV
CompuServe Page CEM-450
Request Recorded,
One Moment, Please
Thank You for Waiting
Welcome to CEMSIG, V. _A(45)
SYSOP on-line
CompuServe sponsor: BILL LOUDEN 70006,111
Name: SYSOP/STAN 70001,760
Last on: 26-Dec-82 21:06:46
High msg#: 6519
You are user number 10375
System contains messages
6237 to 6558
Entry From
A-PCS-50
B-CEM-6
C-With "GO"
Command at
any ! Prompt
Help
(Available at
any point)
Section 0 - GENERA_
Function: sn
0 - GENERAL
1 - NEW PRODUCTS
2 - TI
3 - IBMPC
4 - TIMEX/SINCLAIR
5 - PORTABLE COMPUTERS
6 - EPSON COMPUTERS
7 - SYSOPS
8 - NEWMEM
9 - NORTH STAR
10 - SOFTWARE INFO.
Sections
WECOME TO THE CEMEIG CC AREA!
REGULARLLY SCHEDULED EVENTS
(Updated 12/17-82:
Mondays 10:00 pm EST
SOFTWARE CONFEPENCE
with SYSOP-Randy
Tuesdays 10:00 pm ES"
TI CONFERENCE
with SYSOP-JIM
(and/or SYSOP:Randy)
CO Helpful Hints
/HEL -> List CO Commands
/EXI -> Exit CO & Return to SIG
/UST -> Lists CO Users
---> ANNOUNCE YOUR ARRIVAL <----
---> DON'T BE A LURKER!! <----
SYSOP/Stan SYSOP/Barry
SYSOP/Ron
SYSOP/Jim SYSOP/Randy
Conference Area
Messages &
Answers
Function: xa3
SIG Database Access System
Use ? for help
SIG Access: cat
[70001,1052]
VT100.SUB 11-Dec-82 1725 Accesses: 4 12-Dec-82
[70205,1217]
FKHEX.IBM 02-Nov-82 4720 Accesses: 25 09-Dec-82
MODEMH.IBM 02-Nov-82 21605 Accesses: 21 13-Dec-82
PC-DOS.MOD 04-Sep-82 7545 Accesses: 28 14-Dec-82
SDHEX.IBM 02-Nov-82 2785 Accesses: 21 09-Dec-82
[70215,1017]
GRAF1.FIX 01-Dec-82 375 Accesses: 10 12-Dec-82
GRAPH1.IBM 01-Dec-82 16020 Accesses: 13 12-Dec-82
HIGE.IBM 01-Dec-82 5320 Accesses: 16 09-Dec-82
IBM DIR 12-Oct-82 18690 Accesses: 41 09-Dec-82
IBMDIR.FIX 15-Nov-82 896 Accesses: 23 09-Dec-82
SWITCH.IBM 01-Dec-82 5875 Accesses: 11 13-Dec-82
[70235,1270]
PBUG.TXT 07-Sep-82 4075 Accesses: 30 13-Dec-82
SIG. Data Base

...NETWORK MAZE (from p. 62)

There are even "outlaws" who violate the rules and delight in taking advantage of the unwary. For example, most of the CB fans use "handles" in place of their real names. They become very attached to these handles and become very upset when one of the "outlaws" uses somebody else's handle to insult someone. An expert can find out the user number of the party he is talking to (which should match the known "handle"), but a newcomer does not have the experience to do this.

Another "outlaw" trick is to get a newcomer to give out his secret password. The outlaw then uses the number and password to charge time on the network to the victim's account. This can go on for over a month, or at least until the victim gets the huge bill for time and services. So, never give anyone your password on the network even if he claims to work for the network. That is a common outlaw trick. Change your password every once in a while just to be cautious, but don't forget it! If you forget your password, even CompuServe can't get it for you. Only you and the computer know your password, and it is stored in the computer in a coded form that none can decode. All they can do is issue you a new one, and that can take a couple of weeks. There are also pranksters on the network who delight in playing tricks on others. One of these is the notorious Ninja 4 who can blank his victim's screen or even blast him off the network! Sometimes he just causes the victim's computer to sound its horn or bell without control of the user!

SIGS and Conferences. Conference areas on the SIGS are a very interesting place to "visit." The conference areas are like the CB channels except that they are channels devoted just to the Special Interest Groups (Illustration IV). They are used by SIG members who want instant communication with other members rather than leaving messages to be answered in the future. They are also used for general scheduled conferences attended by all the members of the SIG who care to participate. Usually they are moderated by one or more of the SYSOPs who keep things going.

Often the conference will start at 9 p.m. Eastern Time and people across the country join in as the time zone moves to Central, Mountain and Pacific times. Sometimes there will be a SYSOP in each time zone to conduct the meeting, but more likely people just stay up late to talk to others across the nation. There are special protocols used to control the conference. If these controls did not exist, the conference would be like a room full of people all talking at the same time. When a person is typing a message, it appears on his screen. At the same time, the messages sent by the others appear interleaved with his text. This can be a little difficult to get used to when several people take turns sending messages while you are typing.

The important thing to realize is that your message does not appear on anyone else's screen until you hit RETURN (CR). When you do, your message is sent to all those signed on to the conference. If you have more to say than can be typed in one line, you end your line with a series of dots. This tells all the other members that you have more to send. When you are finished, you indicate it by sending GA (for Go Ahead). Then someone else picks up the conversation.

One of the newest features on the Conference Areas of the SIGS is the interview with a well-known person. This is usually scheduled in advance so that everyone knows about it. In fact, notices are put on all the various SIGS that so-and-so is going to appear at a certain time and SIG. The interview is conducted by the SYSOP with all members getting a chance to ask questions. For those who can not attend, a recorded conversation is stored in the SIG Data Base.

Each Special Interest Group has an area of disk storage used for the storage of text or program material. This is one of the most useful features of CompuServe. The collection of public-domain software on the SIGS attracts more people than almost anything else. For example, the CP/M Users Group software is available on the CP/M SIG and quite a lot of excellent IBM-PC, and TI software is on CEMSIG. In addition to software in the SIGS, there is a lot of software in the Public Access Areas in the Programmers Section (formerly Micronet) of CompuServe.

It is the contribution of the SYSOPs that sets CompuServe apart from other networks. They bring a sense of human participation that mere contact with a computer cannot duplicate. When the network's primary purpose is to allow access to various data bases, human intervention is not necessary; but in interactive areas, there is no substitute for the SYSOPs.

When CompuServe first started, the hobbyist (nonprime-time) area was called Micronet, and it consisted of Bulletin Boards where people could post messages of all kinds. It also had a programming area with computer languages and word processors that could be used in place of a subscriber's home computer. With the development of the SIGS and game areas, this type of usage became less important and, today, it is used mainly by the "experts." Once a subscriber becomes experienced he should try using these areas for programming and mass data storage capabilities.

Games. No mention of the networks would be complete without a discussion of the Games area. There are three types. First are conventional games like Blackjack and Hangman. Second, come the interactive adventure and role-playing games. Finally, there are the interactive war games like Decwars, where you fight against both the computer and other gamesters. The biggest game feature on CompuServe is Megawars, a super-role-playing/war game that a subscriber can join and become a character that fights for either side.

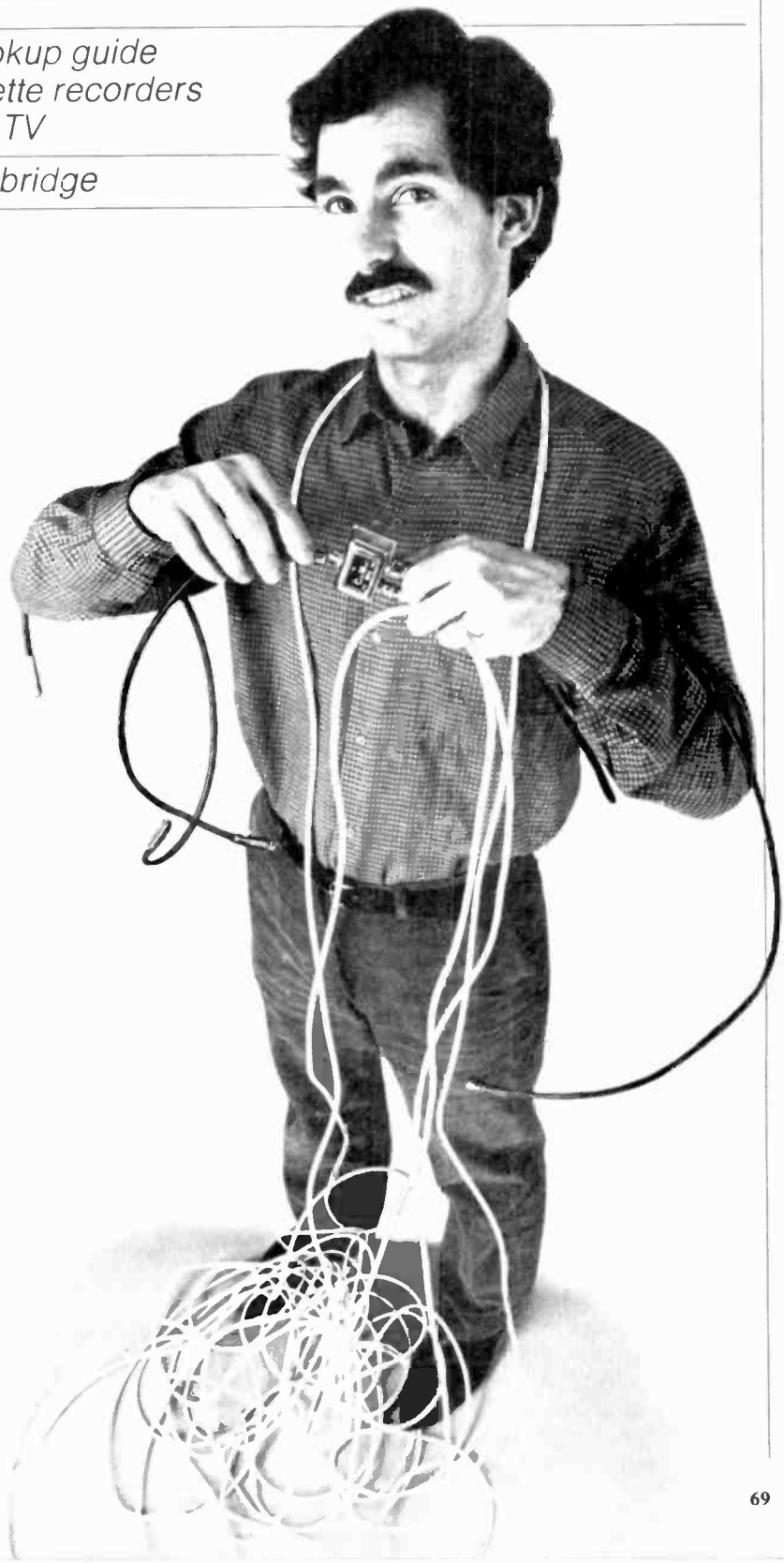
Not to become too one sided, CompuServe does not neglect the arts. It has a Literary SIG for serious writers and poets. ◊

(In Part 2 of this article, we will continue with The Source, Dow Jones Network, BRS After Dark, and others.)

THE VIDEO CONNECTION

An equipment hookup guide for using video cassette recorders with cable TV

By Dave Trowbridge



CABLE television is becoming a major factor in the "video revolution." To a video recording enthusiast, it looks like a dream come true: a seemingly limitless video "library" at one's fingertips. As a result, video equipment manufacturers are scrambling to add cable-oriented features to their products. There are now cable-ready TV and VCR tuners that promise the ability to "browse" through 127 or more channels with a handheld remote control. Some video recorders can be programmed to automatically record up to eight "events" on different channels over a 21-day period, and all video recorders offer the option of recording one channel while watching a different one.

Unfortunately for many videophiles, much of the video gear now available is still not wholly compatible with most modern cable systems. Consequently, if you subscribe to cable and are planning to buy a new television receiver or a video recorder, you should consider your purchase carefully. Otherwise, you may find that your cable system offers more channels than your "cable-ready" set will tune; that it has "offset" channels that your PLL tuner ignores; or that some of the channels on it are scrambled, which can compromise or eliminate important features of your video system. You may even find that you cannot record the channels you pay extra for!

If you already own equipment that is limited by the design of your cable system, don't despair. The

"block converter," a device that converts a whole "block" of vhf channels into uhf channels, may be all you need. On many cable systems (though not all) this versatile video accessory can restore remote channel control, multi-channel programmability, and watch/record versatility to your equipment—features eliminated entirely on many cable systems. It can even be used to deliver the output of a video component or r-f switcher to every television in your home over the existing cable wiring, without interfering with a TV set's remote control function.

Cables and Recording. Though there are many aspects of cable system design that can affect your television or video recorder, three in particular are most likely to limit the usefulness of your video system: the number of channels carried, the presence of "off-set" (off-frequency) channels, and the use of "programming security systems" to prevent unauthorized (free) reception of certain channels.

Although 60% of all cable systems still have twelve channels or fewer, a state-of-the-art system can transmit frequencies as high as 450 MHz, giving it a 66-channel capacity. A "dual-cable" system, one which runs two trunk lines to each neighborhood and two drops to each subscriber, can carry 132 channels. Extending a cable system's bandwidth beyond this point would be quite expensive, and would be liable to interference from broadcast uhf stations (470 MHz and higher), especially since most televisions have unshielded uhf tuners (not to mention the fact that there's not even enough programming available yet for the existing channels!).

Some of the problems encountered in cable use result from the frequencies allocated to cable and their relation to broadcast frequencies. For instance, the standard vhf channels (2 to 13) are the same on cable as they are over the air, unless the cable operator "offsets" them. Until recently, most televisions had unshielded tuner sections. Since there can be only one station broadcasting on a channel in a given area, there was nothing to shield against. On a cable system, however, the off-the-air channel 7, for example, can interfere with cable channel 7, causing "herringbone" or moire patterns in the picture. Some television sets, even "cable-ready" ones, still don't have shielded tuners, however, and are subject to this "co-channel interference."

Another related problem is caused by cable use of many of the same frequencies allocated to land mobile services, such as fire and police departments, and aeronautical radio. This is a source of intermittent "herringbone" on some cable channels, and sometimes you can even *hear* police calls on your TV set. This, too, can be due to a poorly shielded tuner, or, like co-channel interference, a result of deficiencies in the cable system itself (corroded connections, defective coaxial cables, etc.).

Until recently, all television receivers were equipped with 82-channel tuners capable of tuning the 12 standard vhf channels and 70 uhf channels (Congress mandated the inclusion of all uhf channels in 1964). Since cable television systems do not use the uhf band, once they began expanding beyond a 12-channel capacity some form of converter became necessary to enable their subscribers to tune in the additional channels.

CABLE CHANNEL CONVERSION CHART

VHF BANDS	Low-band (Standard)				
Numeric Designation	2	3	4	5	6
Appears on UHF Channel	42	43	44	46	47
Alphanumeric Designation	2	3	4	5	6

Mid-band (Special)									
14	15	16	17	18	19	20	21	22
54	55	56	57	58	59	60	61	62
A	B	C	D	E	F	G	H	I

VHF BANDS	High-band (Standard)						
Numeric Designation	7	8	9	10	11	12	13
Appears on UHF Channel	63	64	65	66	67	68	69
Alphanumeric Designation	7	8	9	10	11	12	13

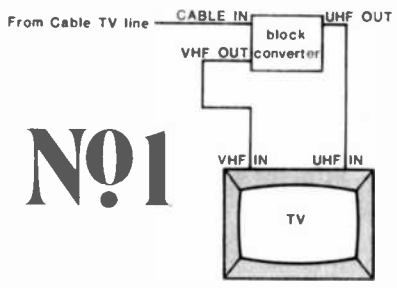
Super-band (Special)														
23	24	25	26	27	28	29	30	31	32	33	34	35	36
70	71	72	73	74	75	76	77	78	79	80	81	82	83
J	K	L	M	N	O	P	Q	R	S	T	U	V	W

Connection 1

At first the cable industry used a block converter to change the additional channels to uhf as shown in connection No. 1. The channel conversion chart at the top of this page shows where the special vhf channels end up on the uhf band on one block converter.

This is still a useful hookup in some cases, but a block converter has certain channel and performance limitations so the cable industry turned to set-top tuner-converters.

A settop converter selects channels one-by-one and converts them to a single vhf channel, usually channel 3 or 4. Since the converter only delivers one channel at a time, it eliminates the remote channel control feature of any television set connected to it because the television must be tuned only to the output channel of the converter. The cable industry has gradually introduced remote-control set-top converters. However, television receiver manufacturers have also been building so-called "cable-ready" tuners that can receive cable channels without the use of an external converter, thus retaining remote control.



No. 1

The first cable-ready sets had 91-channel tuners (12 standard vhf, 9 special vhf and 70 uhf). Later sets had a 105-channel capability (12 standard vhf, 23 special vhf, and 70

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uhf), and now some televisions can tune as many as 142 channels. While certainly useful, the cable-ready feature is somewhat over-rated, for the use of offset channels and scrambling can often render such a tuner unusable.

As channels are added to a cable system, it becomes increasingly difficult to avoid intermodulation distortion from trunk amplifiers and other active components in the system. These distortion products can cause "herringbone" or moire patterns on the screen. In systems with fewer than 35 channels these effects can be greatly diminished by offsetting the frequencies of selected channels in a way that eliminates the worst intermodulations. In systems with more than 35 channels it is usually necessary to install an HRC (Harmonically Related Carrier) headend. In an HRC system all visual carriers are coherent (in phase) and are harmonics of a 6-MHz master oscillator. This means that any distortion generated in the system will fall "zero-beat" on a visual carrier. Thus, it will look like a harmonic of that carrier and will be ignored by the tuner circuitry. An HRC system offers a minimum 6-dB improvement in distortion levels, but all of its channels are 1.25 MHz lower than their "normal" frequencies, except for channels 4 and 5, which are 0.75 MHz higher. Some cable systems may use an IRC (Incrementally Related Carrier) system. This is similar to HRC but lacks the master oscillator and has fewer offset channels.

Offset channels are not a problem if you have a television receiver or video recorder with manual fine-tuning, but many of the latest advanced sets have PLL (phase-lock loop) tuners. Such a tuner generally has a "capture range" (the range within which it will look for a channel) of only ±125 kHz around the nominal frequency of a channel, *and no fine-tuning adjustment.* Therefore, it cannot tune-in an offset channel. However, some PLL tuners are now equipped with a variable-range aft (automatic fine tuning) circuit (usually a switch labelled AFT: NORM/CABLE) that can be set for a wider capture-range. Many do not, though, and cannot tune-in offset channels.

If you have a set with a PLL tuner that does not have a variable aft range, and your cable system is an IRC type, you will have to use the set-top converter supplied by the cable company whether or not your set is cable-ready, and you will lose the use of the remote channel control on your TV set (or VCR).

Connection 2

If your cable system is HRC or has only a few offset channels, you can connect a block converter as shown in connection No. 2 to maintain a measure of remote channel control.

On a HRC system, adjust the local oscillator of the block converter to bring the up-converted channels back to viewable frequencies on uhf, but channels 4 and 5 will have to be selected on the set-top converter because of their different offset.

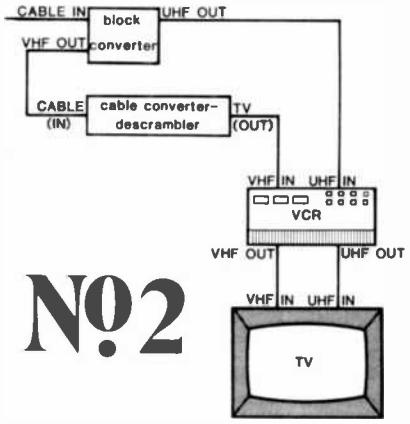
Programming Security. Many cable systems offer several levels of service, called tiers. Some may offer up to ten tiers, but two or three-tier systems are most common. A tier may consist of just one additional channel (such as a movie channel) or of several. Each tier that you add to your cable subscription costs additional money.

The first tier, usually called "basic," often consists of just the 12 standard vhf channels that any TV set can receive. Additional tiers may add services such as ESPN or CNN, the superstations like WTBS and WGN, or movie services such as HBO and Showtime, and may require the use of a set-top converter.

Since so many TV sets and video recorders now have cable-ready tuners (over half the televisions sold this year will), and because a block converter can make any set cable-ready, many cable operators protect their higher tiers with some sort of programming security to prevent free reception. There are many different security systems available. A cable operator will choose one based on three parameters: cost, security (how easy is it to "cheat"?), and transparency (how much does it affect the channel it protects?).

There are two basic types of programming security: trapping and scrambling. Trapping involves the use of a notch filter tuned to suppress a specific channel. If a subscriber decides to add a trapped channel to his service, the cable company sends an installer out to remove the trap, which must be reinstalled if the subscriber later cancels that channel. Traps are completely transparent, moderately secure, and best of all from a videophile's standpoint, have no effect on the operation of a video system.

If your equipment is cable-ready, then once the trap is removed, you get the channel. Unfortunately, traps are somewhat more expensive than the alternative (scrambling) due to the labor costs incurred every time a trap must be removed or reinstalled. To get around this problem, some companies have developed "addressable" traps that can be turned on and off at the headend.



A scrambling system electronically distorts a pay channel in the headend while a set-top converter-descrambler in the subscriber's home descrambles it for viewing. A cable-ready tuner cannot tune a scrambled channel, of course. The number of cable systems using a scrambling system is growing rapidly because the cost of the electronics needed has fallen drastically in the past few years.

Scrambling methods can be divided into three basic types: video inversion, line switching, and sync-pulse modification. In the first, the

video signal is inverted with respect to the sync pulse. Line switching is a rather esoteric system in which the headend actually scrambles the order of the scanning lines in each video field.

Sync-pulse modification is the most popular type of scrambling. There are four methods: the sync pulse may be inverted; it may be suppressed (reduced in level 6 dB or so); its width may be reduced to make it too "fast" for the receiver to detect; or pseudo-random sync pulses may be added. Some systems use a combination of these methods.

In almost all scrambling systems a decoding signal (called a "tag") is sent out by the headend to tell the converter-descrambler how to descramble the picture; and on most cable systems, the tag is amplitude-modulated onto the FM audio carrier of the scrambled channel. Since the limiter in an FM tuner strips the carrier of any AM, this tag cannot affect sound quality.

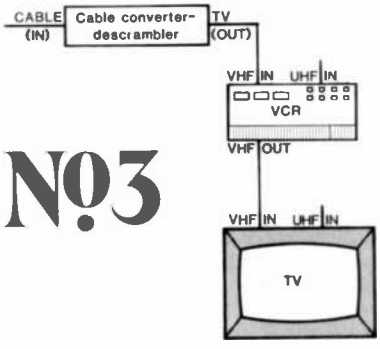
The transparency of these systems varies. One scrambling system uses an analog decoding signal on the audio carrier, and any number of problems in the cable system, from the headend to the line amplifiers, can induce unwanted AM onto that FM carrier. The decoder circuit interprets this as part of the decoding tag and generates a misshapen sync pulse that your television receiver or video recorder cannot lock to. Ironically, it is often older sets that are least affected by this problem, while newer sets are generally affected, especially those without manual vertical and horizontal-hold controls. There is very little you can do about this particular problem except wait for your cable operator to find the source of the unwanted AM. (If the problem affects only your VCR, so that you can watch movies but not record them, your request for service may be assigned a very low priority on the repair schedule.)

More modern scrambling systems use a digital tag on the audio carrier that cannot be influenced by extraneous AM. Not only is such a system more transparent, but a cable operator can assign a different digital code to any or all channels and control the availability of each channel in each home by means of a computer interfaced with the headend. Such a system, called "addressable," can even be combined with interactive circuitry to create a "pay-per-view" system, where the subscriber pays only for those programs he or she selects on the settop converter/descrambler. The "addressable" concept is so attractive to the cable industry that more and more operators are making every channel addressable (every channel scrambled).

To understand how the presence of even one scrambled channel eliminates several important features of your video system, let's look at three ways a VCR and a TV set can interface with a cable system with some (not all) scrambled channels.

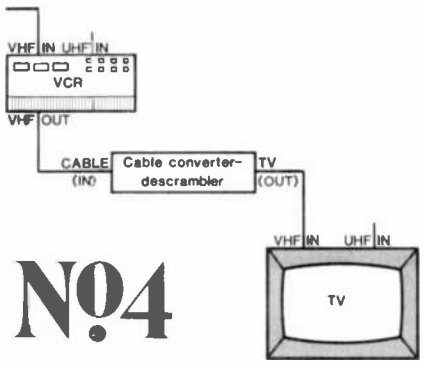
Connection 3

The television and the video recorder can receive only the channel selected on the converter/descrambler, whether they're cable-ready or not in connection No. 3. You can record any channel, scrambled or not, but you can't watch a different channel from the one you're recording. You can automatically record several events on a single channel, but you can't program your VCR to record different channels at different times unless someone is present to select the channels



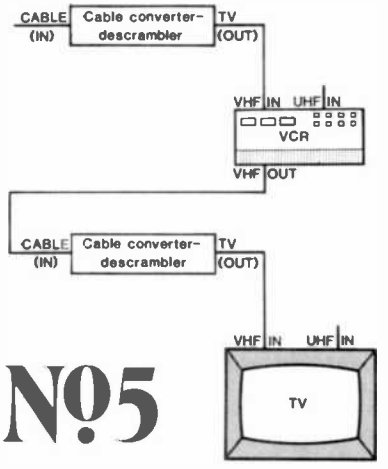
on the settop converter. If your television has a remote channel control, it won't work.

Connection 4



In connection No. 4, the video recorder can record any *non*-scrambled channel that it can tune-in, and it can program any combination of those channels. The television can tune in any channel, but its remote channel control still doesn't work. You can watch any channel while recording any non-scrambled channel, but you can't record the channels you're paying extra for. If your VCR is not cable-ready, this hookup is particularly limiting.

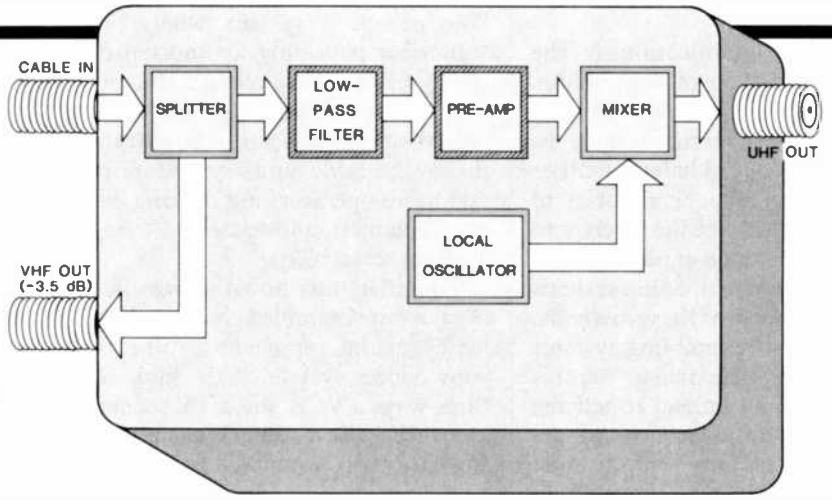
Connection 5



An additional converter/descrambler rented from the cable company and used as shown in connection No. 5 can give you full watch/record versatility *and* the ability to record scrambled channels. You still won't have full, multi-channel programmability (and you're paying $3 to $5 a month for the extra converter). But if you subscribe to a fully addressable system with every channel scrambled, this is the best you can do, although you'll still be doing without remote control.

The Block Converter. The three connections above have one thing in common: the uhf inputs of both the television and the video recorder are unused. On an 82-channel set this means that more than 85% of the tuner's channel capacity is left out. It is this fact that makes the block converter such a good accessory. Not only can it be used to make any 82-channel television set or VCR cable-ready by up-converting the cable frequencies to uhf, it can also give your video system access to both scrambled and nonscrambled channels at the same time, thus restoring a measure of multi-channel programmability, remote channel

How A Block Converter Works



A block converter "beats" an internally generated frequency against a "block" of incoming vhf channels in order to up-convert them to uhf channels. Circuits in solid outlines in the block diagram are found in all block converters; those in dotted outlines only in more advanced models.

As the signal enters the block converter it is split, and a portion is returned to the VHF OUT port so that standard vhf channels can be tuned in their normal positions (as in connection No. 1), or so that a converter/descrambler can be used to access scrambled channels (as in connection No. 2).

After the splitter, some block converters use a low-pass filter, generally at a frequency around 330 MHz. This helps prevent or limit intermodulation distortion caused by the presence of channels higher than the block converter can handle. (The second harmonic of the local oscillator beats against the higher channels, generating a frequency that interferes with the lower channels.)

After the filter, some block converters have a preamp to compensate for the loss caused in the mixer section. This is quite an important feature because the uhf output of a block converter, if it is converting many channels, cannot be amplified; there is no uhf amplifier that can handle twenty to thirty adjacent channels without incurring unacceptable intermodulation distortion in the picture.

The local oscillator generates the frequency to be beat against the incoming vhf channels. This frequency is generally between 540 and 590 MHz. For instance, if channel 2 (54 to 60 MHz) is beat against a 584-MHz oscillator, the result is uhf channel 42 (638 to 644 MHz). The lower the frequency, the more channels the block converter can up-convert before it runs into the limit imposed by the size of the uhf band. (You can't up-convert to a channel higher than 83.) However, intermodulation effects limit any block converter to about 36 channels no matter what oscillator frequency is chosen.

The local oscillator should be tuneable over a range of at least ±6 MHz in order to compensate for offset channels and to allow re-tuning to avoid co-channel interference on a specific channel from a local uhf station.

Finally, in the mixer section, the actual heterodyne conversion takes place. Its output is the UHF OUT port of the block converter. The outputs of a typical block converter are shown in the cable conversion chart.

Disadvantages. As useful as a block converter can be, it has several limitations that can prevent it from operating satisfactorily in some situations. First, it has a limited "dynamic range." Most block converters can accept signal input levels over a range of only about 10 to 15 dB. Less than the rated input range yields a noisy (grainy) picture and intermodulation distortion (herringbone); more generates even worse intermodulation.

Second, its uhf output, as mentioned above, cannot be amplified unless it is handling only one channel at a time. This, taken with the dynamic range limitation, means that a single block converter can rarely be used to supply an up-converted multi-channel signal to more than two VCRs or televisions simultaneously. Of course, you can use separate block converters for each set, but that runs into money!

Third, a block converter is not completely compatible with some PLL tuners. In the frequency allocations, there is a space between channels 4 and 5. This space is less than one channel (6 MHz) wide. When a block converter up-converts the low-vhf band it reproduces this spacing, but there is no corresponding space in the uhf band. This creates offset uhf channels that some PLL tuners cannot manage. The only (partial) solution is to tune the local oscillator of the block converter so that channels 5 and above are on-frequency, and use the set-top converter to tune channels 2, 3, and 4 (connection No. 2).

Last, but not least, the noise generated by the up-conversion process increases with the number of channels converted, due to unavoidable nonlinearities in the circuitry. If you are most concerned with the image quality of your recordings, it is best to sacrifice some convenience and up-convert only a single channel at a time (connection No. 6).

Selecting a Block Converter. Since a block converter can increase the versatility of your video system enormously, it's important to choose a good one. As discussed above, a block converter should have a preamp and a low-pass filter on the input especially if your cable system has more than 36 channels.

It should be temperature and voltage stabilized, a feature of extreme importance for programmed recordings. If the block converter drifts off frequency due to a voltage brown-out or a temperature change (many people turn their thermostats down when going out), your VCR, which you set to record two movies and an important football game, may end up recording only noise, or an entirely different channel!

A block converter should be FCC and UL approved. All converters require what is called Part 15 approval since they generate an r-f signal. Some cable operators will not let you use an unapproved block converter. ◇

control, as well as watch/record versatility.

There are many ways to connect a block converter to accomplish this. The best way for you will depend on the nature of your cable system, which of the features of your video system are most important, and what kind of tuner your television set or VCR recorder has. In the following hookups we'll consider two kinds of tuner: "direct-access" and "preset."

A "direct-access" tuner is one that can tune-in any channel in its range directly without presetting. The old-fashioned "two-knob" mechanical tuners and the latest electronic tuners with "calculator keyboard" or "ten key" controls are both direct access. A cable-ready direct-access tuner (105 or more channels) *cannot* tune uhf and special vhf cable channels at the same time, unfortunately. Such tuners have a switch on the control panel (generally labeled CATV/NORM) that defeats the cable-ready feature when uhf reception is desired. (Remember to use this switch when employing a block converter with this kind of tuner.) Almost all cable-ready televisions have direct-access tuners. A few of the most recent VCRs do, too, giving them greater programming versatility than VCRs with "preset" tuners.

A "preset" tuner is one that must be preset to the channels you want to receive. These generally have 12 or 14 tuning positions, each of which can be set to any channel within the tuner's capability. Channels not preset cannot be received without manually re-tuning the set. Unlike a direct-access tuner, a cable-ready preset tuner *can* receive uhf and special vhf cable channels at the same time. Up until very recently all programmable video recorders had preset tuners.

The most commonly used block converter installation however, was illustrated by connection No. 2. It is best for the following situations: (1) if you have a programmable video recorder, noncable-ready or direct-access cable-ready, and programmability is the most important feature to you; or (2) if you have a direct-access television (cable-ready or not) or a noncable-ready preset television, and you want the maximum number of channels available for remote control and maximum watch/record versatility.

When this hookup is used with a preset tuner, one of the tuner's positions should be set to the vhf output channel of the converter/descrambler so that you can watch or record the scrambled channel (s). The remaining positions should be tuned to the nonscrambled channels of your choice on their up-converted uhf equivalents. You'll have to make some choices here, since your cable system will likely have more nonscrambled channels than your preset tuner has tuning positions. Of course, any channel can be tuned-in by selecting it on the converter/descrambler.

As an example of what this hookup can do, assume you have a programmable VCR with a 14-position preset tuner and a remote-control TV with a direct-access tuner. With connection No. 2, you will be able to program any combination of 13 nonscrambled channels you've preset on the VCR's tuner *plus* one scrambled channel from the converter/descrambler. You cannot program two different scrambled channels. You can watch any nonscrambled channel or one of the scrambled channels while recording that same scrambled channel or one of the 13 preset channels, and you have all of the nonscrambled channels plus one scrambled channel at a time available for remote channel control.

Note that in this hookup, if your cable system has more channels than your block converter can handle, those channels beyond its range will count as scrambled, since the only way to tune them is through the converter/descrambler.

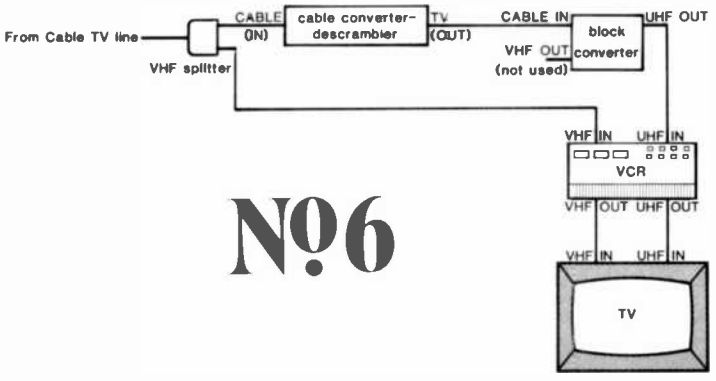
Some video recorders have a single, combined vhf and uhf input and output (Sanyo, Sears, and Toshiba, among them). If you have this kind of VCR you will have to use a vhf/uhf separator/joiner to combine the vhf and uhf lines before the video recorder. The use of this separator/joiner does not change the operation of the block converter installation in any way.

Connection 6

Use connection No. 6 in the following situations: (1) if you have a cable-ready preset VCR and programmability is the most important feature, (2) if you have a single-knob preset television and you want the maximum number of channels available for remote control or watch/record versatility or (3) if your cable system has only the 12 standard vhf channels plus the scrambled channel (s).

Since a cable-ready preset tuner can tune uhf and special vhf simultaneously, you can record any nonscrambled channel directly on vhf, and any scrambled channel up-converted to uhf after it has passed through both the descrambler and the block converter. A significant advantage of this installation is that you get cleaner recordings because the block converter is up-converting only one channel at a time and is less subject to intermodulation distortion.

Connection No. 6 is used with a single-knob preset television when remote control is important because



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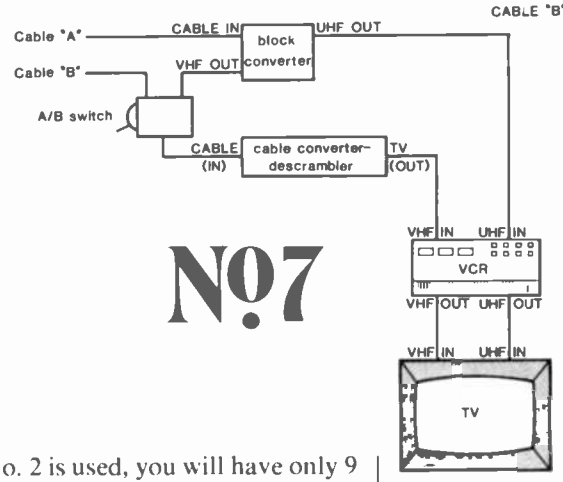
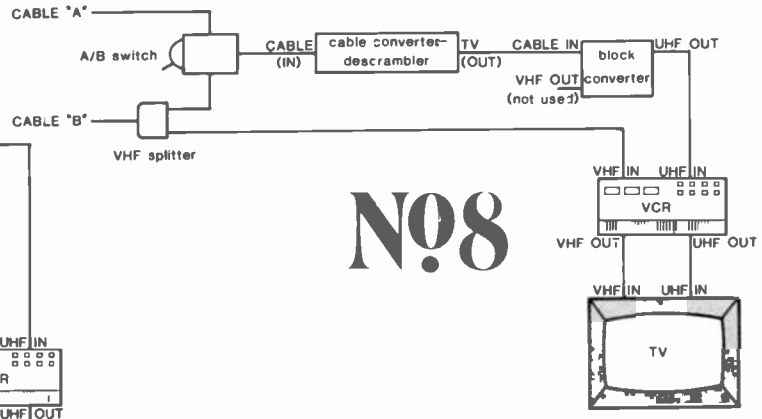


No. 7



No. 8

if No. 2 is used, you will have only 9 channels available for remote selection: 8 uhf plus one vhf (the vhf can't be re-tuned to uhf). With connection No. 6, you get 13 channels for remote control: 12 vhf plus one uhf. The watch/record versatility of the system is improved for the same reason.

Finally, if your cable system has only the 12 standard vhf channels plus the scrambled channel(s), it doesn't make sense to up-convert channels that your tuner can receive directly, so use connection No. 6.

Dual Cable Systems. A dual-cable system is no more than two single-cable systems combined into one, with an A/B switch to select which of the two will be accessed by the converter/descrambler. In the following hookups the A/B switch is shown separately for clarity. The hookups that follow are variants of Nos. 2 and 6, except that here we must consider the distribution of the channels on two cables. Some dual-cable systems put all the scrambled channels on one line and the rest on the other. Other systems may put the basic tier on one cable and all remaining tiers on the other. Space prohibits listing all the possible combinations, but here are two installations that will be useful with most dual-cable systems.

Connection 7

Connection No. 7 is a variation of No. 2. You can program or remotely control any combination of nonscrambled channels from Cable A plus any one channel (scrambled or not) from A or B and watch or record any channel. If A has no scrambled channels, the A/B switch is unnecessary.

Connection 8

Connection No. 8 is a variation of No. 6, and is likewise most useful with cable-ready preset tuners. With this installation you can tune-in any nonscrambled channel from Cable B plus any one channel (whether scrambled or not) from either Cable A or B. Since this hookup is usually used with preset tuners, the addition of another A/B switch wouldn't be of any help.

Double-Input TV. Some recent cable-ready televisions and component video tuners are equipped with a built-in A/B switch to allow accessing both scrambled and nonscrambled channels with your remote control. In this case, connection No. 9 can be used to hook the TV to a single-cable system with scrambled channels.

Connection 9

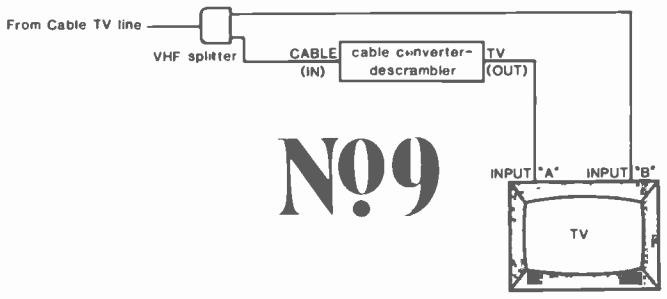
Note that a "double-input" television doesn't need a block converter. No VCR is yet equipped with this feature, though, so a block converter will still be necessary for programmability and full watch-record versatility. Now, however, you can hook up the block converter in the way that best suits your particular VCR without worrying about how the hookup will affect your TV.

Connection 10

Use connection No. 10 with a non-cable-ready VCR or any direct-access VCR, and a double input television. The block converter and descrambler are positioned as in connection No. 2 with respect to the VCR.

Connection 11

With a cable-ready preset VCR and a double-input TV, use connection No. 11. Here the block convert-



No. 9

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The MAXCALL is thin enough to fit into your pocket or purse. Yet its sound rivals any conventional telephone. for automatic redialing just push the "★" key. Even if you haven't used the phone for weeks, it remembers the last number you dialed. Use your MAXCALL all day. Its nickel cadmium rechargable batteries have the strength of Hercules. Overnight, in its slot on the base unit, it recharges to full power.

MAXCALL is so thin it fits in your pocket, but it has an incredible 1000-foot range.

A Nine-Number Memory!

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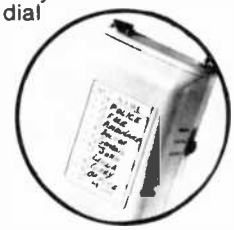

On this card you can list 9 numbers, stored in the unit memory bank.

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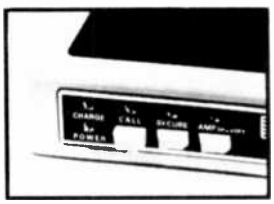

"Call" button activates intercom on every phone on the line. "Secure" button makes portable phone inoperative.

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er and descrambler are positioned as in connection No. 6.

All double-input televisions and tuners are direct-access types, and both inputs on these sets are either cable-ready or not, depending on the setting of the "defeat" switch. An exception is a tuner made by the Proton Corp., which has one uhf/vhf and one cable-ready input, selectable by a front-panel switch.

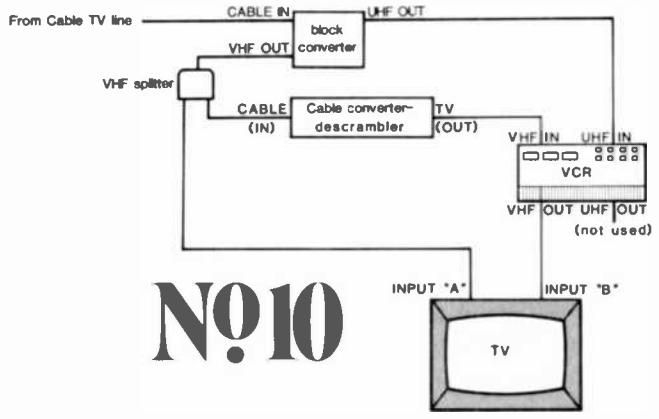
There is one more hookup for a block converter that may well be the most useful one we have discussed. If you have several television receivers that are all connected to the cable system and you have access to the distribution splitter that feeds the signal to them, you can use a block converter to distribute the r-f output of any video component to every TV set or VCR in your home, using the existing cable wiring. This includes your video recorder or videodisc player, a home computer (which then becomes an electronic memo board that can be read from any TV), or a surveillance camera in a security system.

Connection 12

Assuming there is an r-f output, use connection No. 12. A program on any video component can be watched or recorded on every TV receiver in your home on the up-converted uhf equivalent of its vhf output channel, leaving the remote controls on your video equipment unimpaired. Be sure the distribution splitter will pass uhf (many CATV splitters won't); and don't attempt to use a combined uhf/vhf amplifier in this setup. No uhf/vhf amplifier can handle more than about 7 vhf channels. The thirty or so adjacent channels on your cable system can drive such an amplifier into gross distortion and give you a pretty bum picture.

Conclusion. As effective as a block converter can be, it is not always the video panacea that one might hope for. Some things can impair its operation, from defects in a cable system to subtle oversights on the user's part. For example, there could be a weak signal at the input of the converter that might require use of a CATV amplifier, a grainy or snowy picture on a few channels that requires tuning higher in the band to avoid spurious images, co-channel interference from a uhf channel that requires re-tuning of the converter's local oscillator, distorted pictures as a result of too high a signal that requires insertion of an r-f attenuator, and other causes and effects. In most cases these problems will not occur, however.

More importantly, VCR owners have an opportunity to enjoy a host of advantages, from obtaining more channels to watching one channel while recording another one, by following the guidelines presented here. Most VCR instruction manuals ignore the fact that there are cable-TV connections to be made, and even when they do, the common setup presented does not make it possible to watch a channel while recording another one, which is achievable without a block converter, though remote-control facilities and reception of extra channels are not garnered. ◇



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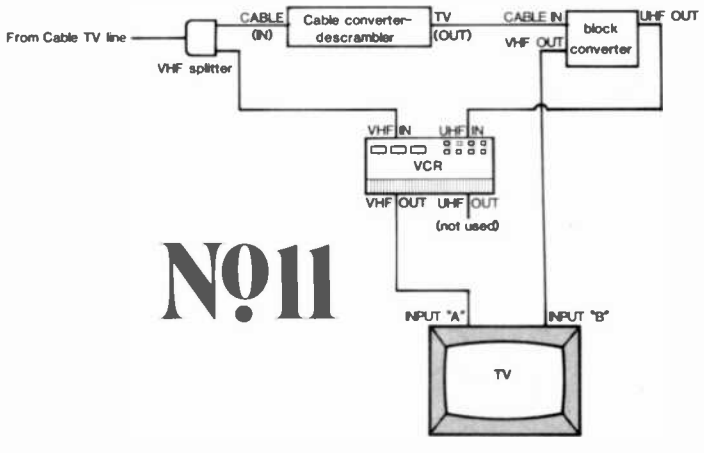

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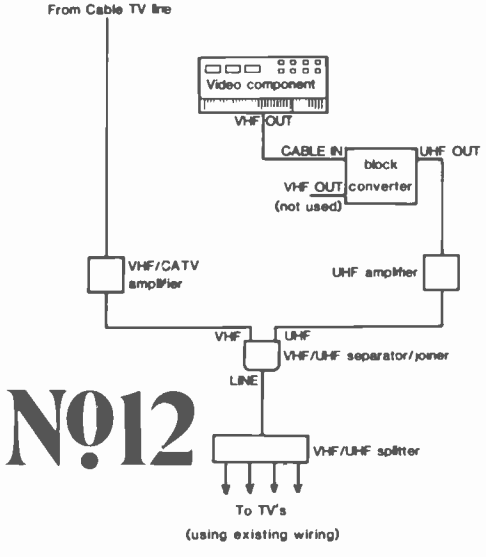

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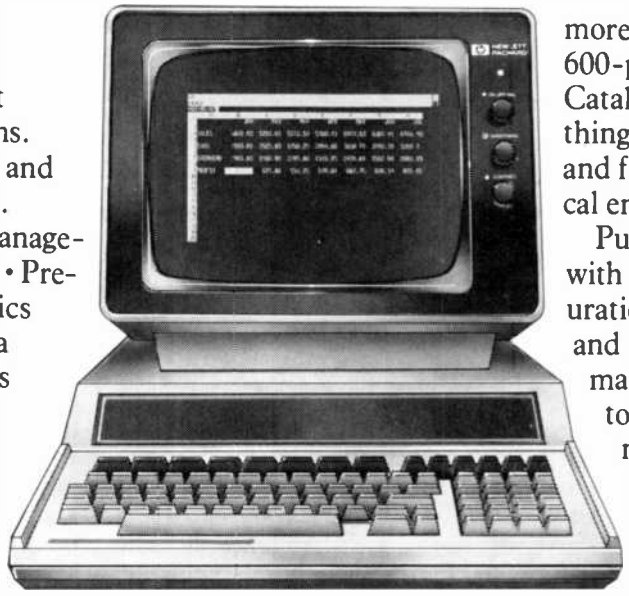

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Learning

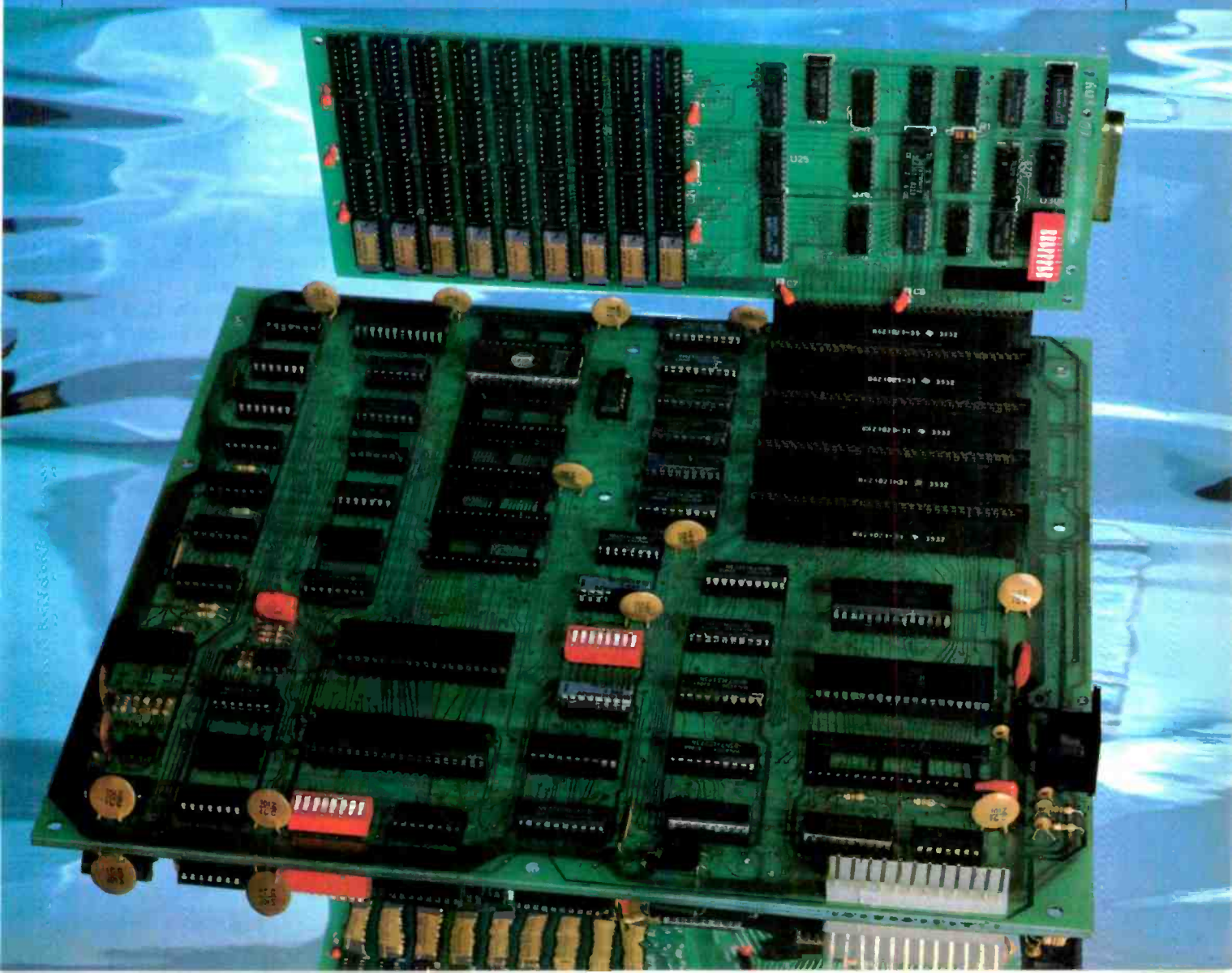
16-BIT MICROCOMPUTER TECHNOLOGY

Part 1: First of a series of articles on how an Intel 8088 CPU-based computer works. This unique microcomputer course is supported by plans to assemble and expand hardware that is compatible with the IBM-PC personal computer, starting here with circuits that will be discussed in subsequent articles.

By George Meyerle

DESIGN of computers has been revolutionized by the development of single-chip microprocessors. Starting with 4-bit types, these ICs quickly evolved to those that use 8-bit data words. Now there is a new generation of 16-bit microprocessors that provides awesomely greater power than 8-bit types.

Among the 16-bit microprocessors is Intel's 8088, which promises to be a leader for a variety of reasons. These include the use of this CPU in the popular IBM-PC machine and similar personal computers. IBM's 62-pin bus structure is supported by hundreds of manufacturers; and the 8088 represents the most cost-effective scheme to date because it is internally structured as both an 8-bit and a 16-bit processor, and externally as an 8-bitter.



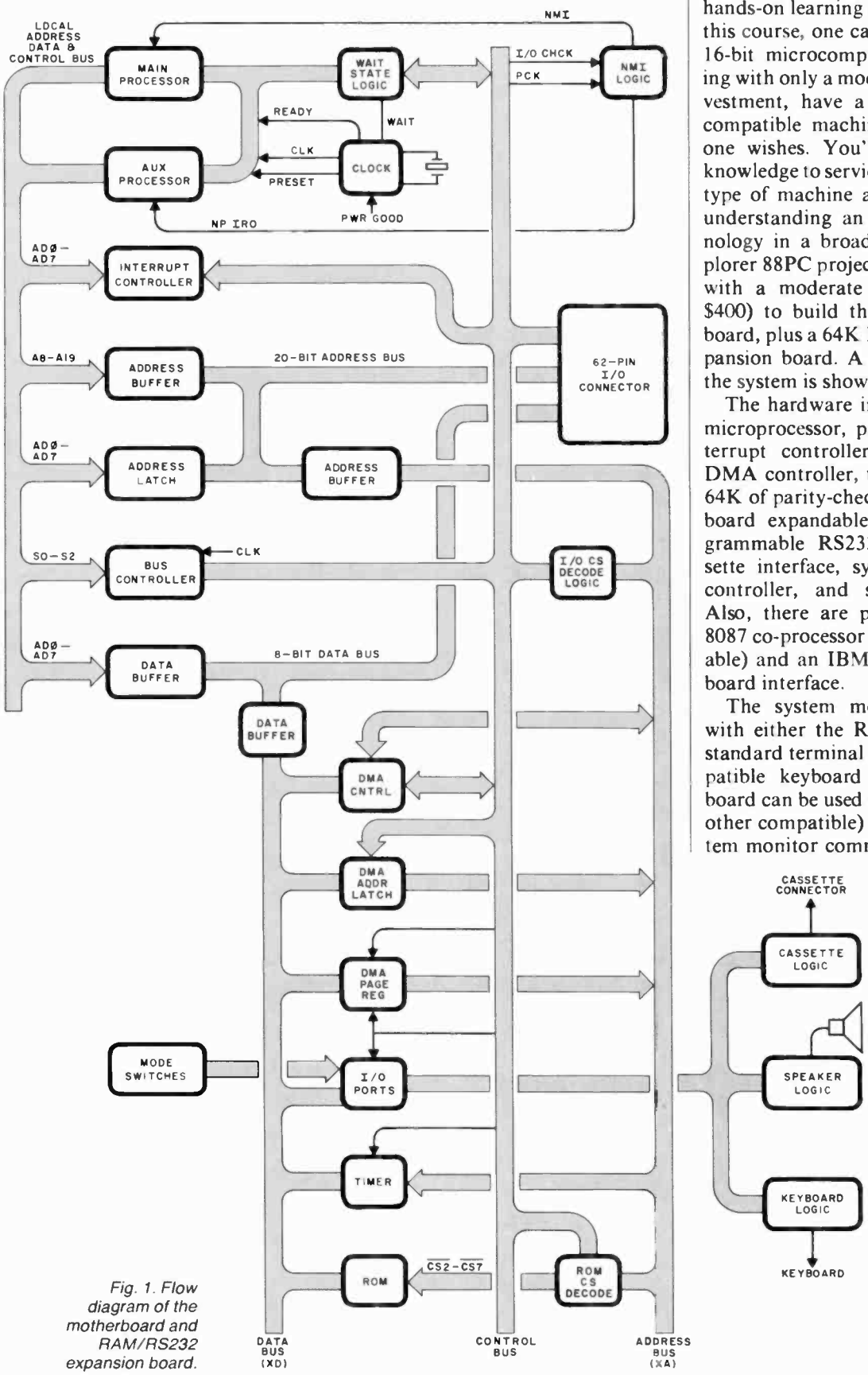


Fig. 1. Flow diagram of the motherboard and RAM/RS232 expansion board.

Thus, the 8088 has been chosen as the heart of a 16-bit microcomputer course that represents a unique hands-on learning experience. With this course, one can learn all about 16-bit microcomputers and, starting with only a modest hardware investment, have a complete IBM-compatible machine at the end if one wishes. You'll also have the knowledge to service and add to this type of machine and the basis for understanding an important technology in a broad sense. The Explorer 88PC project allows a person with a moderate budget (around $400) to build the 88PC motherboard, plus a 64K RAM/RS232 expansion board. A flow diagram of the system is shown in Fig. 1.

The hardware includes the 8088 microprocessor, programmable interrupt controller, programmable DMA controller, timer, I/O ports, 64K of parity-checked memory (on board expandable to 256K), programmable RS232 interface, cassette interface, system clock, bus controller, and system monitor. Also, there are provisions for an 8087 co-processor (soon to be available) and an IBM-compatible keyboard interface.

The system monitor interfaces with either the RS232 port and a standard terminal or the IBM-compatible keyboard port. The keyboard can be used with the IBM (or other compatible) color board. System monitor commands are shown

in Table I. Note that the monitor program in ROM includes a section that tests most of the system hardware and reports status, all under user control. This feature not only tests the 88PC hardware but also teaches a user the fundamental procedures to test, section by section, any peripherals compatible with the IBM PC's 62-pin bus structure (hereafter described as the S-62 bus).

The basic project (motherboard/64K board) can be expanded by adding an IBM compatible BIOS, floppy and hard disks, color boards, EPROM burners, A/D-D/A boards, game adapters, modem boards, an IBM compatible keyboard, and most disk operating systems offered by IBM and others. The Explorer 88PC is not compatible with the IBM-PC in one respect. Some IBM disk BASIC commands imbedded in the IBM cassette BASIC ROMs are not available on the 88PC. This can be overcome either by compiling programs designed for the IBM-PC or by purchasing a compiled version (which is normally how software is sold anyway).

The following section describes in more detail the various components of the motherboard and 64K RAM/RS232 expansion board.

The 8088 Microprocessor. The 8088 microprocessor (Fig. 2) represents a major breakthrough in CPU architecture. Previous generation devices generally executed a program in the following way: first, fetch an instruction from memory; second, read an operand (if required); third, execute the instruction; and fourth, write the result (if required). These steps had to be performed serially. The 8088 performs the same steps but uses two separate processing units within the CPU: the execution unit (EU) executes the instructions, reads operands, and writes results. The two units can operate independently of one another and are able in most cases to overlap instruction fetches with execution. The result is that most of the time required to fetch instructions disappears. The registers and instruction pointer are somewhat more complicated to understand than previous processors due to the fact that a 20-bit address bus is generated by combining two 16-bit registers. From a hardware point of view the 8-bit data bus is multiplexed with the low-order address lines AD0 to AD7. (Addresses A8 to A19 are available on their own pins.)

The clock is 4.77 MHz and RESET and READY lines are handled in a standard fashion. This design configures the 8088 in the maximum (multiprocessor) mode, which requires two signals (bus LOCK and TEST) not found in single-processor CPUs. The bus LOCK pin is an information signal to other processors on the bus utilizing common resources, and the TEST pin is used in conjunction with the WAIT instruction to synchronize an external event. The

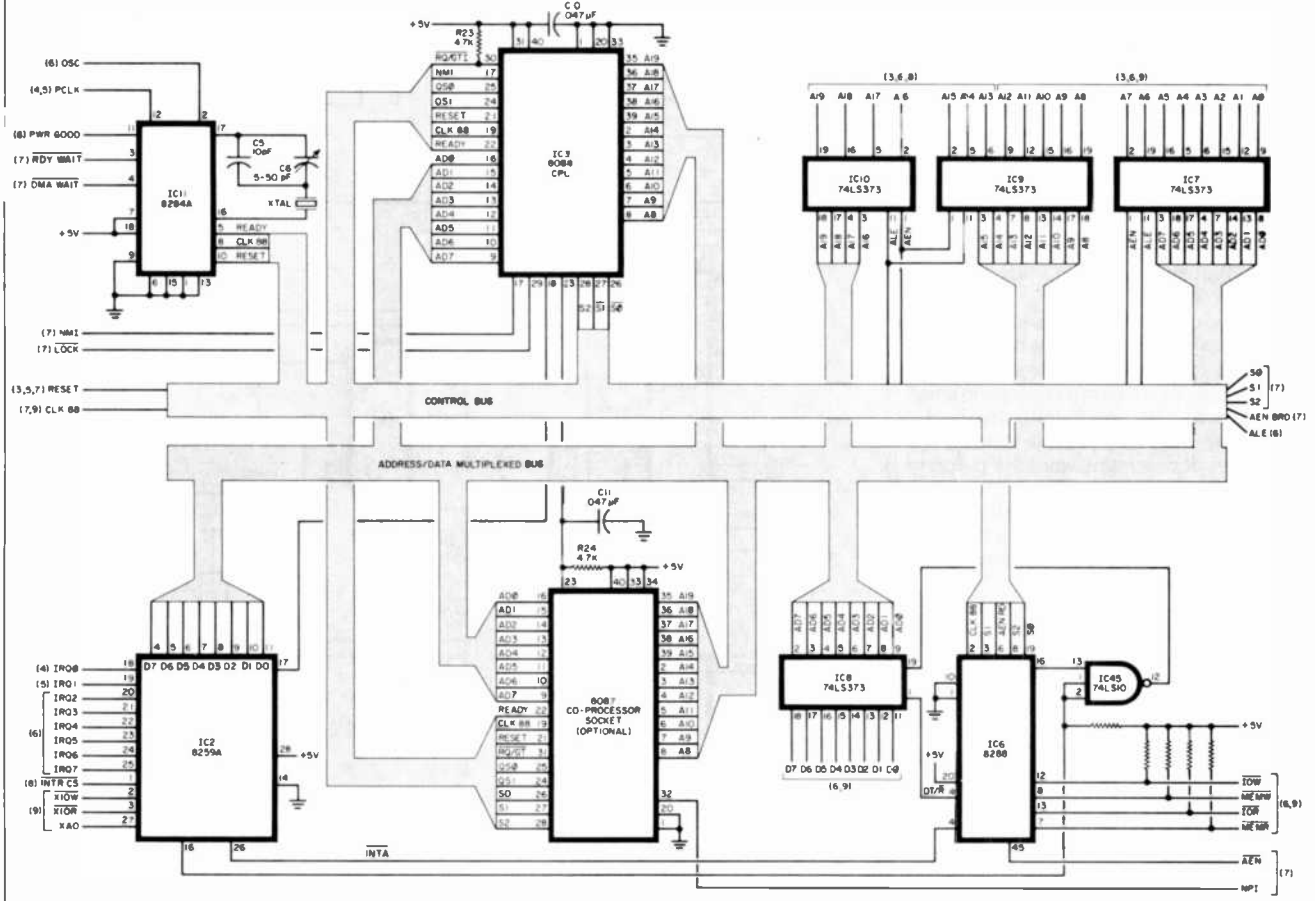


Fig. 2. The microprocessor, buses, and support circuits.

NMI (non-maskable interrupt) input is used to report memory parity errors.

8284A Clock Generator and Driver. Clock generator *IC11* provides CLK88, the CPU clock signal, READY synchronization, RESET logic, a 14.31818-MHz OSC signal for the expansion bus and a PCLK (clock ÷ 2) TTL level signal for peripherals (in this case an input to the timer). Variable capacitor *C6* is connected in series with the crystal to allow trimming the oscillator when using a color board. The RESET line (pin 11) is connected to the "power good/reset" (PWRGOOD) input that resets the CPU in the event of a power-supply failure.

8288 Bus Controller. Bus controller *IC6* provides command and control timing generation as well as bipolar bus drive. CPU status lines *S0, S1,* and *S2* provide status information to the control bus.

8259A Programmable Interrupt Controller. Controller *IC2* allows 8 I/O devices to signal the CPU, via interrupts, that they re-

TABLE I—SYSTEM MONITOR COMMANDS

EXAMINE/CHANGE MEMORY CONTENTS: Load or change programs in memory. These commands also allow entering short programs that test your understanding of 8088 programming.

EXAMINE/CHANGE REGISTER CONTENTS: Load or change the contents of any of the 8088 registers.

DISPLAY BLOCK OF MEMORY: Allows any block of memory to be displayed.

MOVE BLOCK OF MEMORY: Allows user to move contents of memory to new boundary.

INPUT DATA FROM A PORT: Allows any active input port to be read and tested by the monitor.

OUTPUT DATA TO A PORT: Allows data to be output to any active output port.

EXECUTE PROGRAM WITH OR WITHOUT BREAK POINTS: Allows running a program in small segments. Very handy for software debugging when all you do is indicate the address at which you want the program to stop.

EXECUTE PROGRAM IN SINGLE/STEP MODE: Runs a program one step at a time and allows user to examine contents of the 8088 registers at each step.

SAVE PROGRAMS ON CASSETTE: Saves your programs on an ordinary cassette recorder.

LOAD PROGRAMS FROM CASSETTE: Load saved programs back into memory.

EXECUTE DIAGNOSTICS:

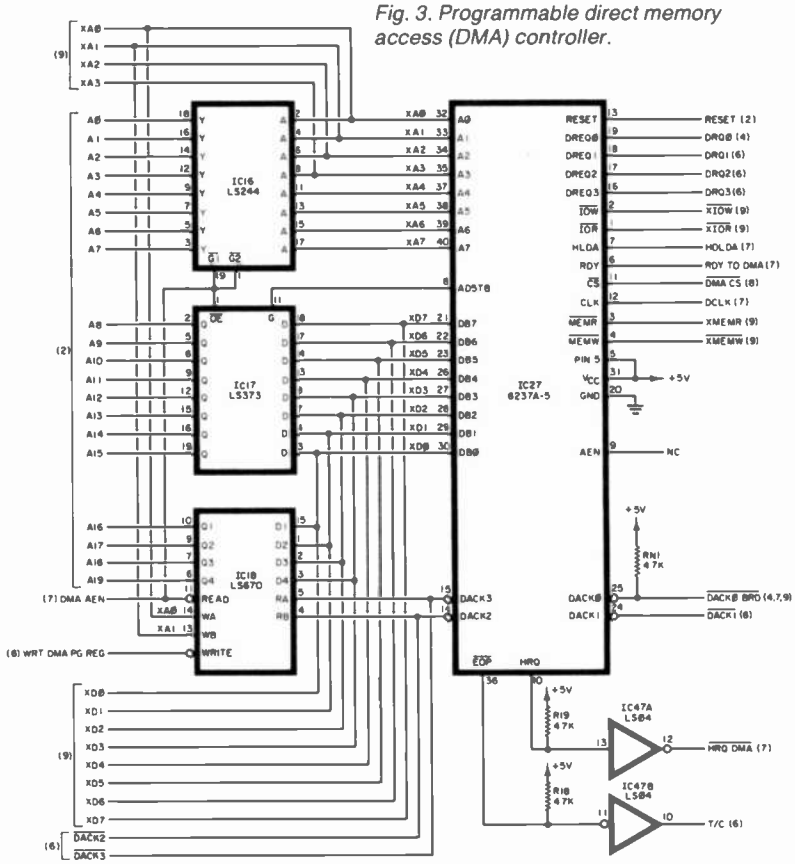
64K MEMORY & ROM SELF TEST: Checks RAM with a walking bit test and ROM with a check sum tests.

DMA TEST: Tests the DMA controller.

INTERRUPT CONTROLLER TEST: Tests operation of interrupt controller.

TIMER TEST: Tests timer vs. instruction times.

Fig. 3. Programmable direct memory access (DMA) controller.



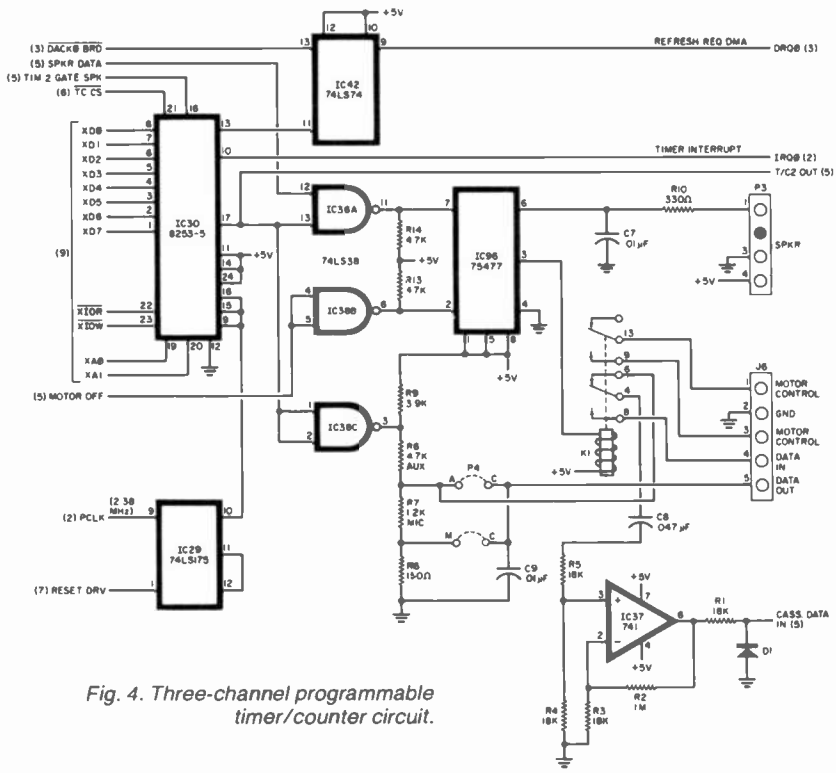


Fig. 4. Three-channel programmable timer/counter circuit.

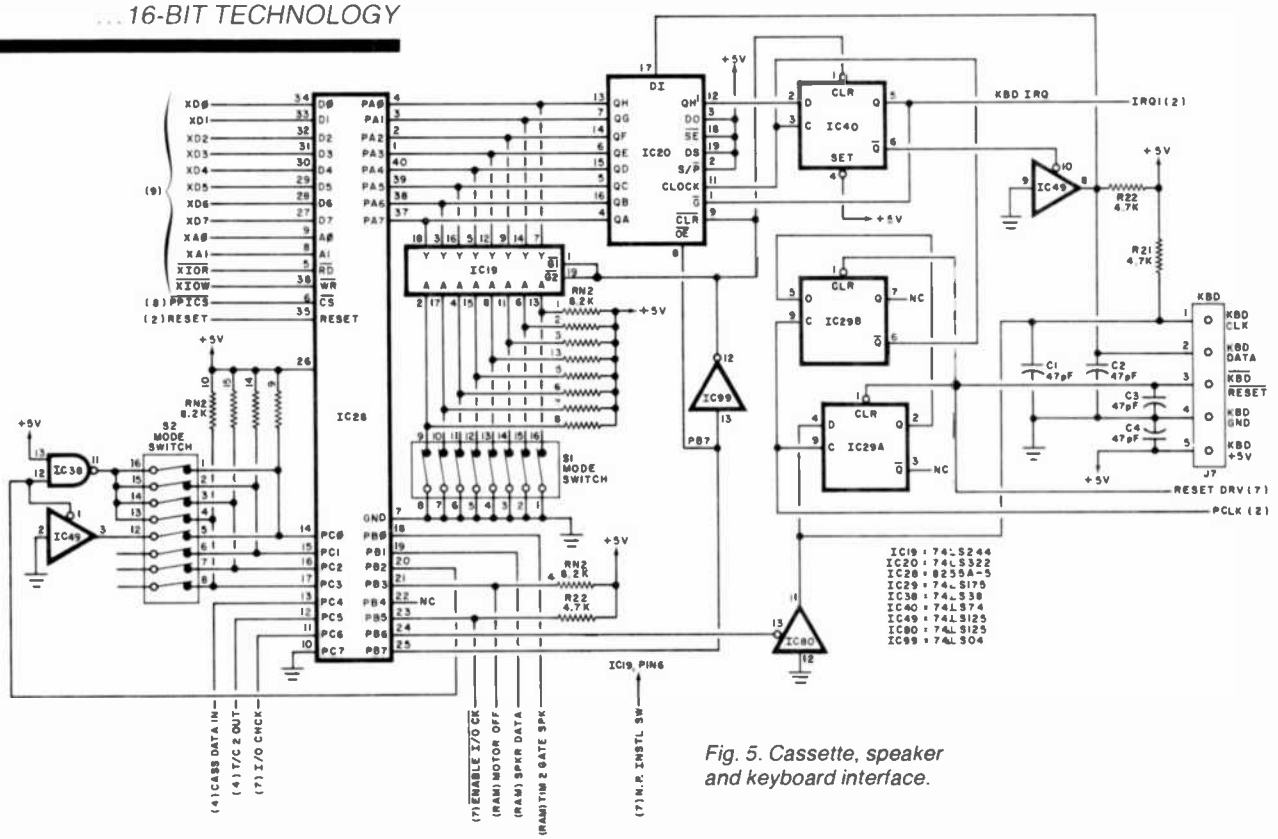


Fig. 5. Cassette, speaker and keyboard interface.

quire service. Without an interrupt controller, the CPU would have to check the status of all the I/O ports in service by repeatedly polling each port. Using the 8259A bypasses that programming step completely (improving throughput considerably). If a device requires attention, the following steps occur:

1. The device signals the 8259A by raising its interrupt line (IRQ0-IRQ7) high.

2. The 8259A evaluates the priority of the request and notifies the CPU via the INTA line if appropriate.

3. The 8259A will then issue a CALL instruction to the CPU via the D0-D7 bus.

4. After the CALL instruction is received by the CPU, it will issue two INTA pulses to the 8259A. This allows the 8259A to release its preprogrammed subroutine address to the CPU via the data bus. The CPU then will call the appropriate service routine.

Level 0, the highest priority interrupt, is connected to channel 1 of the timer/counter (*IC30,* Fig. 4) and provides a periodic interrupt. Level 1 is connected to the optional IBM keyboard input (*IC40,* Fig. 5) which transmits an interrupt for each keyboard input. The remaining six interrupt inputs are tied to the expansion bus (Fig. 6) for use by other I/O devices.

8237A Programmable Direct Memory Access (DMA) Controller (Fig. 3). This chip (*IC27*) allows external devices to cause the transfer of data to or from the system memory at rates to 1.6 megabytes/second. It contains four independent channels, each having a full 64K address and word count capability. The operation is as follows:

1. The I/O device requesting a data transfer signals the 8237A.

2. The 8237A then signals the CPU. After receiving an acknowledge signal from the CPU, the DMA controller begins the transfer. Each channel has registers that are programmed by the system monitor to control the transfers. They include information regarding

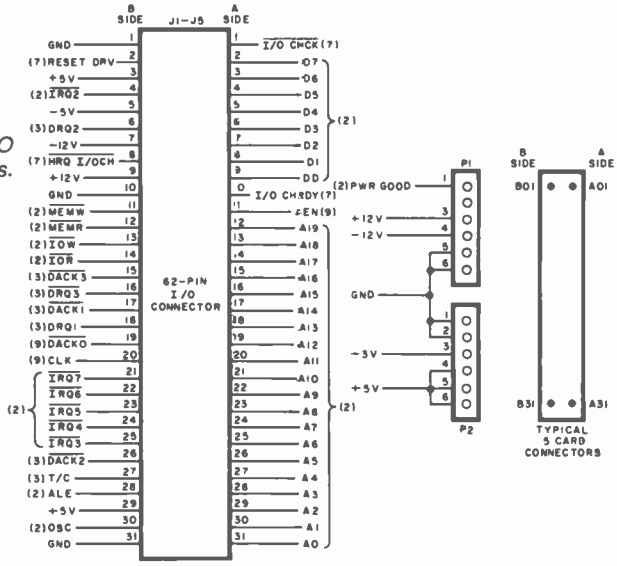


Fig. 6. The I/O expansion bus.

the starting address, number of transfers to be performed, type of transfers, etc.

The first DMA channel is programmed to refresh the system memory. This is done by programming channel 0 of the timer to periodically request a DMA transfer. This generates a memory read cycle which is available to refresh the dynamic RAMs. The three remaining DMA channels are available on the expansion bus.

8253-5 Three-Channel Programmable Timer/Counter. Timer *IC30* (Fig. 4) is organized as eight independent 16-bit software

TABLE II—I/O ADDRESS MAP

Hex. Range	9	8	7	6	5	4	3	2	1	0	Device***	Device****
00-0F	0	0	0	0	0	Z**	A3	A2	A1	A0	DMA 8237-2	Same
20-21	0	0	0	0	1	Z	Z	Z	Z	A0	Interrupt 8259A	"
40-43	0	0	0	1	0	Z	Z	Z	A1	A0	Timer 8253-5	"
60-63	0	0	0	1	1	Z	Z	Z	A1	A0	PPI 8255A-5	"
80-83	0	0	1	0	0	Z	Z	Z	A1	A0	DMA regs	"
AX*	0	0	1	0	1						NMI mask reg	"
CX	0	0	1	1	0						Reserved	"
EX	0	0	1	1	1						Reserved	"
3F8-3FF	1	1	1	1	1	1	1	A2	A1	A0	TP RS232C	RS232C
3F0-3F7	1	1	1	1	1	1	0	A2	A1	A0	5¼" DRV	Reserved
3F8-2FF	1	0	1	1	1	1	1	A2	A1	A0	Reserved	"
378-37F	1	1	0	1	1	1	1	Z	A1	A0	Par. Prtr Prt	"
3DD-3DF	1	1	1	1	0	1	A3	A2	A1	A0	Color/graph.	"
278-27F	1	0	0	1	1	1	1	Z	A1	A0	Reserved	
200-20F	1	0	0	0	0	0	A3	A2	A1	A0	Game I/O	"
380-38F	1	1	1	0	1	1	A3	A2	A1	A0	IBM Mono Dis	"

*At power-on time, the Non Mask Interrupt (NMI) into the 8088 is masked off. This mask bit can be set and reset via system software as follows: Set mask—write (80) to I/O Address (A0) (enable NMI). Clear mask—write (00) to I/O Address (A0) (disable NMI).

**Z = don't care; that is, not in decode.

***With IBM compatible keyboard ROMs.

****With Explorer 88PC monitor ROMs.

8255 I/O BIT MAP

(When equipped with Explorer 88PC ROM)

Hex 0060: Input

PA0 Baud rate select†
PA1 "
PA2 "
PA3 Parity ON/OFF
PA4 Parity EVEN/ODD
PA5 Not used
PA6 "
PA7 "

Hex 0061: Output

PB0 Timer 2 gate speaker
PB1 Speaker data
PB2 Note used
PB3 Cassette motor off
PB4 Not used
PB5 $\overline{\text{Enable I/O CH CK}}$
PB6 Not used
PB7 $\overline{\text{Enable KBD}}$ or CLR KBD & enable sense SW's

Hex 0062: Input

PC0 I/O Read/Write memory (SW2-1)††
PC1 I/O Read/Write memory (SW2-2)††
PC2 I/O Read/Write memory (SW2-3)††
PC3 I/O Read/Write memory (SW2-4)††
PC4 Cassette data in
PC5 Timer channel 2 out
PC6 I/O Channel Check
PC7 Not used

Hex 0063: CMD/Mode Register

Mode Reg. Value 7 6 5 4 3 2 1 0
(Hex 99) 1 0 0 1 1 0 0 1

†PA0	PA1	PA2	RS232C Port
SW1-1	SW1-2	SW1-3	Baud rate
0	0	0	110
1	0	0	150
0	1	0	300
1	1	0	600
0	0	1	1200
1	0	1	2400
0	1	1	4800
1	1	1	9600

††Binary value X32KB

8255 I/O BIT MAP (With optional IBM Compatible Keyboard ROM)

Hex 0060: Input

PA0 +KBD scan code 0 or IPL 5¼" DRV (SW1-1)
PA1 +KBD scan code 1 or Reserved (SW1-2)
PA2 +KBD scan code 2 or Reserved
PA3 +KBD scan code 3 or Reserved
PA4 +KBD scan code 4 or +Display type 1 # (SW1-5)
PA5 +KBD scan code 5 or +Display type 2 # (SW1-6)
PA6 +KBD scan code 6 or No. of 5¼" drvs # # (SW1-7)
PA7 +KBD scan code 7 or No. of 5¼" drvs # # (SW1-8)

Hex 0061: Output

PB0 +Timer 2 gate speaker
PB1 +Speaker data
PB2 +(Read Read/Write Memory Size) or (Read Spare Key)
PB3 +Cassette motor off
PB4 Not used
PB5 −Enable I/O CH CK
PB6 −Hold KBD CLK low
PB7 −(Enable KBD) or +(CLR KDB & Enable Sense SWs)

Hex 0062: Input

PC0 I/O Read/Write Memory (SW2-1) Binary value X32KB
PC1 I/O Read/Write Memory (SW2-2) Binary value X32KB
PC2 I/O Read/Write Memory (SW2-3) Binary value X32KB
PC3 I/O Read/Write Memory (SW2-4) Binary value X32KB
PC4 +Cassette data in
PC5 +Timer channel 2 out
PC6 +I/O channel check
PC7 Not used

Hex 0063: CMD/Mode Register

Mode reg. value 7 6 5 4 3 2 1 0
(Hex 99) 1 0 0 1 1 0 0 1

# PA5 S1-6	PA4 S1-5	Type of Display
0	0	Reserved
0	1	Color card 40X25 (BW mode)
1	0	Color card 80X25 (BW mode)
1	1	IBM mono display (80X25)

# #PA7 S1-8	PA6 S1-7	No. of 5¼" Drvs. in system
0	0	1
0	1	2
1	0	3
1	1	4

Note: PA bit = 0 implies switch is on.
PA bit = 1 implies switch is off.

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programmable counters. Channel 0 is programmed to time and request the refresh signals from DMA channel 0. Channel 1 is used by the system as a general-purpose timer providing a time base for implementing a time-of-day clock. Channel 2 is used to support the tone generation for the speaker output plus the signals for the cassette output. Each channel has a minimum timing resolution of 1.05 μs.

Cassette Interface. Cassette operation is all under software control. Channel 2 of timer *IC30* is used to control the data transfer to the cassette recorder. The cassette input is read by a bit on the 8255 I/O port (*IC28,* Fig. 5). The motor is controlled by an output-port bit on the 8255. (Also see I/O address map, Table II).

Speaker Output. The audio output can be driven from either the I/O output bit from *IC28* (see Fig. 5 and Table II) or the timer *IC30* channel 2 clock output. Note that the timer gate is also controlled by an *IC28* I/O port bit (see I/O address map).

Keyboard Interface and I/O Port (Fig. 5). Provisions have been made to upgrade the Explorer 88PC to include an IBM-compatible keyboard when used with an IBM-compatible color or monochrome board. To implement this upgrade, the 88PC system monitor ROM must be changed to provide the necessary IBM-compatible keyboard decoding routines (see Ordering Information). This ROM set also includes an IBM-compatible BIOS so that other IBM-compatible options, such as a disk controller, can be used. The optional IBM-compatible interface generates an interrupt that reads the input port (pin 5) on *IC28.* This port transfers the data from the keyboard to the computer. Note that the IBM keyboard connects to the computer through a 5-wire cable and transmits data serially. The keyboard does not use standard ASCII code.

8255 System I/O Port. Programmable I/O port *IC28* is used to test the inputs from mode switches *S1* and *S2.* The operating system tests how the switches have been set and configures the system to the hardware being used (number of drives, display, memory size, etc.). This IC also supplies data to the cassette and audio outputs (see Table II for details).

The I/O Expansion Bus. The S-62 (62-line) I/O expansion bus (Fig. 6) is an extension of the 8088 microprocessor bus. It is, however, demultiplexed and includes inter-

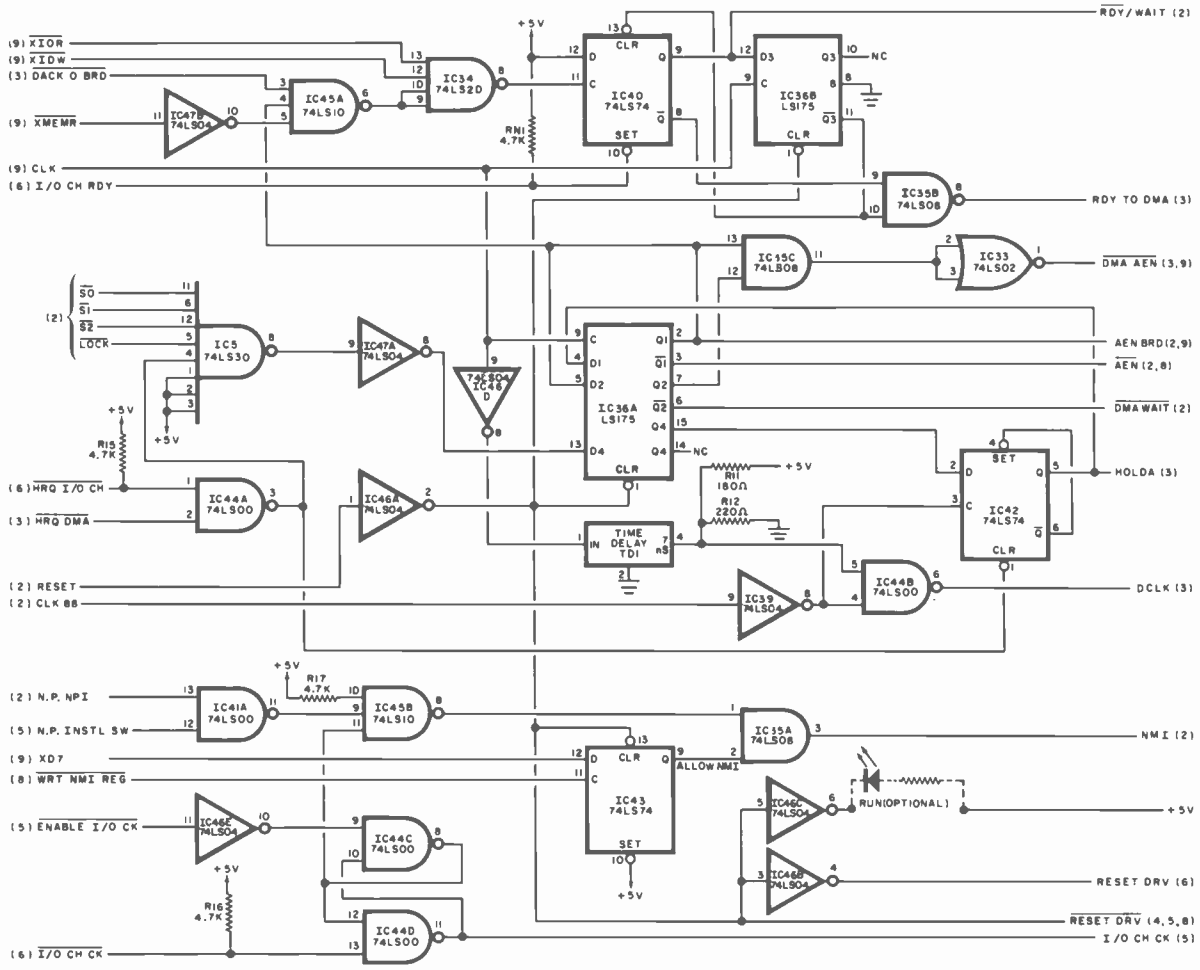

Fig. 7. Motherboard bus arbitration and wait-state generator.

rupts, DMA, and I/O functions. The expansion bus contains an 8-bit bidirectional data bus, 20 address lines, six levels of interrupt, memory and I/O read or write control signals, clock and timing lines, three channels of DMA control lines, memory refresh timing control lines, a channel check lines, and power and ground for the plug-in cards. Four voltage levels are supplied: ±5 and ±12 V dc.

I/O devices are addressed using I/O-mapped address space. The system is designed so that 512 I/O device addresses are available to the plug-in cards. A channel check line is used for reporting error conditions to the processor. Activating this line results in an NMI (nonmaskable interrupt). Memory expansion options use this line to report parity errors. (A complete description of the pinouts for this expansion bus is shown in Table III.)

Motherboard Bus Arbitration and Wait-State Generator. Figure 7 shows the bus arbitration and wait-state generator. If a device on the bus is too slow to respond to the system, *IC40* will generate a WAIT signal, delaying the processor until the device can respond. The balance of the circuits shown are used to coordinate or arbitrate bus and processor activity and will be explained more fully in future articles.

Motherboard System ROM and Other Device Address Decoders. Each system peripheral has been mapped into special memory or I/O address. This section provides the chip- or device-select signals to the DMA and interrupt controllers, timer, on-board I/O ports, and the six system ROM sockets (Fig. 8).

System Board ROM and Bus Drivers. The motherboard has provisions for 48K of ROM. This is divided into six 8K × 8 2564 EPROMs. At this time, *IC26* is the only one used. It houses the system monitor, test routines, and BIOS. As a system is expanded, these sockets will house such utilities as look-up tables for multiprocessor schemes and an expanded BIOS, as well as serve as hardware for specific types of programs. (For example, IBM disc BASIC uses look-up tables plus additional information contained in these ROMs.) In addition to the ROM, Fig. 9 includes bus drivers. They are necessary because the number of circuits connected to the bus exceeds the drive capability of the microprocessor and/or other peripherals.

System RAM/RS232 Port. The discussions of the plug-in RAM board/RS232 port and system power supply are given without figure references, since they will appear in the next installment of this article.

The System RAM/RS232 Port is a plug-in board containing a 64K-byte parity-checking memory (expandable to 256K) and an RS232 port. The RAM address decoding allows its use at the bottom of memory. The RS232 port uses a programmable UART, whose mode, baud rate, parity, etc. have to be

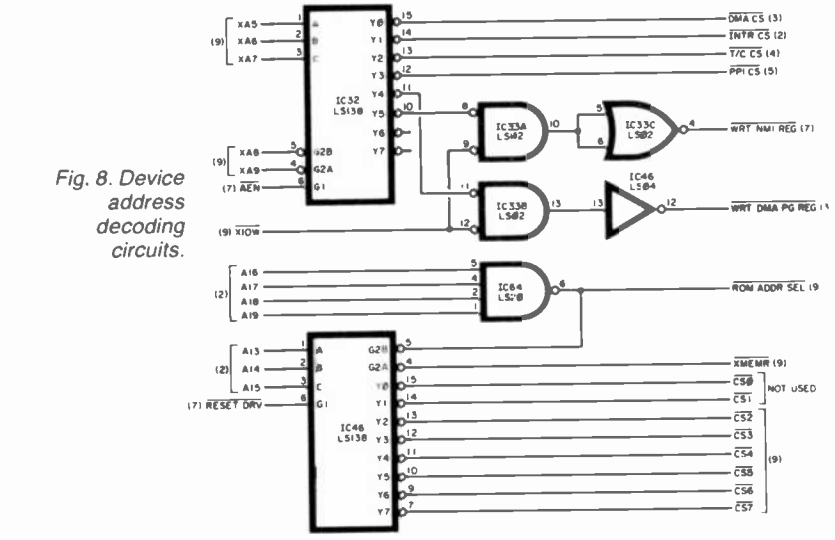

Fig. 8. Device address decoding circuits.

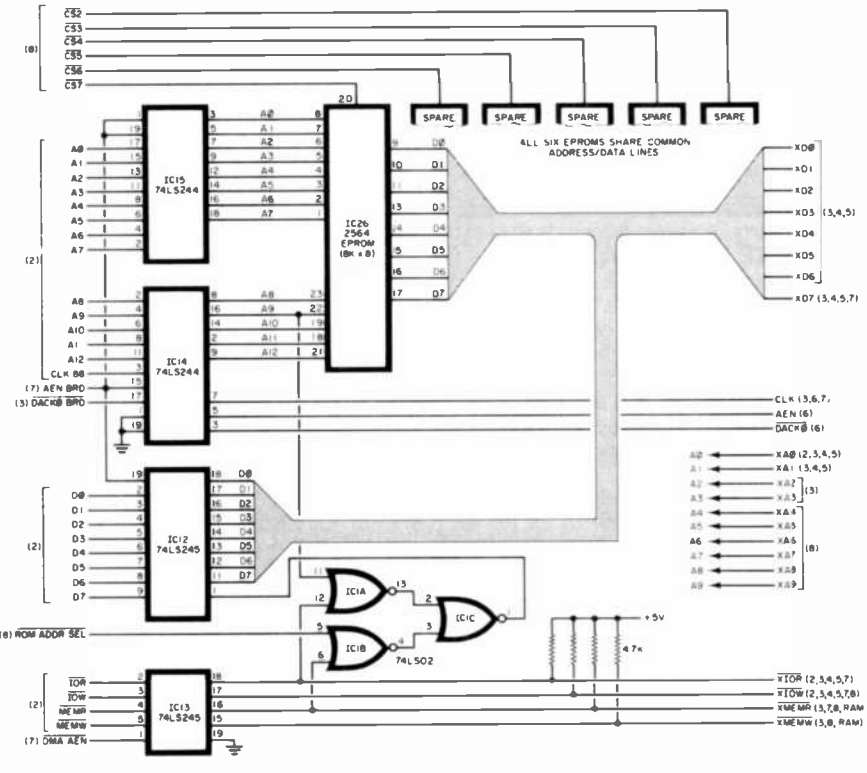

Fig. 9. System board ROM and bus drivers.

programmed by the operating system on power up or reset. In the case of the Explorer 88PC monitor, the initialization is controlled by the setting of the mode switches. The baud rate is selectable from 150 to 9600 baud. When using the optional IBM-compatible keyboard, this port becomes the COMM-1 port which can be used to drive a printer, modem, etc.

Power Supply. The power supply is often the most critical yet least considered part of a computer. The suggested supply is a straight-forward design using heat sinks and of course, a fan. A switching supply could be used but keep in mind that, if the output voltage is not stable, you risk destroying the chip set. The suggested supply provides for an additional 5 A on the 5-V line in the event the builder wants to add a hard disk into the same cabinet as the CPU. This addition is not necessary for the beginner system.

Building the System. The printed circuit boards are so compact and complex that the foil patterns will not be offered. (The boards can be purchased separately if desired.) The system can be wire-wrapped if you have the patience. There are a few suppliers that provide a prototyping board for the expansion bus so that the memory and RS232 port could be constructed that way. Make sure that the power supply you choose is reliable and stable. Remember, if the voltage exceeds 5 V, you risk blowing a few hundred dollars worth of chips.

After building and testing the hardware, a user should learn the function and operation of all the 8088/8086 instructions (if he does not already). The software monitor included is a convenient way to learn the architecture of the system. The Intel 8086 users manual and a new book written by Russell Rector and George Alexy entitled *The 8086 Book Includes the 8088* is sufficient to give a good understanding of both the hardware and software principles. The IBM technical reference manual (available at most IBM retail outlets) is also a handy reference book. It includes information about a cassette BASIC and a system BIOS that is, of course, not supplied with this project. ◊

KIT INFORMATION

The following items are available from Netronics R&D Ltd., 333 Litchfield Rd., New Milford, CT 06776: complete kit including motherboard and plug-in RAM with I/O port with 64K bytes of RAM $399.95 (with 128K bytes, $479.95; with 192K bytes, $659.95, 256K bytes $739.95). Please add $10 for shipping and handling (s/h).

Also available separately are an IBM-compatible keyboard with cable at $299.95; IBM-compatible color board at $299.95 (both with $10 s/h); extra 8K ROM required with IBM-compatible at $35; 62-pin bus connectors at $4.25 each (plus $1 s/h); monitor and keyboard BIOS source listing at $35 (plus $2 s/h); motherboard pc at $75 (plus $2 s/h); RAM-I/O pc board at $30 (plus $2 s/h); and power supply with fan at $149.95 (plus $8 s/h), with extra power for hard disk $169.95 (plus $8 s/h).

TABLE III—S-62 BUS DESCRIPTION

(as set forth by IBM)

OSC (Oscillator): A high-speed clock with a 70-ns period (14.31818 MHz). Has a 50% duty cycle.

CLK (Clock): Divide-by-three of the oscillator with a period of 210 ns (4.77 MHz). Has a 33% duty cycle.

RESET DRV (Reset Drive): Used to reset or initialize system logic upon power-up or during a low line voltage outage. Signal is synchronized to the falling edge of clock. Active high.

A0-A19 (Address Bits 0 to 19): Used to address memory and I/O devices within the system. The 20 address lines allow access of up to 1 megabyte of memory. A0 is the Least Significant Bit (LSB) while A19 is the Most Significant Bit (MSB). These lines are generated by either the processor or the DMA Controller. Active high.

D0-D7 (Data Bits 0 to 7): Provide data bus bits 0 to 7 for the processor, memory, and I/O Devices. D0 is the Least Significant Bit (LSB) and D7 is the Most Significant Bit (MSB). Active high.

ALE (Address Latch Enable): Provided by the 8288 Bus Controller and used on the System Board to latch valid addresses from the processor. Available to the I/C Channel as an indicator of a valid processor address (when used in conjunction with AEN). Processor addresses are latched with the falling edge of ALE.

$\overline{\text{I/O CH CK}}$ (I/O Channel Check): Provides the CPU with parity (error) information on memory or devices in the I/O Channel. When this signal is active Low, a parity error is indicated.

I/O CH RDY (I/O Channel Ready): This line (normally high or "READY") is pulled low ("NOT READY") by a memory or I/O device to lengthen I/O or memory cycles. Allows slower devices to attach to the I/O Channel with a minimum of difficulty. Any slow device using this line should drive it low immediately upon detecting a valid address and a READ or WRITE command. This line should never be held low for any period in excess of 10 clock cycles (2.1 μs). Machine cycles (I/O or memory) are extended by an integral number of CLK cycles (210 ns).

IRQ2-IRQ7 (Interrupt Request 2 to 7): Used to signal the processor that an I/O device requires attention. They are prioritized with IRQ2 as the highest priority and IRQ7 as the lowest. An Interrupt Request is generated by raising an IRQ line (low to high) and holding it high until acknowledged by the processor (Interrupt Service Routine).

$\overline{\text{IOR}}$ (I/O Read Command): Instructs an I/O device to drive its data onto the data bus. It may be driven by the processor or the DMA Controller. Active low.

$\overline{\text{IOW}}$ (I/O Write Command): Instructs an I/O device to read the data on the data bus. It may be driven by the processor or DMA Controller. Active low.

$\overline{\text{MEMR}}$ (Memory Read Command): This command line instructs the memory to drive its data onto the data bus. It may be driven by the processor or the DMA controller. Active low.

$\overline{\text{MEMW}}$ (Memory Write Command):Instructs the memory to store the data present on the data bus. It may be driven by processor or the DMA Controller. Active low.

$\overline{\text{DRQ1-DRQ3}}$ (DMA Request 1 to 3): Asynchronous channel requests used by peripheral devices to gain DMA service. They are prioritized with DRQ1 having highest priority and DRQ3 the lowest. A request is generated by bringing a DRQ line to an active level (high). A DRQ line must be held high until the corresponding DACK line goes active.

$\overline{\text{DACK0-DACK3}}$ (DMA Acknowledge 0 to 3): Used to acknowledge DMA requests (DRQ1-DRQ3) and to refresh system dynamic memory (DACK0). Active low.

AEN (Address Enable): Used to degate the processor and other devices from the I/O Channel to allow Direct Memory Access (DMA) transfers to take place. When this line is active (high), the DMA Controller has control of the address bus, data bus, read command lines, (memory and I/O), and the write command lines, (memory and I/O).

T/C (Terminal Count): Provides a pulse when the terminal count for any DMA channel is reached. This signal is active high.

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A Pseudo Cursor FOR OSCILLOSCOPES

Add a calibrated time base to dual-trace scopes

By D. E. Patrick

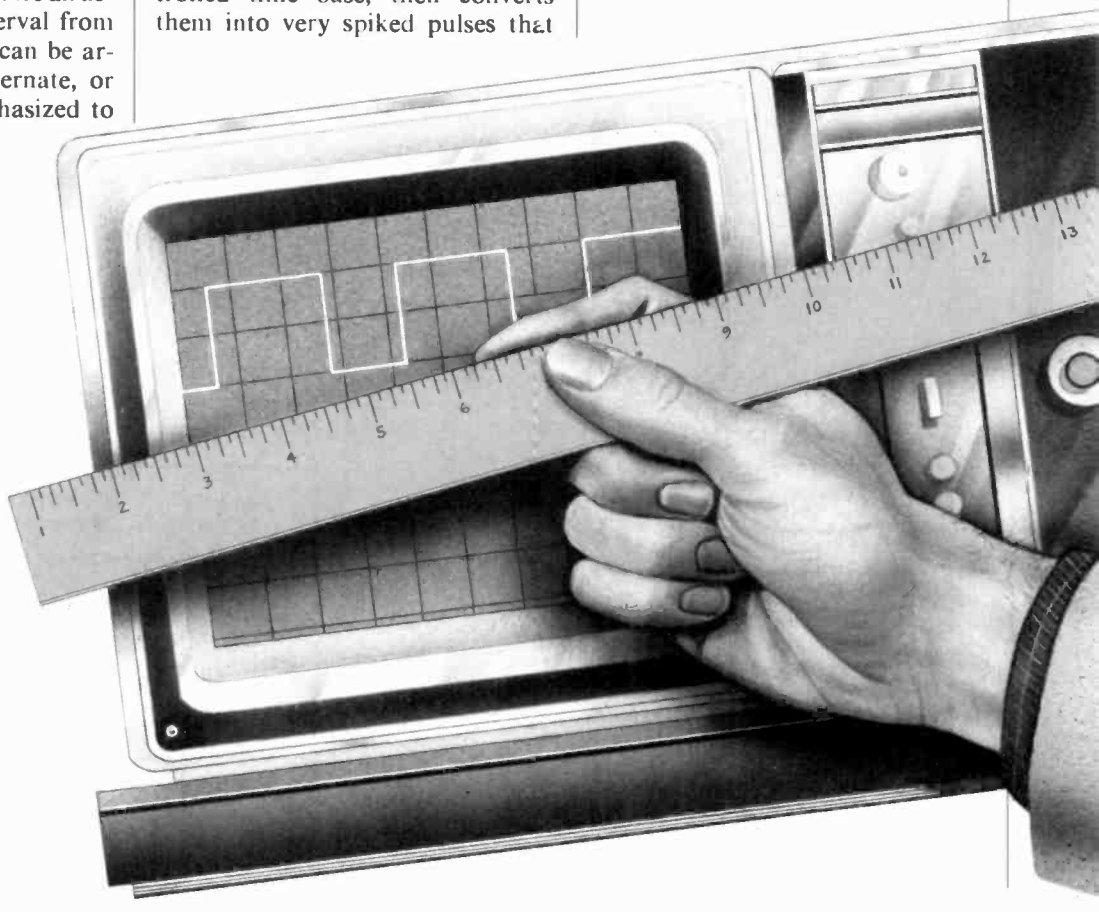
KNOWING the exact timing relationships between points on a signal displayed on a dual-trace scope is a function of the accuracy (linearity) of the sweep used. In most cases, this can reach 3% or so, dropping to much higher percentages in older and uncalibrated instruments. Unfortunately, most electronics experimenters seem to have uncalibrated scopes in daily operation. As a result, the graticule markings are almost relative.

The "Pseudo Cursor" described in this article can overcome this problem. It's the second trace of a dual-trace instrument and will display a "picket-fence" of narrow, spiked pulses, with each pulse an accurately known time interval from its neighbor. The pulses can be arranged so that every alternate, or every fifth pulse, is emphasized to make timing interpolation easy. Since the pulses are derived from a crystal-controlled oscillator, pulse interval spacing and thus, timing accuracy can be known to (typically) 0.002%.

Circuit Operation. As shown in the block diagram of Fig. 1, the dual-trace scope is set up so that one trace is synchronized with the signal of interest. Since a common time base is used, the second trace is also synchronized. The second trace vertical amplifier is connected to the output of the Pulse Generator.

The Pulse Generator, in turn, accepts pulses from a crystal-controlled time base, then converts them into very spiked pulses that are applied to the second trace of the scope. Since the Pulse Generator is synchronized to the scope sweep circuit (via the sweep gate signal), the "picket fence" generated on the second trace is locked with the signal under observation. If the time interval between pulses on the picket fence is known, any interval on the signal under observation can be measured. Since the pulse interval timing is based on a crystal-controlled oscillator, their spacing interval can be as accurate as the crystal used—typically 0.002% or better.

A circuit within the Pulse Gener-



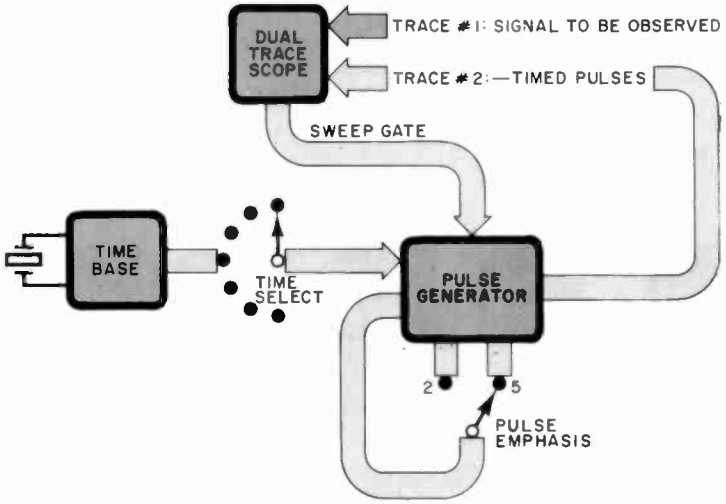


Fig. 1. One trace is synchronized with the signal of interest. The second is connected to the output of a pulse generator.

PARTS LIST

C1—10-to-40-pF capacitor. Can be eliminated (along with R9) above 1 MHz
IC1,IC2—7490 decade counter
IC3—7406 open-collector hex inverter
IC4—7400 quad 2-input NAND gate
Q1—2N3904 or similar
Q2—2N3906 or similar
R1—100-kilohm to 1-megohm resistor (see text)
R2,R5,R7,R8—1-kilohm resistor
R3—470-ohm resistor
R4—4.7-kilohm resistor
R6—820-ohm resistor
R9—100-kilohm potentiometer (see C1 above)
S1—Four-pole, double-throw switch
S2—Spdt switch

Note—The following is available from Electronic Technical Consultants, POB 29278, Denver, CO 80229): complete kit of parts at $34.95 plus $3.50 for shipping and handling. Also available separately are the pc board at $8.00 and the power supply at $10.00.

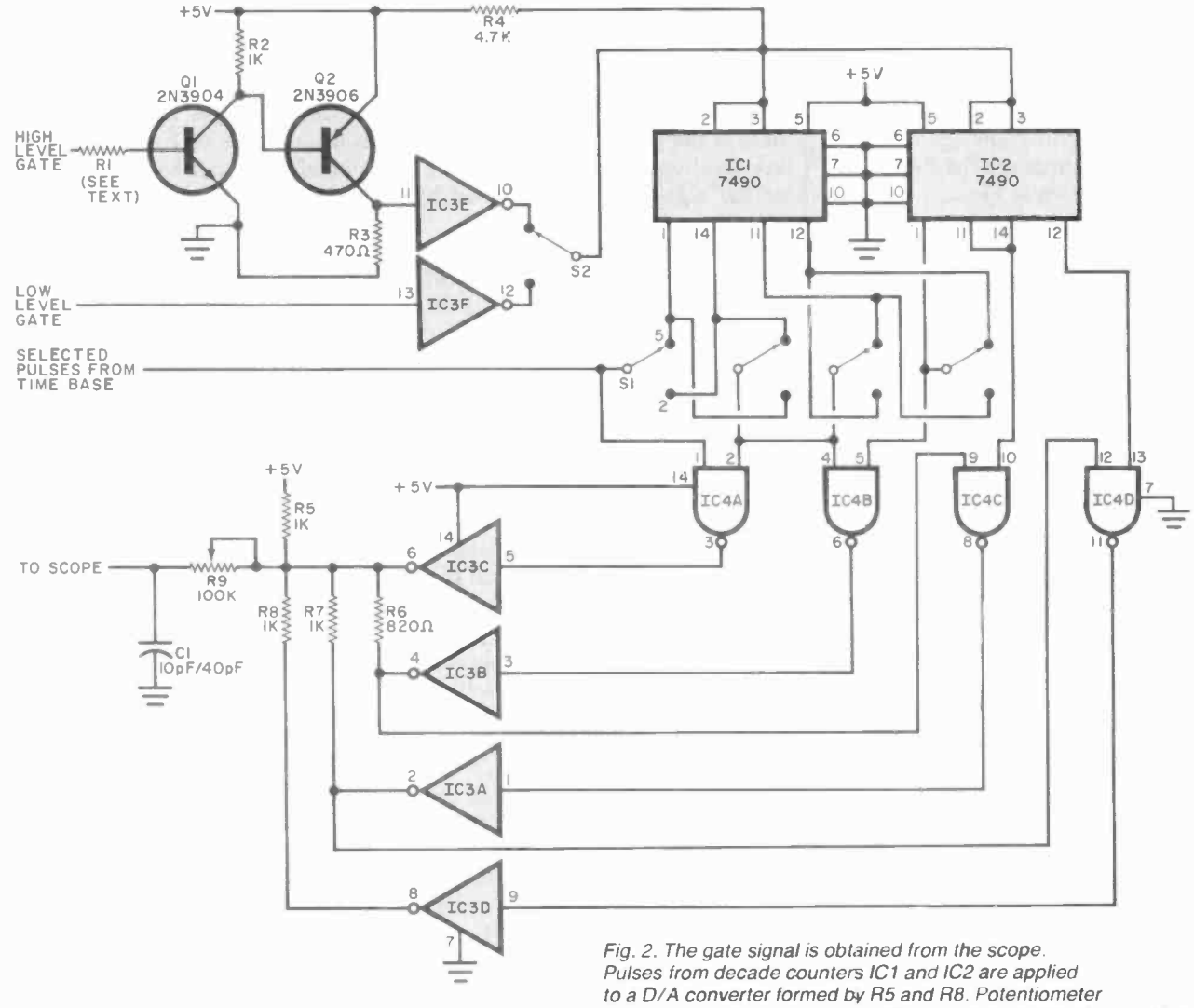


Fig. 2. The gate signal is obtained from the scope. Pulses from decade counters IC1 and IC2 are applied to a D/A converter formed by R5 and R8. Potentiometer R9 and capacitor C1 can be omitted for clock pulses above 1 MHz.

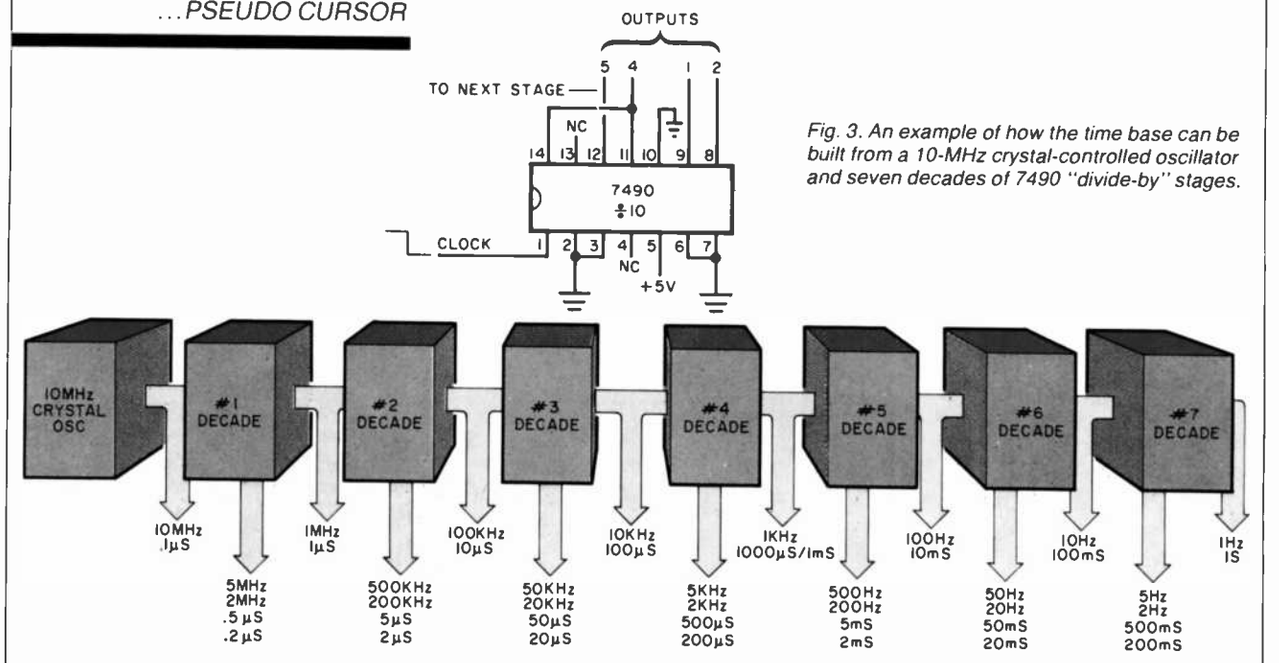


Fig. 3. An example of how the time base can be built from a 10-MHz crystal-controlled oscillator and seven decades of 7490 "divide-by" stages.

ator allows emphasis of either each alternate or each fifth pulse to ease timing interpolations. A selector switch within the time base allows almost any time interval to be selected. The circuit of the Pulse Generator is shown in Fig. 2.

In operation, decade counter *IC1* continuously accepts the selected timing pulses from the time base at its counting (pin 1) input. Both *IC1* and *IC2* have their outputs set to all zeroes if their 0 SET (pins 2 and 3) is high and will start counting when these pins are made low. This is how both decade counters are forced to start from zero at the beginning of each sweep, and count up during the sweep.

The gate signal used to turn *IC1* and *IC2* on must be in existence as long as the sweep is crossing the CRT. In a triggered sweep scope, such a gate is available from the sweep horizontal circuit and can be applied to pin 13 of inverter *IC3F*. For example, such a signal is available in a Heath IO-4510 at *IC404*, pin 9 or pin 8, while in the Tektronix T922 it is available at pin 3 of *U2334A*.

In some cases, the actual sweep ramp voltage can be applied to the base of *Q1* which will remain on as long as the ramp voltage is higher than the *Q1* turn-on voltage. Resistor *R1* in series with the base of *Q1* can range from 100,000 ohms to a megohm or so, depending on the level of the ramp.

Thus, contingent on the amplitude of the gating signal, either the low-level input consisting of *IC3F*, or the high-level input formed by *Q1*, *Q2*, and *IC3E* is selected.

The output at pin 12 of *IC1* can be used as the trigger for the second decade counter, *IC2*. Since the ICs used for *IC1* and *IC2* are biquinary (divide-by-2/divide-by-5) decade counters, switch *S1* can be used to select either of these division modes. With switch *S1* in the position shown, each fifth pulse on the second trace will be emphasized. If the user prefers one or the other of these emphasis modes, *S1* can be removed from the circuit and the pins of *IC1*, *IC2*, and *IC4* can be wired accordingly.

NAND gates *IC4A* through *IC4D* accept the various division outputs of the two decade counters, and apply their NAND outputs via inverter elements within *IC3* to a rudimentary digital-to-analog converter formed by resistors *R5* through *R8*. The composite signal is applied to the second trace input of the scope via an optional low-pass filter produced by potentiometer *R9* and capacitor *C1*. This filter can be deleted when clock pulses above 1 MHz are being used. In use, *R9* is adjusted for a clean "picket fence" display on the second trace of the scope.

The time base can be built up from any type of 10-MHz crystal-controlled oscillator capable of driving a TTL load, and followed by as many "divide-by" stages as desired. In the example shown in Fig. 3, note that, with a 10-MHz oscillator and seven decades of 7490 countdown, intervals from 0.1 microsecond to 1 second can be measured with crystal accuracy. If desired, other counting chains can be used. For example, a 7492 can produce a divide-by-2/divide-by-6; a 7493 can produce a divide-by-2/divide-by-8; etc. Any TTL handbook will show how to build almost any modulo counting chain desired for almost any application.

Construction. Since the circuits are not critical, any type of construction can be used from point-to-point wiring to the design, etching, and drilling of a small pc board. As previously mentioned, selector switch *S1* may be removed after a choice is made to whether every alternate or every fifth pulse is to be emphasized. Likewise, switch *S2* and the unused gating circuit may be eliminated once the correct gating signal is found within the scope being used. ◇

Use a TRIPLE-THREAT IC

How a CD4040's 12 flip-flops can be used to make a frequency divider, counter, or meter

By Sami A. Shakir

A MAJOR advantage in using state-of-the-art semiconductors is that a number of transistors and several conventional ICs often can be replaced by a single IC. A case in point is the CD4040 CMOS 12-stage ripple binary up-counter. This versatile IC can be used to make a low-cost frequency divider, long-term counter or even a simple frequency meter. In this article, we'll discuss how you can go about doing all three inexpensively and with minimum parts count.

Technical Details. All 12 of the CD4040's cascaded flip-flops are capable of being reset to zero by applying a high (+V) at the RESET input. For normal counting however, the RESET input is held low.

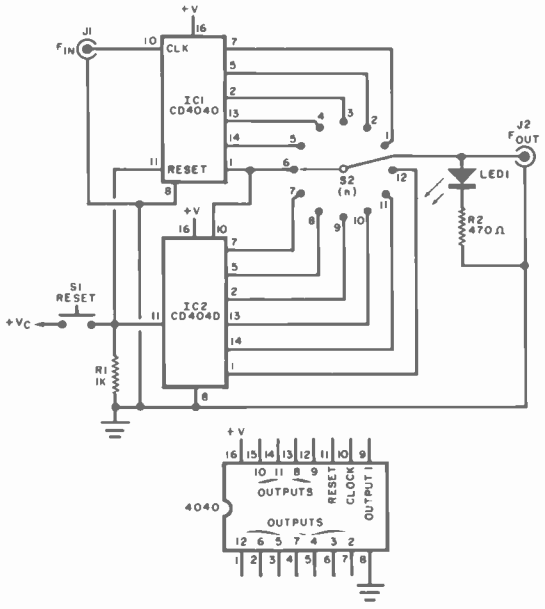
If an input signal is applied to the clock input, each stage will divide the frequency of the signal by 2, the last stage dividing the frequency by 2^{12} (4096). Cascading two counters as shown provides 24 stages that each divide by two, for a grand total of 16,777,216 divisions. In general, stage n will divide the input by 2^n, where n is the stage number.

Maximum input frequency to the circuit depends upon supply voltage. For example, with 5-, 10-, and 12-volt supplies, maximum input signals are about 4, 10, and 12 MHz, respectively. Since the 4040 is a CMOS device, it has the advantage of low power consumption, wide 1- to-15-volt power supply range and high noise immunity.

Possible Applications. The circuit shown here can be used as a frequency divider, timer, and simple form of frequency meter as follows:

Frequency Divider. Twelve-position switch *S2* permits a selection of every other counting stage. In this configuration, each position permits division by 4 of the input frequency. Thus, for any selected position of *S2*, the circuit will divide the input frequency by 4^n, where n is the number of the switch position selected. Of course, a 24-pole switch can be substituted to obtain *every* divide-by capability of the two-chip circuit. In the frequency-divider mode, any signal within the maximum range of the IC can be divided down as desired. One possible application of the frequency-divider mode is to allow an r-f generator to cover the audio range. If an accurate oscillator is used as the input, you will end up with a precision audio source.

Timer. If the power line-frequency of 60 (or 50) Hz is used as the input signal, the circuit can be used as a timer that can be reset using *S1*. A 60-Hz input has a period of 0.016667 second (16.667 ms), which means the first stage will change state every 0.01667 second, the second stage will double this time, and so on to the last stage, which changes state every 139,809.57 seconds (1.618 days). Since the selected



PARTS LIST

IC1,IC2—CD4040 12-stage counter
LED1—Any light-emitting diode
J1,J2—Miniature open-circuit phone jack
R1—1-kilohm, ¼-W resistor
R2—470-ohm, ¼-W resistor
S1—Spst normally open pushbutton switch (Radio Shack 275-1547)
S2—Single-pole, 12-position (or 24-position) nonshorting rotary switch (Radio Shack 275-1385 or similar)

position of *S2* will be high after 4^n (0.01667) seconds, *LED1* will turn on to indicate that the output is high. This high can then be used to control other circuits, the only precaution here being that the input voltage of the circuit being controlled must be about equal to the supply voltage for the timer circuit.

Frequency Meter. This mode is just the reverse of the timer mode, because here the input frequency is not known. If we assume the period of the input signal is T, the first stage will change state every $2 \times T$ seconds and, hence, will come back to its state after $4 \times T$ seconds. Therefore, any position of *S2* will yield a period of $4^n \times T$ (*n* being the switch selected). The output is monitored by *LED1*. Hence a period is measured from the time the LED turns off until it turns on again. If you use a stop watch or wristwatch to measure the period, you can calculate the unknown frequency from $f = 4^n/T$, where T is the time measured, for position *n*, to turn off *LED1* and then turn it on again.

Frequency measurement accuracy depends upon time-measurement accuracy. Consequently, accuracy is greater for large values of T since the percentage error due to human reflexes in the measuring process decreases. You should choose the highest possible position for *S2* for greatest accuracy. However, to avoid making the measurement process a lengthy one, an optimum choice for *S2* is the position in which an extinguish/turn-on period is a few seconds. (Note: If the input signal level is low, a suitable amplifier should be used to increase it to where it will reliably drive the circuit.)

Construction. Since the circuit has so few components, perforated-board construction can be conveniently used. Selector switch *S2*'s positions can be numbered from 0 to 11 (or 0-23 if you substitute a 24-position switch as described above). Any LED with the appropriate current-limiting resistor (*R1*) can be used to monitor the output. The board can be installed in almost any metallic or plastic box. Finally, any 3-to-15-volt source can be used to supply power to the circuit. ◇

Automobile IDIOT LIGHTS

Very low-cost circuit monitors your car's electrical system with high-low voltage indicators

By Richard M. Hilbert

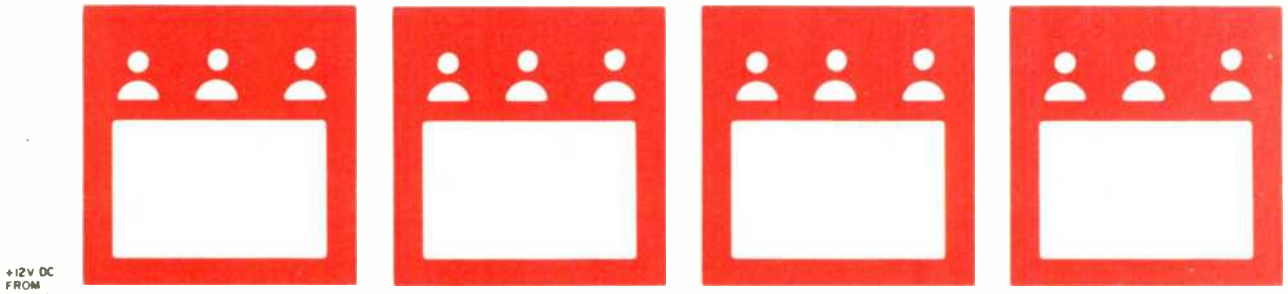
Many people think "idiot" lights are just that. But how often do we really look at gauges and how many motorists really know when an instrument indicates a normal reading or a potential problem? On the other hand, a bright red light attracts attention immediately and warns of a malfunction.

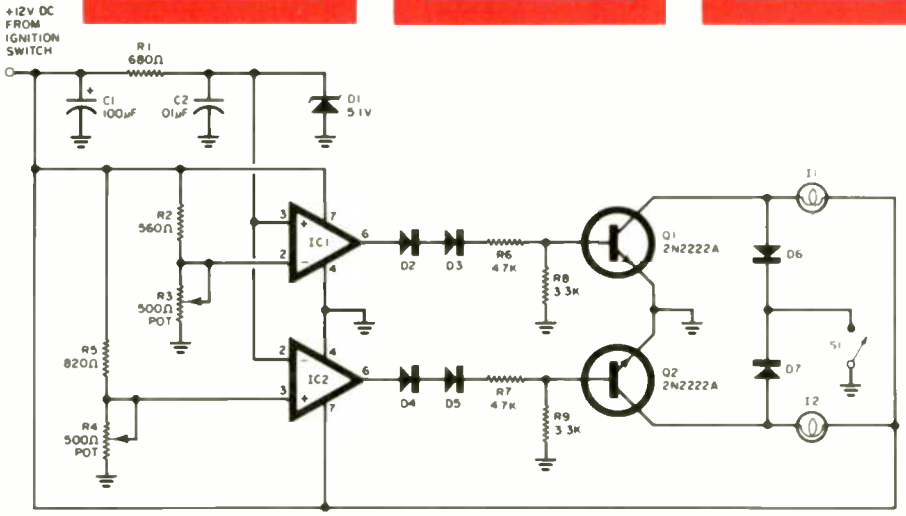
The high-low voltage unit described here monitors a vehicle's electrical system for a preset high and low voltage. For instance, a 12-volt system normally operates between 12 and 14.5 volts. Any drop below 12 volts turns on *I1* and any increase above 14.5 volts turns on *I2*. Either indicates a problem.

Construction. Construction of the unit is not critical and neither are parts. Many substitutions can be made. All components fit nicely on a 1¾" × 2¼" piece of phenolic perf board. Components *D6*, *D7*, and *S1* can be eliminated if desired. They were added to the original circuit to test the lamps because only the low-voltage lamp comes on during engine cranking (which is perfectly normal). Helitrim potentiometers do not have to be used, but they are easier to "fine tune" than regular potentiometers.

Calibration and Use. The circuit as shown is accurate to ±10 millivolts. A variable dc-power supply and a digital voltmeter were used to set up the unit. To calibrate, adjust the power supply to the desired low-limit voltage, hook up as shown on the schematic, and adjust *R3* until *I1* just goes out. Then increase power supply voltage to the desired high limit and adjust *R4* until *I2* turns on. All that is left to do is connect the unit to its permanent location.

In the prototype, *I1*, *I2*, *D6*, *D7*, and *S1* were mounted on a remote panel. However, all components could be installed in a minibox and mounted in, on, or under the dashboard. ◊





PARTS LIST

C1—100-µF, 25-V electrolytic
C2—0.01-µF, 50-V capacitor
D1—5.1-V, 1-watt zener diode
D2-D7—1N4001 silicon diode
I1,I2—#382, 12-V indicator lamp or equivalent with socket
IC1,IC2—LM-741 op amp
Q1,Q2—2N2222A transister
R1—680-ohm, ½-W resistor
R2—560-ohm, ¼-W resistor
R3,R4—500-ohm potentiometer
R5—820-ohm, ¼-W resistor
R6,R7—4.7-kilohm, ¼-W resistor
R8,R9—3.3-kilohm, ¼-W resistor
S1—Spst momentary, normally open switch

LITERATURE

MICRO CATALOG FROM ROCKWELL

A new publication, designated "Short-Form Catalog, part number D-2" is now available from the Electronic Devices Division of Rockwell International. The 16-page, four-color brochure covers microcomputers, development systems, modems, and expansion devices. Included are summaries of Rockwell's 4-, 8- and 16-bit microprocessors, the R6500 AIM 65 and AIM 65/40 board-level computers with their associated support products, and LSI-based 2400 and 9600 bps modems. A separate chart compares the performance of the Rockwell R6500 family to competitive microprocessor families. **Address:** Sales Support Services, Electronic Devices Division, Rockwell International, Box 3669, RC 55, Anaheim, CA 92803.

A/D CONVERTERS

A six-page application note discussing some common pitfalls in using and testing A/D converters is available from ILC Data Device Corporation. Entitled "Getting the Best from A/D Converters", it describes common problems encountered by system designers such as track-and-hold timing, noisy grounds, and T/H output drive limitations. Suggestions are made for achieving specified converter performance, and for eliminating time-consuming debugging procedures. Attention is given to output impedance problems, grounding difficulties, and ADC summing point sensitivities. **Address:** Marketing Dept., ILC Data Device Corporation, 105 Wilbur Place, Bohemia, NY 11716.

WIRING AND PC BOARD TOOLS

The new 65-A-1982 is a 24-page full-color catalog of wire wrapping tools and other electronic assembly tools and parts from OK Machine and Tool Corporation. It features a new line of PC boards, IC dispensers, circuit troubleshooting kits, etc. **Address:** O.K. Machine and Tool Corporation, 3455 Conner St., Bronx, NY 10475.

How to Use Subroutines

By Jim Keogh

IN THE PAST, we have presented several useful subroutines in this column. Some readers have asked for more information on how to use these subroutines to develop their own programs. Here are some ideas on combining subroutines with your own system.

A subroutine is a group of computer commands that have the computer perform a certain function when the commands are executed. Building a program or system from a group of subroutines is called module programming. Each subroutine or module is linked to other modules in a manner similar to the construction of a building.

Let us take a look at a rather simple program that analyzes data and presents it in the form of a bar graph on the display screen. The program receives data, manipulates the data, and then displays the results. The modules that make up the program are:

Input. The first module is for the input of data. A set of commands must be written that enable the data to be received into the program. Input modules can be designed to handle data coming directly from the keyboard, from a data tape, from a disk, or even from another program.

Manipulation. The next module accepts the data from the first module and performs the necessary analysis. There are countless ways to analyze data and each method may produce an independent module.

Display. The display module takes the results of the manipulation and displays them. As with the other modules, it can take one of a variety of forms.

In our example, the programmer will have to develop three modules or subroutines before the input data can be displayed in the form of a bar graph. Although we said the programmer must develop each module, that is not necessarily the case. There are other techniques that can be used to acquire the modules needed for the program.

A programmer can review other programs he or she has developed and borrow a module that has the same function. A programmer can also review the work of others (such as those presented in this column) and pick up some tips.

There is really no need to rethink the logical commands for each function within a program unless the programmer is designing a piece of unique software. Just as electronic devices are built from existing circuit designs, programs can be built up from existing subroutines.

In our example, all the programmer has to do is develop or locate two of the three modules required: the input module and the manipulation module. The display module is a subroutine presented here a few months ago. With the three modules (subroutines) available, the only task is to combine them.

The Connection. Unfortunately, building a program from subroutines or modules is not like constructing a building in every way. You can't just nail one module to another. At this point it is more like combining off-the-shelf electronic circuits. The circuits may be adequate for your project, but additional circuits are needed for the interconnections.

Software subroutines also need a few commands to connect subroutines. Before you set out to connect subroutines, you must have a thorough understanding of each one's function. You must be able to follow the logic and the commands of each module before you are ready to connect them.

To develop this understanding, you must read the subroutine line by line and determine how the computer will function after each command. Don't try to shortcut this approach! Without it, you can easily become lost when modifying and linking modules. It is much less time-consuming to review the logic of the module before developing a large program containing several modules. After you run the program, you might find yourself spending hours trying to find bugs in the software that could have been avoided by taking the necessary precautions at the subroutine stage.

Once the logic of each module is known, it will become obvious as to where one is in conflict with the other. Conflict in the logic flow of subroutines can come when each subroutine uses a different variable for the same data. Other problems can arise from the size of the dimension commands. These situations can be corrected by modifying a command statement in the module.

The programmer may also find that he has to modify subroutines that do not involve a problem of connecting modules. For example, the programmer may want to have certain portions of the display printed in a position different from that contained in a subroutine. As long as the programmer has a thorough understanding of how the subroutine functions, this modification can probably be made in a short time.

Of course, an entire subroutine does not have to be used just as it was written. It can always be enhanced by using some original additional ideas. For example, a subroutine that draws a game board could be enhanced by adding color and sound (assuming your computer has color and sound). In this case, you would have adjusted the function of the subroutine to suit your own taste.

When you see a subroutine you would like to use, remember it is just a guide that can be either used intact or greatly modified to suit your needs.

Subroutines as Learning Tools. So far we have concentrated on how to select a software subroutine and combine it with others to develop a program. You do not have to have a program in mind to find a use for a subroutine. Subroutines show you how to have a computer perform a specific function, and they can also be used as material to increase your own knowledge of programming.

For example, suppose you wanted to develop a program to have

your computer keep score in a game. In a recent column, we discussed how to program registers so that the computer could keep track of several events. The register is the logic used to develop a subroutine to keep score. You might not develop a program containing a register module, but you might learn the logic behind such a subroutine.

Subroutines can be used as lessons in BASIC programming. They are advanced material for the newcomer to programming. To use subroutines as learning tools, you must have a good understanding of the command statements in the BASIC language. Without this knowledge, you will have a difficult time trying to follow the logic of the module. Once you speak and understand the language of programming, you can quickly increase your understanding by reviewing how a subroutine was able to present a certain function on the computer.

For example, one reader pointed out that, after developing a good foundation in the BASIC language, she still felt that developing a simple target game was too difficult to attempt. However, after reviewing, in detail, the subroutines in the target game, she realized she was "reading" more into the program than was actually there.

The projectile moving from the bottom to the top of the screen was a routine she thought was well above her ability and understanding. However, when she studied such a subroutine, she realized that the movement of the projectile was nothing more than turning on and off a series of lights on the display screen. She already knew how to light up portions of the screen and was soon developing her own target games.

Let us review some of the more common techniques used to dissect a subroutine. First, when you look at the program list, don't try to review the entire program in one glance. Looking at a program in that manner can overwhelm even the best programmer.

A good approach is to study ten lines at a time. Try to identify commands and routines (that is, loops) contained within the ten lines. Make sure you have a clear understanding of what the computer will do using those ten lines.

If the function of the instructions on the lines is not clear, key them into the computer and run the program. Finally, if the logic still escapes you, key the program into the computer and have it trace it for you.

Be sure that you also follow commands that send the computer to different lines in the program (GOTO, GOSUB, etc.). Don't take the shortcut and skip following the branches. Remember when you are programming, you either know how to program a certain function or you don't know how. The computer will not let you program half a program.

Whenever you pick up a program or subroutine written by someone else, take a few moments to study what it was designed to do. You'd be surprised what tips and hints about programming you will discover. The more time you spend investigating programming logic, the more often you will be saying, "So that's how they do it!" Then you will be developing your own creations and others will be saying, "How does he do it?" ◇

"I don't care if it is your Pet, get it out of the bed."

COMPUTER VIDEO GAMES

Reviews of the Latest Computer Game Software

PRINCESS AND THE FROG

Romox Inc., 64K ROM cartridge.

As a person who is "less than gentle" on floppy disks, I eagerly rushed to my Atari with this new ROM cartridge from Romox. However, I must admit it was a disappointment when I ran the program.

It was readily apparent from the packaging that this was another of the many "Frogger" clones, but this game didn't even try to vary the elements much. The instructions were limited to a few incomplete statements printed on the reverse side of the packaging. As they were printed in dark letters on a black background and extremely difficult to read, I saw why Romox didn't bother to make them very extensive.

Nonetheless, proceeding with every intention of forgiving all these minute details if the game was an interesting variation, or a challenge to the player, I loaded the cartridge, grasped the joystick and proceeded to play.

The first feature (or lack of) that came to the forefront, was the absence of the usual theme music that comes with nearly every game. While this music adds to the overall atmosphere, I do confess to approving of its absence, as cute jingles can quickly become very annoying after a very short time. The game sounds that were part of the play, while nothing spectacular, were more than adequate.

"If it's still possible, I'd like to place a human-being-to-human-being call!"

On my 12-inch Sony TV screen, the graphics were marginally acceptable. It took some pretty close observation to distinguish the jousting knights that were the first obstacles to be evaded. After just 2 or 3 tries, this became quite easy to do. Then it was on to the second section. Here, the player (frog) must cross a moving moat by hopping upon the backs of snakes and alligators and landing safely on the far side. Bonus points are awarded for connecting with female frogs along the way.

All in all, the "Princess and the Frog" is another in an endless series of unimaginative copies of successful arcarde and computer games. It is very quickly mastered by a novice game player and offers little that would allow a favorable recommendation. Save your money.

PREPPIE

Adventure International. 16K disk.

This game by Russ Wetmore had come highly recommended, and I'm very happy to report, that I was not disappointed in the least. This is one of the more imaginative variations of the Frogger style of action games, with graphics and sound that rival the original.

In this 2-player game, each player controls a "Preppie" (complete with matching designer shirt), through 2 obstacles in pursuit of wayward golf balls. In the first section, our Preppie must dodge golf carts, lawnmowers, tractors, and similar moving vehicles to reach the safe zone in the center of the screen.

The second challenge finds him crossing a moving stream by hopping from logs to canoes to the backs of that familiar alligator, that sometimes takes a dive below the surface.

Each successive difficulty level is truly a step up from the previous one and more than adequately accommodates the beginner yet challenges the experienced player.

The author is to be commended for the catchy soundtrack and his excellent use of the Atari superior color graphics capabilities. The instructions were complete and very readable. While the disk version is copy-protected, and cannot be backed up by the purchaser for his own purposes, AI does have what is probably one of the most reasonable policies in the industry. A free replacement is offered for a full year in the event the original disk fails to boot, and a modest $5 handling fee levied after that. Should the purchaser want a backup available on hand at all times, a coupon is enclosed that allows an additional copy to be ordered immediately without the documentation for $3.99.

Preppie provided hours of fun without losing its appeal and I recommend it without reservation to all game players.

SHAMUS

Synapse Software

It's difficult to talk about "Shamus," by Wm. Malaga, without using lots of superlatives and expressing a level of excitement not generated by most new games. "Shamus" is an arcade game requiring fast reflexes, a nimble touch on the joystick, and thought and planning to succeed.

The object of this game is to maneuver your SHAMUS through 4 maze-like levels of 36 rooms to find the secret and defeat the dreaded foe, the "Shadow." Equipped only with the powerful Ion-shivs, Shamus must battle hoards of opponents every step of the way.

As if all this weren't enough to challenge players, the author has included 4 selectable skill levels that range from challenging to outright impossible. As stated in the instructions, you better not expect to master this game in 1 or 2 sittings but rather enjoy it for quite a while.

If there were an award for the outstanding computer game of the year, my vote would be cast for "Shamus." I recommend it without reservation to every Atari owner who isn't satisfied by the mediocre fare that is all too commonplace. Get one for a friend, too! ◇

New Peripheral Transforms Apple II into A Computerized Oscilloscope

By Forrest M. Mims

IF EVER there was an important technological breakthrough in peripherals for personal computers, it's the Model 85 aScope™ from Northwest Instrument Systems, Inc. Briefly introduced in this column last month, the aScope is a compact, modular accessory that transforms the Apple II computer into a powerful, programmable, dual-trace oscilloscope with memory capability and a 50-MHz bandwidth.

The aScope module has two BNC connectors and two rows of edge connectors (Fig. 1). The $995 price for the module and its operating software might at first seem rather steep; but when plugged into an Apple II, the combination provides the capabilities of a highly sophisticated laboratory oscilloscope worth over $10,000.

The most important circuit components of the aScope are a high-speed sample-and-hold system and an 8-bit analog-to-digital converter. The aScope provides real-time processing and digitization for sweep speeds of 1 ms/div and slower. For sweep speeds of 10 ns/div to 500 μs/div, the inherent speed limitation of the A/D converter is overcome by employing a sampling method called *equivalent time digitization.*

The aScope provides both normal and automatic triggering. The trigger level is programmable in 10 mV steps from 5 mV/div to 200 mV/div, and 200-mV steps from 500 mV/div to 5 V/div. Both the slope (plus or minus) and source (channel 1 or 2) are programmable.

The rise time of the aScope is 40 μs or less in the real-time mode and 7 ns or less in the equivalent time digitizing mode. The vertical sensitivity ranges from 5 mV/div to 5 V/div, programmable in the standard 1-2-5 sequence.

The features that distinguish the aScope from conventional oscilloscopes are made possible by the Apple II. For example, a software-generated graticule can be displayed upon command. A movable cursor and an on-screen digital-voltmeter readout permits the amplitude of any selected point on a waveform to be accurately measured with or without a graticule.

Waveforms can be stored and later recalled for comparison with other waveforms. They can be printed on an Epson MX-80 printer with graphics option or an Apple Silentype.

Figure 2 is a screen photograph from an Apple II/aScope display showing a dual-trace rendition of a sine wave and a square wave. Note the convenient on-screen calibration information on the bottom left side of the photo. Also note the cursors near the center of each waveform. The information on the bottom right side of the screen provides the amplitude of each signal at the respective cursor locations.

Another screen photo of an Apple II/aScope combination is shown in Fig. 3. Here the graticule has been selected to permit two waveforms to be visually compared. The upper waveform (channel 1) is being displayed by means of equivalent time digitization (note the 10-ns/div sweep speed). The lower waveform is designated as the reference, apparently because it has been recalled from memory.

The aScope is an outstanding example of what can be achieved by combining a personal computer with a sophisticated semiconductor subsystem. The aScope also illustrates what can be accomplished by considering a personal computer as an advanced, programmable processing system for test equipment peripherals. Perhaps we will next see additional peripherals that convert computers into fully program-

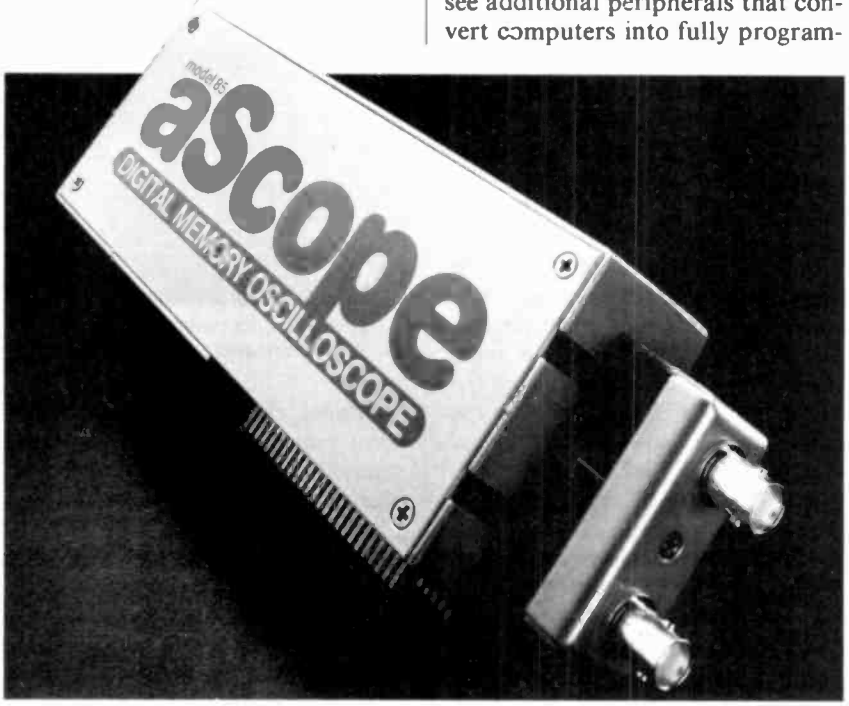


Fig. 1. The aScope converts an Apple II into a digital oscilloscope.

mable spectrum analyzers, automotive tune-up analyzers, digital multimeters, and even function generators.

The aScope is supplied with a user's manual (available separately) and all necessary software on a 5¼ inch diskette. It requires an Apple II with 48K RAM, a video display, Disk II drive, and DOS 3.3. For more information, write Northwest Instrument Systems, Inc. (PO Box 1309, Beaverton, OR 97075), or call 800-547-4445.

A 7-Bit Flash A/D Converter. In last month's discussion about flash A/D converters, Motorola's MC10315L/MC10317L 7-bit flash A/D converter was mentioned briefly. I have since received a data sheet for this new device.

The only difference between the MC10315L and MC10317L is the method of overranging. When the MC10315L is overranged, all output bits remain high and the overrange output goes high. When the MC10317L is overranged, all output bits go *low* and the overrange output goes high. This permits the MC10317L to be paired with an MC10315L to provide an 8-bit A/D flash converter.

The MC10315L/MC10317L employs a string of resistors that provides an ascending series of reference voltages to each of 128 latched comparators. The input signal is applied to a pin that is common to the inputs of all the comparators.

The comparator outputs are fed into a 128-to-7-bit encoder. The output from the encoder goes to a clocked output latch that stores between samples the digitized input signal. The maximum sampling frequency is 15 MHz. The device typically has a non-linearity of just ±0.16%.

The MC10315L/MC10317L is supplied in a 24-pin ceramic DIP. Though it's price may be too high for many experimenters, it is substantially cheaper than previous flash A/D converters. Its applications include digital oscilloscopes, fast A/D conversion for microcomputers operated in a "real time"

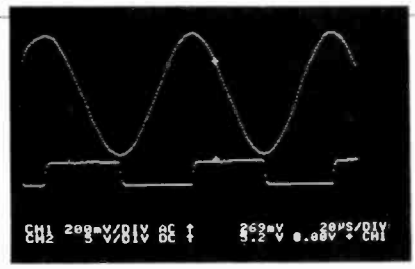


Fig. 2. Results of use of aScope in the digital voltmeter mode.

mode, high-speed instrumentation, video special effects and encoding, and radar signal processing. For more information, contact Motorola Semiconductor Products, Inc. (Box 20912, Phoenix, AZ 85036).

A Piezoelectric Cooling Fan. Piezo Electric Products, Inc. has formally introduced a family of miniature piezoelectric blowers. These remarkable new fans are designed to cool components such as power semiconductors. They incorporate a pair of piezoelectric benders formed by sandwiching a thin metal tab between a pair of piezoceramic layers. When powered directly by the ac line (115 volts at 60 Hz), each bender waves a rectangular Mylar "blade" back and forth. A molded plastic housing directs the resultant flow of air into a highly directional stream.

Since the piezoelectric benders are operated well within their elas-

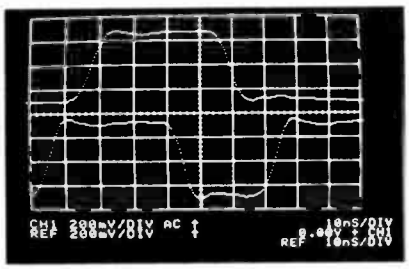


Fig. 3. The aScope/Apple II providing graticule and a pair of traces.

tic limits, the fans are expected to have much longer operating lives than the 10,000 hours of typical electromagnetic rotary fans. In fact, Piezo Electric Products has operated a piezoelectric bender for more than three years with no detectable degradation in performance.

Two of the new fans are now available. Module A is a miniature piezoelectric blower designed for printed-circuit board mounting. It weighs only 0.7 oz. and consumes 25 mW. Module B is a more powerful fan that consumes 150 mW and delivers an air flow of 300 ft./min. A module C fan that is more powerful than the other two is not yet available.

The Module A is $96 per dozen, while the Module B is $120 per dozen. For more information about these fans and other novel piezoelectric products, write Piezo Electric Products (212 Durham Ave., Metuchen, NJ 08840). You may also wish to refer to this column in the June 1982 POPULAR ELECTRONICS ("New Piezoelectric Products," p. 73).

A High Speed Z80. Zilog, Inc., the company that developed the Z80 microprocessor, has now introduced an 8-MHz version of this popular chip. Earlier versions of the Z80 operate at 2.5, 4.0, and 6.0 MHz.

Designated the Z80H, the new microprocessor is supported by Zilog's Z8500 family of peripheral circuits designed for more powerful 16-bit microprocessors. This increases system throughput of the Z80H by four to six times over comparable systems based on the 4-MHz Z80A. The Z8500 peripherals include the Z8530 Serial Communications Controller (SCC), the Z8531 Asynchronous Serial Communication Controller (ASCC), the Z8536 Counter/Timer and Parallel I/O Unit (CIO), the Z8538 Bus Control Interface Unit (F10), the Z8060 FIFO Expander, and the Z8516 Direct Memory Access Unit (DTC).

The Z80H is priced at $19.95 in 1,000-unit quantities. It is supplied in a 40-pin plastic DIP. For more information, write Zilog, Inc. (1315 Dell Avenue, Campbell, CA 95008).

New Liquid-Crystal Display Developments. Liquid-crystal displays continue to become more versatile and popular. Driving such displays formerly presented several circuit design difficulties, but now a range of driver ICs is available. The latest liquid-crystal display drivers is a family of three CMOS chips announced by National Semiconductor Corporation (2900 Semiconduc-

tor Dr., Santa Clara, CA 95051).

National's MM74C945 and MM74C947 are 4-digit up/down counters complete with latches and decoders. The MM74C946 is a 4½ digit counter. All three chips include the backplane oscillator/driver necessary to drive liquid-crystal displays. The internal oscillator/driver can be disabled by grounding the output pin. This permits an external oscillator to drive the display and therefore facilitates the cascading of multiple displays and counters.

Each of these new counter chips sells for $6.95 in 100-unit quantities. Considering the complexity of these counters, this price represents a real bargain. But if RCA has its way, National and every other maker of liquid crystal driver circuits will have to add a dollar to the price of their drivers and devices that use liquid-crystal display drivers. That's the royalty fee RCA has just set for the non-exclusive use of its 1972 patent "Circuits for Driving Loads such as Liquid Crystal Displays" (U.S. Patent 3,653,745).

Executives of many firms that make devices that use liquid-crystal displays were surprised to receive a certified letter from RCA offering a nonexclusive license for the use of its liquid-crystal driver patent in return for a one dollar royalty for *each* use. The term of the license will expire when the patent expires on April 4, 1989.

Considering the enormous number of digital watches, clocks, instruments, chips, displays, and other devices that use or incorporate liquid crystal drivers, the potential return to RCA is substantial. But companies making use of the patented technology are sure to resist paying royalties now that the patent holder has waited more than ten years to collect them.

As you might expect, RCA's action is attracting considerable attention in the electronics industry. However, at this stage, it's impossible to predict whether RCA or the affected companies will win what may become a major series of lawsuits. ◇

OPERATION ASSIST

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

Thomas Model 145L, Serial # 1853216 electronic organ. Need service manual. Eugene L. Evanoff, Box 33, Casa Grande, AZ 85222.

Amcomm Model S 225 two meter amateur transceiver. Need schematic and technical information. Bob Duckworth, 331 4th St., NE, Apt. 1, Atlanta, GA 30308.

MSI source 2102 data terminal and **Microswitch** keyboard # 54SW1. Need any information available. Harold Howard, Star Route, Box 87, Mineral Wells, TX 76067.

Seeburg Model 600 stereo console. Need any information available. John Clayton, 207 Elizabeth, Cleburne, TX 76031.

Princeton Applied Research Model CR-4 low noise amplifier, **Perkin Electronics** MTVR 040-1 power supply, **International Centronics, Inc.,** CPG 200-3 lochpulse generator and **Computer Measurements Co.,** 1144A counter. Need service manuals for all the items listed. Jim Powell, 300 Collier Blvd., Napa, CA 94558.

Hallicrafters Model TW-2000 receiver. Need name and address of parts supplier. C. Mansell, 10556-48 St., Edmonton, Alta, CAN.

RCA # 34392 meter. Need owner's manual. Gino M. Salvadori, 8313 Bardwell Ave., Van Nuys, CA 91402.

Microdot FM signal generator. Need service literature and schematic. Robert Haskett, 5657 Navy Road, Millington, TN 38053.

Knight Model KG854 amplifier. Need schematic or any additional information. Edward L. Metzger, 20 Elm Estates, Corbin, KY 40701.

Teleprinter Model GGC-15. Need schematic, manual and parts. Marcel Trottier, Oneida Acres, Williston, VT 05495.

Kirby Model 98 flyback transformer tester and **Solar** Model CE capacitor analyzer. Need operating manuals and schematics. Leland H. Bates, 39 Radcliff Rd., Springfield, IL 62703.

Lafayette Model SSB-140 CB radio. Need owner's manual and schematic. Gary Kawamote, 1141 W. 3rd St., Cleveland, OH 44113.

Magnavox Model T944 chassis B&W TV. Need part # 250526. **Zenith** transoceanic radio GA40 chassis. Need tubes 1U4 and 50A1. Henry Ludzus, 23 Monroe St., Oakville, CT 06779.

Remington Rand EDC III calculator. Need schematic diagram and instructions. Luis Piris, Box 1714, Christiansted, St. Croix, Virgin Islands 00820.

Jackson Model CRO-3 oscilloscope. Need schematic or any information available. Don Longacre, 16 North St., Caledonia, NY 14423.

Hallicrafters Model S-38B receiver. Need schematic, manual and trouble shooting information. Gary Howell, 571 W. Champion Ave., Warren, OH 44483.

Commercial Trades Institute Model VT-20 VTOM. Need schematic, manual and troubleshooting information. Al Clark, 4799-3 Locks Road, Chillicothe, OH 45601.

Heathkit Model HX-11 transmitter and **Hallicrafters** Model CB-7 transceiver. Need service manuals, technical operating instructions or any information available. Mr. Sam Sussman, 87 Cumberland Cr., London, Ontario N5X 1B7, CAN.

COMPUTER HOTLINE

The C & E Staff Answers Your Questions About Computers

COMMODORE RECORDING

Q: *How can I build a cable to use an ordinary cassette recorder with a VIC-20 in place of the VIC1530 Dataset? Where can I get information to connect an Epson MX-80 printer to a VIC-20 and software if necessary?—Larry Stempnik, Warren, MI.*

A: The Commodore VIC-20, like all other Commodore computers, uses digital recording rather than the audio recording used in other cassette-operated computer data storage systems. You cannot use an ordinary cassette recorder for this purpose. The VIC1530 Datasette is the least expensive digital recorder built, but it works very well. Buy it if you want to have full use of your VIC-20. It is a bargain!

APPLE MAINTENANCE

Q: *I have an Apple II Computer, which I selected because of its large number of accessories and modifications. I expected that Apple would be friendly to its customers who are interested in "do it yourself maintenance." Now I find that Apple will not sell me parts or service manuals! This is the first time that I have ever encountered this from a manufacturer. I have had problems with the disk drives and controller which so far I have been unable to repair without a service manual. I would be grateful for technical information from a second source.*
—Arthur Thompson, Hereford, AZ.

A: This is a problem that we will hear much more about as more computers become appliances rather than hobbyist devices.

Apple has one of the most exten-

sive maintenance programs of any manufacturer. Every dealer must have technicians trained in an Apple School. They provide very large and complete manuals and diagnostic software to their dealer service people. Their parts distribution is entirely through the dealers. Every dealer must maintain a full parts inventory. When a defective part is sent back to Apple, a replacement is sent to the dealer's service department to fill his parts kit.

This is the reason that they have no way to handle parts sales to individuals. They also do not want to have their repair parts end up in the hands of the "unauthorized" dealers. (Although I don't think they will admit this!) My advice to you is make friends with your local dealer and try to use his services to get parts and technical information.

PRINTER GLITCHING

Q: *I have a parallel printer that runs very well when it is located next to my computer. If I move the printer to the other side of the room, it prints incorrect characters. What is wrong with it?—Tony Davis, Rockaway, IL.*

A: There is probably nothing wrong with either your printer or your computer. The problem is likely caused by moving a parallel interface cable more than 10 ft. from the data source. When this happens, the cable picks up the ambient electrical noise in the room and induces noise on the lines. You only have to change one bit from a "zero" to a "one," for example, to change a character into something else or just "garbage."

As a rule, you can go from 0 to 10 ft. with a parallel interface cable (depending upon noise level at the location). You can go up to 50-ft with an RS232C serial interface. A 20 mA current loop serial interface extends this to a few hundred feet. For longer cable runs, you will need a "short haul" modem and a private line.

MORE ON TI 99/4A

Q: *Why aren't there more articles on the TI 99/4A Computer ? At its current low price, it is a very popular machine. What is the outlook for future software and peripherals for it?—George Reynolds, Virginia Beach, VA.*

A: Texas Instruments sent us a complete TI 99/4A Computer with an Expansion Box, Memory Module, and LOGO and Pascal modules. We want to do a complete review and test of this equipment, but we are missing two important parts of the system—the disk drive and controller in the Expansion Unit. They have promised to send us these components as soon as they can. We will then write a feature on this popular computer. We want to report on the new features since there is no point in considering the TI 99/4A as a cartridge operated "video computer." ◇

DX LISTENING

News of Stations and Programs Around the World

By Glenn Hauser

Alaska. The World Christian Broadcasting Corp. continues its project to build a shortwave station to reach the USSR from Anchor Point on the Kenai Peninsula. A target date of May 1983 is foreseen, providing WCBC can show that r-f from the transmitters will not endanger the environment.

Antarctica. LRA-36, operated by the Argentine army from Esperanza Base at the tip of Palmer Peninsula, has been widely heard in North America on 15474 kHz between 2200 and a variable closing between 0030 and 0100. The station, also known as *Radio Nacional Arcangel San Gabriel,* has been running IDs in several languages including English, and asking for reports.

Australia. *Radio Australia* has reached a nadir in its service, as more and more transmitters have had to be retired for lack of spare parts before new transmitters can go on line. However, the future looks bright, as *Radio Australia* is to be funded separately from its parent body, the ABC. In November, *Radio Australia* moved into its own studio complex in the Melbourne suburb of Burwood. Several BBC sites unexpectedly relayed *Radio Australia* briefly during the Commonwealth Games. The DX program *Spectrum,* with Dick Speekman, former host of Radio Nederland's *DX Jukebox,* has become a weekly feature, Sundays at 0612, 0810, 1612, 2112, and GMT Mondays at 0330.

Austria. *Austrian Radio* has installed some new antennas, resulting in much stronger signals into North America. A new high-power transmitter should also be in use.

Bolivia. Here are some program recommendations from a New Zealand listener, Barry Hartley; they can also be heard by early-rising North Americans. *Radio Panamericana,* La Paz on 6105 kHz, opens the day at 1030 GMT with "Bolivia en Antena," a combination musical travelogue and mailbag program which in effect is an external service. Another La Paz station, *Radio Illimani,* on 6025 and 4945 kHz, runs Altiplano music for peasants at 1000, followed at 1100 Sundays by another mailbag show, "El Club de la Amistad."

Brazil. We learn from Takayuki Inoue in Japan that the 17815-kHz transmitter of Radio Cultura, Sao Paulo, on the air at 0900-0500 GMT, is directional with an azimuth of 342°. This just happens to be right on New Bedford, Massachusetts, a major Portuguese—speaking area. It may be, however, that the 342° beam was actually chosen for general coverage of the Amazon.

Burma. Isao Ugusa, a Japanese DX listener who speaks Burmese and publishes *DX Front Line,* specializing in Southeast Asia, reports that the Karen National Union, a minority group based on race rather than politics, planned to reactivate its clandestine station *Voice of Kawthoolei.* It formerly operated on 4880 kHz at 1130-1330 GMT, extended to 1400 on Saturday and Sunday.

Canada. Radio Canada International has held preliminary talks with Swiss Radio International about the possibility of exchanging relay facilities in order to improve each other's coverage. A government commission has also called for RCI to immediately expand its target areas to improve Asia and the Pacific. However, to do this effectively, new transmitters in the Vancouver area would be needed to supplement those in New Brunswick.

(To be continued next month)

GEMINI–
FOR PRINTER VALUE THAT'S OUT OF THIS WORLD

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

The Gemini 10 has a 10″ carriage and the Gemini 15 a 15½″ carriage. Plus, the Gemini 15 has the added capability of a bottom paper feed. In both models, Gemini quality means a print speed of 100 cps, high-resolution bit image and block graphics, and extra fast forms feed.

Gemini's flexibility is embodied in its diverse specialized printing capabilities such as super/sub script, underlining, backspacing, double strike mode and emphasized print mode. Another extraordinary standard feature is a 2.3K buffer. An additional 4K is optional. That's twice the memory of leading, comparable printers. And Gemini is compatible with most software packages that support the leading printers.

Gemini reliability is more than just a promise. It's as concrete as a 180 day warranty (90 days for ribbon and print head), a mean time between failure rate of 5 million lines, a print head life of over 100 million characters, and a 100% duty cycle that allows the Gemini to print continuously. Plus, prompt, nationwide service is readily available.

So if you're looking for an incredibly high-quality, low-cost printer that's out of this world, look to the manufacturer with its feet on the ground—Star and the Gemini 10, Gemini 15 dot matrix printers.

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CIRCLE NO. 38 ONFREE INFORMATION CARE

Experimenting with VMOS Power Transistors

By Forrest M. Mims

ABOUT a year ago, in a "Solid-State Developments" column, I discussed the design, fabrication, and operating advantages of various kinds of VMOS field-effect transistors ("The New Power FETs," POPULAR ELECTRONICS, February 1982, p. 94). The key advantages of these VMOS devices include ultra-low "on" resistance, ultra-high input impedance, nanosecond switching time, high power capability, and both linear- and switching-mode operation. I also described practical circuits for a linear VMOS lamp dimmer, a pulse-modulated lamp dimmer, and a variable-rate lamp flasher.

This month, we'll examine in some detail the design and operation of a basic common-source VMOS amplifier. We'll also experiment with both unidirectional and bidirectional VMOS analog switches. Then we'll conclude with a brief look at a VMOS high-power variable resistor.

Where to Get Them. When I first wrote about VMOS power transistors, Radio Shack was the only major hobby dealer that carried the new devices. That still holds true today. They sell two Siliconix products, the VN20KM ($1.59) and the VN67AF ($2.49), both of which can be used in all the circuits that follow. Figure 1 gives the pin outlines for the transistors and lists some of their key specifications. (Additional information on the devices is available in the data sheets.)

SPECIFICATION	VN10KM	VN67AF
MAXIMUM DRAIN-SOURCE VOLTAGE	60 V	60 V
MAXIMUM DRAIN CURRENT	0.5 A	2.0 A
DRAIN-SOURCE ON RESISTANCE	5 Ω	3.5 Ω
TURN-ON DELAY TIME	2 ns	2 ns
RISE TIME	5 ns	2 ns

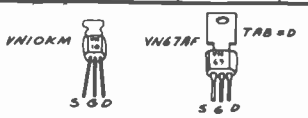

Fig. 1. VMOS pin outlines.

Although Radio Shack remains the only major hobby source of VMOS transistors, the devices are available through industrial distributors who represent VMOS manufacturers. In addition to Siliconix, major domestic manufacturers of VMOS transistors include International Rectifier, Intersil, and Motorola.

Operating Precautions. Though the drain-source channel of a VMOS transistor can safely handle very high currents and voltages, the gate connection retains the usual vulnerability of MOSFET devices to electrostatic discharge damage. To avoid this problem, handle VMOS FETs like any other MOS device, and make sure to store loose components in conductive foam. Some VMOS power FETs include a protective zener diode between the gate and the source. Although the diode protects the input from static electricity, it can also impair the performance of the device.

If you use VMOS power FETs in high-power applications, be sure to observe all appropriate temperature and power ratings. In some cases a heat sink may be necessary. See the manufacturer's specifications for detailed information.

A Basic VMOS Amplifier. Figure 2 shows a basic VMOS common-source amplifier. The amplifier is so named because *Q1*'s source is common to both the input and the output of the circuit. It is therefore the MOSFET counterpart to the bipolar transistor common-emitter amplifier.

In operation, *R1* and *R2* form a voltage divider that biases *Q1's* gate to a point where the drain-source voltage (V_{DS}) is half the supply voltage (V_{DD}). The required gate voltage (V_{GS}) can be measured with the help of a test circuit, or it can be found by referring to the family of curves that shows the output characteristics for individual power MOSFETs as a function of drain current (I_D) and V_{DS}.

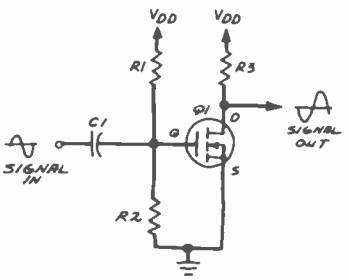

Fig. 2. Basic common-source amplifier.

Let's assume we wish to use the circuit in Fig. 2 as a tone amplifier that directly drives a small 8-ohm speaker. If V_{DD} is 9 V and if the speaker is rated at 2 W, then the maximum forward current (I_D) through *Q1* and the speaker is, from Ohm's law, the power divided by the voltage (2/9) or 222 mA.

Incidentally, knowing I_D and V_{DD}, we can apply Ohm's law to find the necessary resistance for *R3*. Discounting the channel resistance of the VMOS FET (typically 0.5 to 5 ohms when fully on) to provide a safety margin, it is V_{DD} divided by I_D (9/0.222) or 40.5 ohms.

Now that we know I_D and V_{DS}, we can refer to the manufacturer's output characteristics curves for *Q1* to find the required V_{GS}. For Siliconix's VN10KM, V_{GS} is typically about 3.5 V when I_D is 222 mA and V_{DS} is 4.5 V. (The output characteristics curves are printed in Siliconix's *VMOS Power FETs Design Catalog* and in the 1982 and 1983 editions of Radio Shack's *Semiconductor Reference Guide.)*

Knowing the V_{GS} required to bias *Q1* so that V_{DS} is one-half V_{DD} means that the values for *R1* and *R2* can now be selected. Since V_{GS} is 3.5

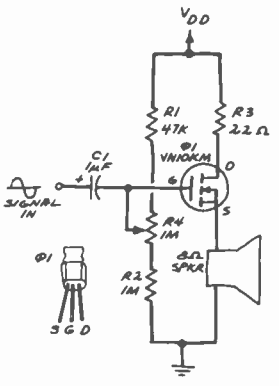

Fig. 3. VMOS audio amplifier.

V and V_{DD} is 9 V, V_{GS} is 0.39 V_{DD}. Therefore, the resistance of *R2* should be $0.39(R1 + R2)$. Assuming we wish to keep the circuit's input resistance high, a reasonable approximation using standard resistance values would be to use 750 kilohms for *R2* and 1.2 megohms for *R1*. This will provide a V_{GS} of 3.46 V.

We can calculate the voltage gain (A_v) of the basic amplifier by multiplying load resistor *R3* times *Q1's* transconductance (g_{fs}). The typical g_{fs} of Siliconix's VN10KM is 200 millimhos. Therefore, A_v is 40.5×0.2 or 8.1.

Though a voltage gain of 8.1 may seem very small, the amplifier's power gain can be *considerably* higher. For example, assume the input signal is a 1-V peak-to peak sine wave originating from a source having an output impedance of 10 kilohms. The equivalent input power (P_i) of this ac signal is found by dividing the square of the signal's rms voltage by the source's resistance. The rms value of the signal is 0.3535 times its peak-to-peak amplitude (or 0.707 times the peak amplitude). For the values given above, P_i is $(1 \times 0.3535)^2/10{,}000$ or 12.5 μW.

The output power (P_o) is found by dividing the square of the rms output voltage by the load resistance *(R3)*. Since the voltage gain (A_v) of the amplifier is 8.1, then the output voltage is 1×8.1 V peak-to-peak. Therefore, P_o is $(8.1 \times 0.3535)^2/40.5$ or 0.202 W. The power gain is P_o/P_i or 16,195.

Incidentally, since the speaker in Fig. 3 is directly coupled to the VMOS transistor, it receives a dc bias even with no input signal. The resultant displacement of the speaker's cone will cause distortion of high-level audio signals. This distortion can be eliminated by inserting a transformer between the circuit and the speaker at *R3*. It may then be necessary to recalculate the circuit parameters.

For more information about predicting the performance of a common-source power MOSFET amplifier, see *Design of VMOS Circuits* by Robert Stone and Howard Berlin (Howard Sams & Co., 1980). This excellent book provides detailed step-by-step design procedures in chapter 4. It also contains a wealth of information about various VMOS circuits. Incidentally, the examples given on pp. 39-40 of this book multiply peak-to-peak signal values by 0.707 instead of 0.3535. While this gives incorrect values for P_i and P_o, it does not affect the example calculation of power gain.

A Real VMOS Amplifier. If you enjoy working with numbers, the preceding discussion probably makes the design of a common-source MOSFET amplifier seem relatively straightforward. But for those of us who also enjoy experimenting with real circuits, the mathematical approach has a serious drawback since the predictions are based on "typical" values of transconductance (g_{fs}) and gate voltage (V_{GS}).

Since the voltage gain (A_v) of the amplifier is the product of the load resistance *(R3)* and g_{fs} ($g_{fs} = A_v/R3$). A_v can be found by measuring the voltage at the input and output and dividing the latter by the former. Now g_{fs} can be easily determined for individual MOSFETs under specific operating conditions. (Incidentally, g_{fs} is sometimes designated g_m.)

V_{GS} can be found by injecting a sine wave into the amplifier while watching the waveforms at the input and output of the amplifier on a dual-trace scope. The voltage divider network (*R1* and *R2*) should be trimmed until the output waveform is a maximum-amplitude, undistorted version of the input waveform.

Figure 3 shows a practical version of the amplifier that works quite well. Note the addition of *R4* to permit quick adjustment of V_{GS}. The data sheet specifies for the VN10KM used in the circuit minimum and typical values of g_{fs} (or g_m) of, respectively, 100 and 200 millimhos. The *typical* value gives a predicted A_v of 4.4 ($A_v = R3g_{fs}$).

I measured an A_v of only 3.0 when the speaker was shorted to leave a load resistance of 22 ohms. This corresponds to a g_{fs} of 140 millimhos. As you can see, using the "typical" data sheet value can be misleading.

Applications for the VMOS Amplifier. The simple circuit in Fig. 3 is well suited for use as a high input impedance small speaker driver. The input impedance can be increased by increasing *R1* and *R2* in the proper proportion to permit *R4* to determine V_{GS}.

In audio applications a scope is not always necessary to adjust *R4*. Simply feed a tone or a voice signal into the input and listen to the speaker while adjusting *R4* for maximum undistorted volume.

The circuit in Fig. 3 also makes an excellent LED driver for an amplitude-modulated lightwave communications transmitter. Simply replace the speaker with a LED and increase *R3*'s resistance to limit the current through the LED to a safe value. For maximum optical power output, select an AlGaAs or GaAs:Si LED.

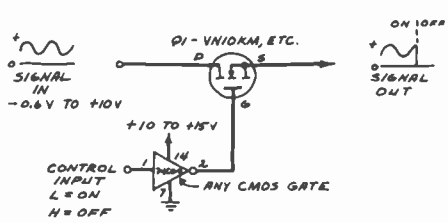

Fig. 4. Basic unidirectional analog switch.

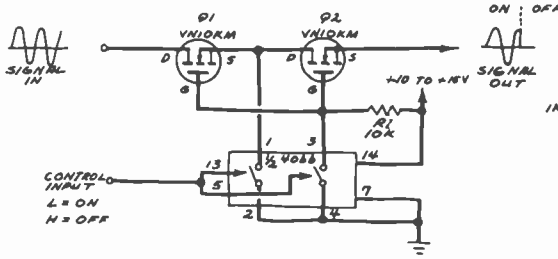

Fig. 5. Simple analog switch.

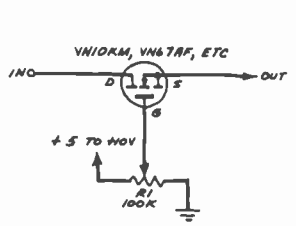

Fig. 6. High-current pot.

To operate the circuit as a LED audio transmitter, connect a signal source or microphone preamplifier to the input. Then adjust *R4* for best reception while monitoring the transmitted signal with a lightwave receiver.

The circuit in Fig. 3 works very well at high frequencies. With the values shown and with the speaker removed, the frequency response is virtually flat to beyond a megahertz, the limit of my Heath function generator. When *R4* is properly adjusted, the circuit faithfully reproduces 1-MHz sine and triangle waves. When a fast risetime (50-ns) 1-MHz square wave is fed into the amplifier, the output experiences a delay of only 5 ns. The ringing that occurs at the leading and trailing edges of the output signal can be minimized by careful adjustment of R_{GS} and, at very high frequencies, careful, point-to-point wiring.

A VMOS Unidirectional Gate. A VMOS FET can easily be used as a one-way gate for a positive-polarity, variable-amplitude analog signal. Figure 4 shows how such a gate can be turned on or off by a CMOS gate. Any gate signal having sufficient amplitude to turn *Q1* on can be used.

Since a VMOS FET can handle currents in excess of an ampere, the basic circuit in Fig. 4 is ideal for many different applications. It may not be well suited, however, for low distortion audio applications. Furthermore, if a waveform having both positive and negative components is applied to the gate in Fig. 4, as much as half the signal will pass through the gate even when it is off.

A VMOS Bidirectional Analog Gate. Siliconix's Application Note AN72-2 (Walt Heinzer, "VMOS—A Solution to High Speed, High Current, Low Resistance Analog Switches") describes a bidirectional VMOS gate made from two VN88AF VMOS FETs and a DG300 dual analog switch. Figure 5 shows a modified version of the Siliconix circuit that I assembled with two VN10KM's and a CMOS 4066 analog gate. This circuit transmits ac analog signals at frequencies up to and exceeding a megahertz.

The circuit in Fig. 5 provides excellent input-output isolation in the off state when the output load is a low resistance (a few hundred ohms). When the output load is 10 kilohms, about 4% (−30 dB) of the input signal appears at the output when the gate is off.

A VMOS Variable Resistor. The drain-source channel of a VMOS transistor can be considered a variable resistor when the drain-source voltage is about 3 V. According to *Design of VMOS Circuits,* the book cited earlier, in this mode a VMOS FET "...exhibits a fairly linear inverse relationship between drain-source resistance and gate-source voltage. For the 2N6656, for example, its gate-source resistance can vary from about 2 ohms (V_{GS} = 10 V) to essentially infinity."

Figure 6 shows how a VMOS power transistor can be used as a variable resistor having a much higher power rating than some miniature trimmer resistors. This circuit suggests many interesting applications, particularly since *R1* can be replaced by temperature- or light-sensitive resistors. ◊

A Digitally Programmable VMOS Variable Resistor

By Forrest M. Mims

MICROPROCESSORS and computers can be readily interfaced to power switching devices like SCRs, triacs and VMOS FETs. But of all these on/off switching devices, the VMOS FET is the only one that can also be used in a variable resistor mode. This is done by varying the voltage (V_{GS}) at the gate of the transistor, which in turn controls, in a nearly linear fashion, the resistance of the transistor's drain-source channel.

A digital-to-analog converter provides a convenient means for allowing a computer to generate a variable voltage. Figure 1 shows a very simple, low-cost, 4-bit D/A converter that applies (under digital control) a variable voltage to the gate of a VMOS FET.

The D/A converter is made from an R-2R resistor ladder network and two op amps. Of course, a single-chip D/A converter such as the DAC801 can be used to provide higher resolution (8 bits or 256 voltage levels) as well as better accuracy.

How It Works. The D/A conversion is accomplished by the resistor ladder network. When all inputs are low, the network output is 0 V. When all inputs are high, the output is nearly +V. Intermediate binary inputs provide directly proportional output voltages.

The first 471 op amp buffers, inverts, and gives dual polarity to the output from the ladder network. The second 741 provides a means of adjusting the baseline of the output voltage (above, below, or at ground). This is achieved by adjusting *R11*, which permits the output voltage applied to the gate of *Q1* to be set to any point.

Testing the Circuit. Interfacing the circuit in Fig. 1 to the computer's data bus is best accomplished by interposing buffers between the data bus and the D/A converter.

If you want to test the circuit *without* a computer, the nibble generator circuit in Fig. 2 provides a convenient source of a stepped, automatically recycled binary count (0000 to 1111 and repeat). The count is controlled by *R1*. Capacitor *C1* can be increased to a few tens of microfarads for much slower count rates.

When the circuit in Fig. 1 is connected to a data bus or nibble generator that provides a repetitive series of ascending binary counts, you can test *Q1*'s operation. Just connect a small lamp (with a rating equal to the power supply) at R_L. When *R11* is properly adjusted, the lamp will respond to an ascending count by gradually brightening. It will then suddenly turn off and again begin to brighten as the cycle repeats.

Be sure to connect a voltmeter to pin 6 of the second 741 while performing the lamp test. You can then monitor V_{GS} while adjusting *R11*. For best results, slow the count rate when you are making voltage readings.

Going Further. This circuit has many interesting applications. For example, *Q1* can be used as the frequency control resistor for a 555 tone generator circuit. Use the basic 555 clock circuit in Fig. 2, but omit *R1* and connect *Q1*'s drain to +V. Connect its source through a 50-kilohm trimmer resistor to pin 7 of the 555. Reduce *C1*'s value to 0.01 μF. Connect a small speaker through a 200-ohm resistor from pin 3 of the 555 to +V. Adjusting *R11*, the tone generator trimmer, and *R1* of the clock will provide a repetitive series of stepped frequency tones.

For more information about using VMOS FETs as variable resistors, see this month's "Experimenter's Corner." Also, refer to application notes published by the various VMOS FET manufacturers. ◇

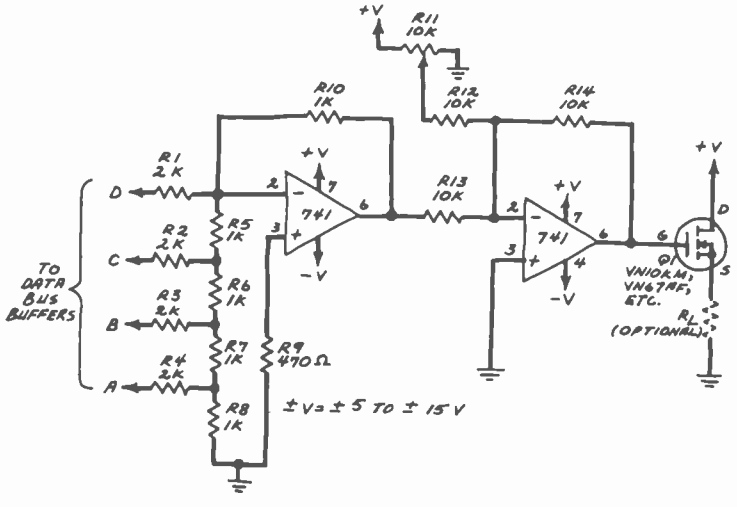

Fig. 1. Digitally programmable VMOS variable resistor.

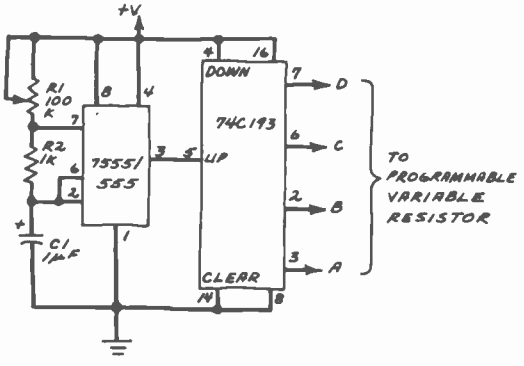

Fig. 2. Nibble generator for testing programmable variable resistor.

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22	JDR Microdevices	116,117
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37	Magtek Media	96
	Memotech	23
63	Morrow Designs	32-33
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17,27	New Horizons	25,78
	NRI Schools	26-29
40,47	Protecto Enterprises	37,108
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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.

74LS00

74LS00	.24	74LS86	.39	74LS169	1.75	74LS323	3.50
74LS01	.25	74LS90	.55	74LS170	1.49	74LS324	1.75
74LS02	.25	74LS91	.89	74LS173	.69	74LS352	1.29
74LS03	.25	74LS92	.55	74LS174	.55	74LS353	1.29
74LS04	.24	74LS93	.55	74LS175	.55	74LS363	1.35
74LS05	.25	74LS95	.75	74LS181	2.15	74LS364	1.95
74LS08	.28	74LS96	.89	74LS189	8.95	74LS365	.49
74LS09	.29	74LS107	.39	74LS190	.89	74LS366	.49
74LS10	.25	74LS109	.39	74LS191	.89	74LS367	.45
74LS11	.35	74LS112	.39	74LS192	.79	74LS368	.45
74LS12	.35	74LS113	.39	74LS193	.79	74LS373	.99
74LS13	.45	74LS114	.39	74LS194	.69	74LS374	.99
74LS14	.59	74LS122	.45	74LS195	.69	74LS377	1.39
74LS15	.35	74LS123	.79	74LS196	.79	74LS378	1.18
74LS20	.25	74LS124	2.90	74LS197	.79	74LS379	1.35
74LS21	.29	74LS125	.49	74LS221	.89	74LS385	1.90
74LS22	.25	74LS126	.49	74LS240	.95	74LS386	.45
74LS26	.29	74LS132	.59	74LS241	.99	74LS390	1.19
74LS27	.29	74LS133	.59	74LS242	.99	74LS393	1.19
74LS28	.35	74LS136	.39	74LS243	.99	74LS395	1.19
74LS30	.25	74LS137	.99	74LS244	.99	74LS399	1.49
74LS32	.29	74LS138	.55	74LS245	1.49	74LS424	2.95
74LS33	.55	74LS139	.55	74LS247	.75	74LS447	.37
74LS37	.35	74LS145	1.20	74LS248	.99	74LS490	1.95
74LS38	.35	74LS147	2.49	74LS249	.99	74LS624	3.99
74LS40	.25	74LS148	1.35	74LS251	.59	74LS668	1.69
74LS42	.49	74LS151	.55	74LS253	.59	74LS669	1.89
74LS47	.75	74LS153	.55	74LS257	.59	74LS670	1.49
74LS48	.75	74LS154	1.90	74LS258	.59	74LS674	9.65
74LS49	.75	74LS155	.69	74LS259	2.75	74LS682	3.20
74LS51	.25	74LS156	.69	74LS260	.59	74LS683	3.20
74LS54	.29	74LS157	.65	74LS266	.55	74LS684	3.20
74LS55	.29	74LS158	.59	74LS273	1.49	74LS685	3.20
74LS63	1.25	74LS160	.69	74LS275	3.35	74LS688	2.40
74LS73	.39	74LS161	.65	74LS279	.49	74LS689	3.20
74LS74	.35	74LS162	.69	74LS280	1.98	74LS783	24.95
74LS75	.39	74LS163	.65	74LS283	.69	81LS95	1.49
74LS76	.39	74LS164	.69	74LS290	.89	81LS96	1.49
74LS78	.49	74LS165	.95	74LS293	.89	81LS97	1.49
74LS83	.60	74LS166	1.95	74LS295	.99	81LS98	1.49
74LS85	.69	74LS168	1.75	74LS298	.89	25LS2521	2.80
				74LS299	1.75	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
64 pin ST	4.25	call
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
28 pin ZIF	10.95	call

ZIF = TEXTOOL
(Zero Insertion Force)

CONNECTORS

RS232 MALE	2.95
RS232 FEMALE	3.50
RS232 FEMALE RIGHT ANGLE	5.25
RS232 HOOD	1.25
S-100 ST	3.95
S-100 WW	4.95

DIP SWITCHES

4 POSITION	.85
5 POSITION	.90
6 POSITION	.90
7 POSITION	.95
8 POSITION	.95

7400

7400	.19	74132	.45
7401	.19	74136	.50
7402	.19	74141	.65
7403	.19	74142	2.95
7404	.19	74143	2.95
7405	.25	74145	.60
7406	.29	74147	1.75
7407	.29	74148	1.20
7408	.24	74150	1.35
7409	.19	74151	.55
7410	.19	74152	.65
7411	.25	74153	.55
7412	.20	74154	1.25
7413	.25	74155	.75
7414	.49	74156	.65
7416	.25	74157	.55
7417	.25	74159	1.65
7420	.19	74160	.85
7421	.35	74161	.89
7422	.35	74162	.85
7423	.29	74163	.89
7425	.29	74164	.85
7426	.29	74165	.85
7427	.29	74166	1.00
7428	.45	74167	2.95
7430	.19	74170	1.65
7432	.29	74172	5.95
7433	.45	74173	.75
7437	.29	74174	.89
7438	.29	74175	.89
7440	.19	74176	.89
7442	.49	74177	.75
7443	.65	74178	1.15
7444	.69	74179	1.75
7445	.69	74180	.75
7446	.69	74181	2.25
7447	.69	74182	.75
7448	.69	74184	2.00
7450	.19	74185	2.00
7451	.23	74186	16.50
7453	.23	74190	1.15
7454	.23	74191	1.15
7460	.23	74192	.79
7470	.35	74193	.79
7472	.29	74194	.85
7473	.34	74195	.85
7474	.33	74196	.79
7475	.45	74197	.75
7476	.35	74198	1.35
7480	.59	74199	1.35
7481	1.10	74221	1.35
7482	.95	74246	1.35
7483	.50	74247	1.25
7485	.59	74248	1.85
7486	.35	74249	1.95
7489	2.15	74251	.75
7490	.35	74259	2.25
7491	.40	74265	1.35
7492	.50	74273	1.95
7493	.35	74276	1.25
7494	.65	74279	.75
7495	.55	74283	2.00
7496	.70	74284	3.75
7497	2.75	74285	3.75
74100	1.75	74290	.95
74107	.30	74293	.75
74109	.45	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	.49	74390	1.75
74125	.45	74393	1.35
74126	.45	74425	3.15
74128	.55	74426	.85
		74490	2.55

CMOS

4000	.29	4527	1.95
4001	.25	4528	1.19
4002	.25	4531	.95
4006	.89	4532	1.95
4007	.29	4538	1.95
4008	.95	4539	1.95
4009	.39	4541	2.64
4010	.45	4543	1.19
4011	.25	4553	5.79
4012	.25	4555	.95
4013	.38	4556	.95
4014	.79	4581	1.95
4015	.39	4582	1.95
4016	.39	4584	.75
4017	.69	4585	.75
4018	.79	4702	12.95
4019	.39	74C00	.35
4020	.75	74C02	.35
4021	.79	74C04	.35
4022	.79	74C08	.35
4023	.29	74C10	.35
4024	.65	74C14	.59
4025	.29	74C20	.35
4026	1.65	74C30	.35
4027	.45	74C32	.39
4028	.69	74C42	1.29
4029	.79	74C48	1.99
4030	.39	74C73	.65
4034	1.95	74C74	.65
4035	.85	74C76	.80
4040	.75	74C83	1.95
4041	.75	74C85	1.95
4042	.69	74C86	.39
4043	.85	74C89	4.50
4044	.79	74C90	1.19
4046	.85	74C93	1.75
4047	.95	74C95	.99
4049	.35	74C107	.89
4050	.35	74C150	5.75
4051	.79	74C151	2.25
4053	.79	74C154	3.25
4060	.89	74C157	1.75
4066	.39	74C160	1.19
4068	.39	74C161	1.19
4069	.29	74C162	1.19
4070	.35	74C163	1.19
4071	.29	74C164	1.39
4072	.29	74C165	2.00
4073	.29	74C173	.79
4075	.29	74C174	1.19
4076	.79	74C175	1.19
4078	.29	74C192	1.49
4081	.29	74C193	1.49
4082	.29	74C195	1.39
4085	.95	74C200	5.75
4086	.95	74C221	1.75
4093	.49	74C373	2.45
4098	2.49	74C374	2.45
4099	1.95	74C901	.39
14409	12.95	74C902	.85
14410	12.95	74C903	.85
14411	11.95	74C905	10.95
14412	12.95	74C906	.95
14419	7.95	74C907	1.00
14433	4.18	74C908	2.00
4502	.95	74C909	2.75
4503	.65	74C910	9.95
4508	1.95	74C911	8.95
4510	.85	74C912	8.95
4511	.85	74C914	1.95
4512	.85	74C915	1.19
4514	1.25	74C918	2.75
4515	1.79	74C920	17.95
4516	1.55	74C921	15.95
4518	.89	74C922	4.49
4519	.39	74C923	4.95
4520	.79	74C925	5.95
4522	1.25	74C926	7.95
4526	1.25	74C928	7.95
		74C929	19.95

Prices Slashed! 74S00

74S00	.32	74S163	1.95
74S02	.35	74S168	3.95
74S03	.35	74S169	3.95
74S04	.35	74S174	.95
74S05	.35	74S175	.95
74S08	.35	74S181	3.95
74S09	.40	74S182	2.95
74S10	.35	74S188	1.95
74S11	.35	74S189	6.95
74S15	.35	74S194	1.49
74S20	.35	74S195	1.49
74S22	.35	74S196	1.49
74S30	.35	74S197	1.49
74S32	.40	74S201	6.95
74S37	.88	74S225	7.95
74S38	.85	74S240	2.20
74S40	.35	74S241	2.20
74S51	.35	74S244	2.20
74S64	.40	74S251	.95
74S65	.40	74S253	.95
74S74	.50	74S257	.95
74S85	1.99	74S258	.95
74S86	.50	74S260	.79
74S112	.50	74S274	19.95
74S113	.50	74S275	19.95
74S114	.55	74S280	1.95
74S124	2.75	74S287	1.90
74S132	1.24	74S288	1.90
74S133	.45	74S289	6.89
74S134	.50	74S301	6.95
74S135	.89	74S373	2.45
74S138	.85	74S374	2.45
74S139	.85	74S381	7.95
74S140	.55	74S387	1.95
74S151	.95	74S412	2.98
74S153	.95	74S471	4.95
74S157	.95	74S472	4.95
74S158	.95	74S474	4.95
74S161	1.95	74S482	15.25
74S162	1.95	74S570	2.95
		74S571	2.95

VISA MasterCard

ORDER TOLL FREE
800-538-5000
800-662-6279
(CALIFORNIA RESIDENTS)

LINEAR

LM301	.34	LM381	1.60	LM1310	1.49
LM301H	.79	LM382	1.60	MC1330	1.69
LM307	.45	LM383	1.95	MC1349	1.89
LM308	.69	LM384	1.95	MC1350	1.19
LM308H	1.15	LM386	.89	MC1358	1.69
LM309H	1.95	LM387	1.40	LM1414	1.59
LM309K	1.25	LM389	1.35	LM1458	.59
LM310	1.75	LM390	1.95	LM1488	.69
LM311	.64	LM392	.69	LM1489	.69
LM311H	.89	LM394H	4.60	LM1496	.85
LM312H	1.75	LM399H	5.00	LM1558H	3.10
LM317K	3.95	NE531	2.95	LM1800	2.37
LM317T	1.19	NE536	6.00	LM1812	8.25
LM318	1.49	NE555	.34	LM1815	5.20
LM318H	1.59	NE556	.65	LM1818	2.90
LM319H	1.25	NE558	1.50	LM1820	3.50
LM319	1.25	NE561	19.95	LM1830	3.50
LM320	(see 7900)	NE562	6.00	LM1871	5.49
LM322	1.65	NE564	2.95	LM1872	5.49
LM323K	4.95	LM565	.99	LM1877	3.25
LM324	.59	LM566	1.49	LM1889	1.95
LM329	.65	LM567	.89	LM1896	1.75
LM331	3.95	NE570	3.95	LM2877	2.05
LM334	1.19	NE571	2.95	LM2878	2.25
LM335	1.40	NE592	2.75	LM2900	.85
LM336	1.75	LM703	.89	LM2901	1.00
LM337K	3.95	LM709	.59	LM3900	.59
LM337T	1.95	LM710	.75	LM3905	1.25
LM338K	6.95	LM711	.79	LM3909	.98
LM339	.99	LM723	.49	LM3911	2.25
LM340	(see 7800)	LM723H	.55	LM3914	3.95
LM348	.99	LM733	.98	LM3915	3.95
LM350K	4.95	LM741N-8	.35	LM3916	3.95
LM350T	4.60	LM741N-14	.35	MC4024	3.95
LM358	.69	LM741H	.40	MC4044	4.50
LM359	1.79	LM747	.69	RC4136	1.25
LM376	3.75	LM748	.59	RC4151	3.95
LM377	1.95	LM1014	1.19	LM4250	1.75
LM378	2.50	LM1303	1.95	LM4500	3.25
LM379	4.50	LM1304	1.19	LM13080	1.29
LM380	.89	LM1305	1.49	LM13600	1.49
LM380N-8	1.10	LM1307	.85	LM13700	1.49

H = TO-5 CAN T = TO-220 K = TO-3

VOLTAGE REGULATORS

7805T	.89	78L05	.69	7905K	1.49
7808T	.89	78L12	.69	7912K	1.49
7812T	.89	78L15	.69	7915K	1.49
7815T	.89			7924K	1.49
7824T	.89	78H05K	9.95		
		78H12K	9.95	79L05	.79
7805K	1.39			79L12	.79
7812K	1.39	7905T	.99	79L15	.79
7815K	1.39	7908T	.99		
7824K	1.39	7912T	.99	LM323K	4.95
		7915T	.99	UA78S40	1.95
		7924T	.99		

T = TO-220 K = TO-3 L = TO-92

LED DISPLAYS

HP 5082-7760	.6"	CC	1.29
MAN 72	.3"	CA	.99
MAN 74	.3"	CC	.99
FND-357 (359)	.375"	CC	.75
FND-500 (503)	.5"	CC	.99
FND-507 (510)	.5"	CA	.99

LED LAMPS

	1-99	100-up
Jumbo Red	.10	.09
Jumbo Green	.18	.15
Jumbo Yellow	.18	.15

TRANSISTORS DIODES

PN2222	NPN SWITCH	TO-92	10/1.00	100/8.99
PN2907	PNP SWITCH	TO-92	10/1.25	100/10.99
2N2222	NPN SWITCH	TO-18	.25	50/10.99
2N2907	PNP SWITCH	TO-18	.25	50/10.99
2N3055	NPN POWER	TO-3	.79	10/6.99
3055T	NPN POWER	TO-220	.69	10/5.99
2N3904	NPN SWITCH	TO-92	10/1.00	100/8.99
2N3906	NPN SWITCH	TO-92	10/1.00	100/8.99
IN4148 (IN914)	RECTIFIER		25/1.00	1000/35.00
IN4004	SWITCHING		10/1.00	100/8.99

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	16	.59
SN74157N	**16**	**.59**
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	.89
SN74177N	14	.69
SN74179N	16	1.49
SN74180N	14	.69
SN74181N	24	1.95
SN74182N	16	.89
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	.89
SN74197N	14	.89
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

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	.65
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*

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

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
CA3080E	8	.89
CA3081N	16	1.49
CA3082N	16	1.49
CA3083N	16	1.49
CA3086N	14	.69
CA3089N	16	1.69
CA3096N	16	1.19
CA3130E	8	1.49
CA3140E	8	.99
CA3160H		1.95
CA3401N	14	.59
CA3600N	14	3.95

CD—CMOS

CD4000	14	.29
CD4001	**14**	**.29**
CD4002	14	.29
CD4006	14	.89
CD4007	14	.29
CD4008	**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	.59
CD4723	16	1.19
CD4724	16	1.19
MC14409	16	13.95
MC14410	16	13.95
MC14411	24	11.95
MC14412	16	13.95
MC14419	16	7.95
MC14433	24	13.95
MC14538	16	1.19
MC14541	14	1.19

(More in Catalog)

MICROPROCESSOR COMPONENTS

MICROPROCESSOR CHIPS

Part No.	**Pins	Function	Price
CDP1802	40	CPU	$9.95
2650	40	MPU	14.95
IDM2901ADC	40	CPU—4 bit slice (Com. Temp. Gr.)	19.95
MCS6502	40	MPU w/Clock (65K bytes mem.)	9.95
MC6802CP	40	MPU w/Clock and RAM	7.95
INS8035N-6	40	MPU—8-bit (6MHz)	5.95
INS8039N-6	40	CPU-Sgl. chip 8-bit (128 bts. Ram)	5.95
INS8040N-6	40	CPU (256 bytes RAM)	5.95
INS8070N	40	CPU (64 bytes RAM)	11.95
INS8073N	40	CPU w/Basic Micro Interpreter	14.95
P8085A	40	CPU	5.95

Z80, Z80A, Z80B, Z8000 SERIES

Z80	40	CPU (MK3880N)(780C) 2MHz	$4.95
Z80-CTC	28	Counter Timer Circuit	5.95
Z80-DART	40	Dual Asynchronous Rec./Trans.	11.95
Z80-DMA	40	Direct Memory Access Circuit	15.95
Z80-PIO	40	Parallel I/O Interface Controller	5.95
Z80-SIO/0	40	Serial I/O (TxCB and RxCB Bonded)	15.95
Z80-SIO/1	40	Serial I/O (Lacks DTRB)	15.95
Z80-SIO/2	40	Serial I/O (Lacks SYNCB)	15.95
Z80-SIO/9	40	Serial I/O	15.95
Z80A	40	CPU (MK3880N-4)(780C-1) 4MHz	5.95
Z80A-CTC	28	Counter Timer Circuit	5.95
Z80A-DART	40	Dual Asynchronous Rec./Trans.	11.95
Z80A-DMA	40	Direct Memory Access Circuit	17.95
Z80A-PIO	40	Parallel I/O Interface Controller	5.95
Z80A-SIO/0	40	Serial I/O (TxCB and RxCB bonded)	16.95
Z80A-SIO/1	40	Serial I/O (Lacks DTRB)	16.95
Z80A-SIO/2	40	Serial I/O (Lacks SYNCB)	16.95
Z80A-SIO/9	40	Serial I/O	16.95
Z80B	40	CPU (MK3880N-6) 6MHz	11.95
Z80B-CTC	28	Counter Timer Circuit	13.95
Z80B-PIO	40	Parallel I/O Interface Controller	13.95
Z8001	48	CPU Segmented	51.95
Z8002	40	CPU Non-Segmented	55.95
Z8030	40	Serial Comm. Controller	44.95
Z8036	40	Counter/Timer & Parallel I/O Unit	29.95

6800/68000 SERIES

MC6800	40	MPU	4.95
MC6802CP	40	MPU with clock and RAM	7.95
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
MC68000L8	64	MPU 16-Bit (8MHz)	69.95
MC68488P	40	General Purpose Int. Adapter	8.95
MC68652P2	40	Multi. Protocol Comm. Controller	24.95
MC68661PB	28	Enhanced Prog. Comm. Int.	8.95

8080A SERIES

INS8080A	40	CPU	3.95
TMS5501	40	Synchronous Data Interface (SIRC)	14.95
INS8154	40	128 Byte RAM 16-Bit I/O	13.95
INS82C06	20	Octal D Flip Flop Tri-State (74C374)	2.49
DP8212	24	8-bit Input/Output (74S412)	2.25
DP8214	24	Priority Interrupt Control	3.95
DP8216	16	Bi-Directional Bus Driver	2.25
DP8224	16	Clock Generator/Driver	2.25
DP8226	16	Bus Driver	2.25
DP8228	28	System Cont./Bus Driver (74S428)	3.49
DP8238	28	System Controller (74S438)	4.49
INS8243	24	I/O Expander for 48 Series	5.95
INS8245	18	16-Key Keyboard Encoder (74C922)	4.49
INS8246	20	20-Key Keyboard Encoder (74C923)	4.95
INS8247	28	Display Controller (74C911)	8.95
INS8248	28	Display Controller (74C912)	8.95
INS8250N	40	Asyn. Comm. Element (INS8250)	10.95
DP8251	28	Prog. Comm. I/O (USART)	4.49
DP8253	24	Prog. Interval Timer	6.95
DP8255	40	Prog. Peripheral I/O (PPI)	4.49
DP8257	40	Prog. DMA Control	7.95
DP8259	28	Prog. Interrupt Control	6.95
DP8275	40	Prog. CRT Controller	29.95
DP8279	40	Prog. Keyboard/Display Interface	6.95
DP8303	20	8-Bit Tri-State Bi-Directional Trans.	3.95
DP8304	20	8-bit Bi-Directional Receiver	2.49
DP8307	20	8-bit Bi-Directional Receiver	2.49
DP8308	20	8-bit Bi-Directional Receiver	2.49
DP8310	20	Octal Latched Peripheral Driver	4.95
DP8311	20	Octal Latched Peripheral Driver	4.95

MICROPROCESSOR MANUALS & DATA BOOKS

M-Z80	User Manual	7.50
M-CDP1802	User Manual	7.50
M-2650	User Manual	5.00
10400	1982 Intel Data Book (1405 pg.)	14.95
30001	1981 Nat. CMOS Book (628 pg.)	6.95
30002	1980 Nat. Interface Book (640 pg.)	6.95
30003	1982 Nat. Linear Book (1952 pg.)	11.95
30005	1981 Nat. TTL Book (624 pg.)	9.95
30008	1980 Nat. Memory Data Book (464 pg.)	6.95
30011	1980 Nat. Linear Applications (736 pg.)	15.95
30013	1983 Zilog Data Book (641 pg.)	7.95
205610	1981 Intel Peripheral Design (828 pg.)	9.95

DYNAMIC RAMS

Part No.	**Pins			Price
1103	18	1024x1	(300ns)	.99
4027	**16**	**4096x1**	**(250ns)**	**2.49**
4116N-2	16	16,384x1	(150ns)	1.89 - 8/14.95
4116N-3	16	16,384x1	(200ns)	1.69 - 8/12.95
4116N-4	16	16,384x1	(250ns)	1.49 - 8/10.95
4164N-150	16	65,536x1	(150ns)	7.95 - 8/59.95
4164N-200	16	65,536x1	(200ns)	7.49 - 8/54.95
MM5261	18	1024x1	(300ns)	.49 - 8/1.95
MM5262	**22**	**2048x1**	**(365ns)**	**.49 — 8/1.95**
MM5270	18	4096x1	(250ns) MK4096	4.95
MM5280	22	4096x1	(200ns) 2107	3.95
MM5290-2	16	16,384x1	(150ns)	1.89 - 8/14.95
MM5290-3	16	16,384x1	(200ns)	1.69 - 8/12.95
MM5290-4	16	16,384x1	(250ns)	1.49 - 8/10.95
MM5298-3	16	8192x1	(200ns)	1.69

STATIC RAMS

1101	16	256x1	(650ns)	1.49
2101	22	256x4	(450ns) 8101	2.49
2102	16	1024x1	(350ns)	.89
21L02	16	1024x1	(450ns) L.P.	1.49
2111	18	256x4	(450ns) 8111	2.95
2112	16	256x4	(450ns) MOS	2.95
2114	18	1024x4	(450ns)	1.95 - 8/13.95
2114L	18	1024x4	(450ns) L.P.	2.25 - 8/15.95
2114-2	18	1024x4	(200ns)	2.25 - 8/15.95
2114L-2	18	1024x4	(200ns) L.P.	2.49 - 8/17.95
2141-3	18	4096x1	(150ns)	3.95
2147	18	4096x1	(70ns)	4.95
2148	18	1024x4	(70ns)	8.95
TMS4044	18	4096x1	(450ns)	3.95
TMS4045	18	1024x4	(450ns)	3.95
5101	22	256x4	(450ns) CMOS	4.95
MM5257	18	4096x1	(450ns) 4044	4.95
HM6116P-3	24	2048x8	(150ns) CMOS	7.95
HM6116-4	24	2048x8	(200ns) CMOS	6.95
HM6116LP-4	24	2048x8	(200ns) L.P. CMOS	7.95
7489	16	16x4	(50ns) 3101	2.25
74C920	22	256x4	(250ns) CMOS (6551)	3.95
74C921	18	256x4	(250ns) CMOS	3.95
74C929	16	1024x1	(250ns) CMOS (6501)	3.95
74C930	18	1024x1	(250ns) CMOS (6518)	3.95
74S189	16	16x4	(35ns) 93405	1.95
74S200	16	256x1	(80ns) 93410	3.95
74S206	16	256x1	(60ns) 93411	3.95
74S289	16	16x4	(35ns) 3101	2.25
82S10	16	1024x1	(50ns) O.C. (93415)	3.95
82S25	16	16x4	(50ns) O.C. (74S289)	2.25

EPROMS

1702A	24	256x8	(1us)	4.95
2708	24	1024x8	(450ns)	3.95
2708-5	24	1024x8	(550ns) SM00246	2.95
TMS2516	24	2048x8	(450ns) 2716	6.95
TMS2532	24	4096x8	(450ns) NMC2532	9.95
TMS2564	28	8192x8	(450ns)	19.95
TMS2716	24	2048x8	(450ns) 3 voltage	7.95
2716	24	2048x8	(450ns)	4.95
2716-1	24	2048x8	(350ns)	6.95
2732	24	4096x8	(450ns)	9.95
27580	24	1024x8	(450ns) single +5V	2.95
MM2764	28	8192x8	(450ns)	16.95
MM2764-3	28	8192x8	(300ns)	19.95

PROMS

74S188	16	32x8	PROM O.C. (6330-1)	1.49
74S287	16	256x4	PROM T.S. (6301-1)	1.95
74S288	16	32x8	PROM T.S. (6331-1)	1.95
74S387	16	256x4	PROM O.C. (6300-1)	1.95
74S471	20	256x8	PROM T.S. (6309-1)	5.95
74S472	20	512x8	PROM T.S. (6349-1)	4.95
74S473	20	512x8	PROM O.C. (6348)	4.95
74S474	24	512x8	PROM T.S. (DM87S296N)	4.95
74S475	24	512x8	PROM O.C. (6340)	4.95
74S478	24	1024x8	PROM T.S. (TBP28S86)	8.95
74S570	16	512x4	PROM O.C. (6305)	2.95
74S571	16	512x4	PROM T.S. (6306)	2.95
74S572	18	1024x4	PROM O.C. (6352)	4.95
74S573	18	1024x4	PROM T.S. (82S137)	4.95
82S23	16	32x8	PROM O.C. (27S18)	2.95
82S115	24	512x8	PROM T.S. (27S15)	9.95
82S123	16	32x8	PROM T.S. (27S19)	2.95
82S126	16	256x4	PROM O.C. (27S20)	3.95
82S129	16	256x4	PROM T.S. (27S21)	3.95
82S130	16	512x4	PROM O.C. (27S12)	5.95
82S185	18	2048x4	PROM T.S. (TBP24S81)	9.95
DM87S180N	24	1024x8	PROM O.C. (82S180)	9.95
DM87S181N	24	1024x8	PROM T.S. (82S181)	9.95
DM87S184N	18	2048x4	PROM O.C. (82S184)	9.95
DM87S185N	18	2048x4	PROM T.S. (82S185)	9.95
DM87S190N	24	2048x4	PROM O.C. (82S190)	19.95
DM87S191N	24	2048x8	PROM T.S. (82S191)	19.95

DATA ACQUISITION

DC10		Mostek DC/DC Convert. +5V to -9V	2.95
MC3470P	18	Floppy Disk Read AMP System	4.95
MC1408L7	16	7-bit D/A Converter (DAC0807LCN)	2.49
MC1408L8	16	8-bit D/A Converter (DAC0808LCN)	2.95
ADC0804	20	8-bit A/D Converter (1 LSB)	3.49
DAC0806	16	8-bit D/A Converter (0.78% Lin.)	1.95
ADC0809	28	8-bit A/D Converter (8-Ch. Mult.)	4.49
AY-5-1013A	**40**	**30K Baud Uart (TR1602)**	**4.95**

CONNECTORS

DB25 — D Subminiature (meets RS232)

Part No	Description	Price
DE9P	9 Pin Plug	$1.79
DE9S	9 Pin Socket	1.95
DA15P	15 Pin Plug	1.95
DA15S	15 Pin Socket	2.95
DB25P	**25 Pin Plug (Meets RS232)**	**2.49**
DB25S	**25 Pin Socket (Meets RS232)**	**3.25**
DB25P-831	25 Pin Right Angle Plug	4.95
DB25S-831	25 Pin Right Angle Socket	5.25
DC37P	37 Pin Plug	4.95
DC37S	37 Pin Socket	5.95
DD50P	50 Pin Plug	5.95
DD50S	50 Pin Socket	8.95

Accessories

DE-9H	Hood for DE-9 Series Connectors	$1.19
DA-15H	Hood for DA-15 Series Connectors	1.29
DB25H	Hood for DB25 Series Connectors	1.25
DC37H	Hood for DC37 Series Connectors	1.39
DD50H	Hood for DD50 Series Connectors	1.49
D20418-2	2 screws for mtg. connectors to a panel	.79

Solder Eyelet/Wire Wrap Edge Card

Part No	Cnts.	Sp	Description	Price
15/30SE	15/30	156	Solder Eyelet	$1.79
18/36SE	18/36	.156	Solder Eyelet	1.95
22/44SE	22/44	156	Solder Eyelet	2.49
22/44PC	22/44	156	PC type (no mtg. ears)	.99
50/100SE	50/100	175	Solder Eyelet	9.95
22/44WW	22/44	156	Wire Wrap - Level 3	4.95
67031-5	22/44	156	WW (Pins .0625x.03x.75)	3.95
R-681-1	50/100	125	Wire Wrap - Level 3	7.95
R-681-2	50/100	125	Wire Wrap - Level 1	6.95

RF Coaxial Connectors

Part No	Description	Price
PL259	UHF Plug	$.89
SO239	UHF Panel Receptacle	.69
PL258	UHF Straight Adapter	.89
UG175/U	UHF Reducing Adapter	.49
UG88/U	BNC Plug	1.49
UG89/U	BNC Jack	1.69
UG306/U	BNC Angle Adapter	2.49
UG260/U	BNC Plug	1.49
UG1094/U	BNC Bulkhead Receptacle	.89

IC SOCKETS

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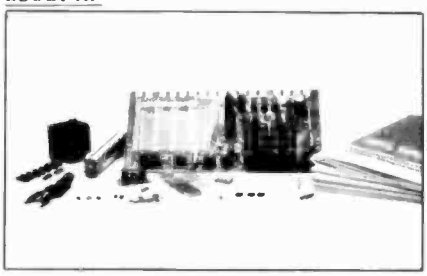

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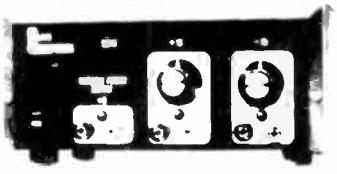

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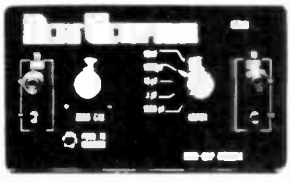

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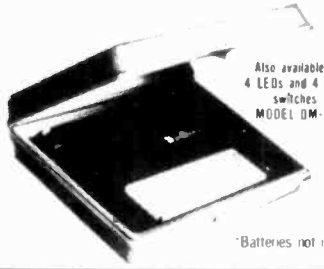

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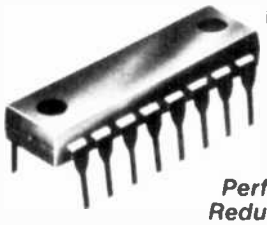

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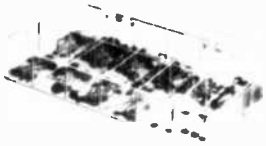

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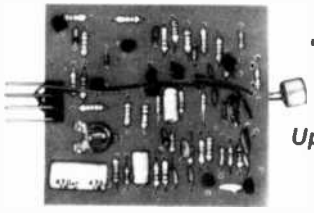

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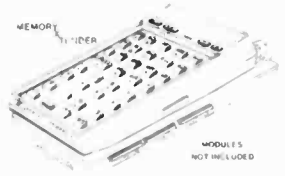

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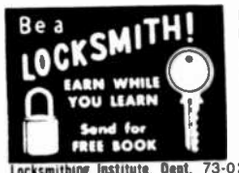

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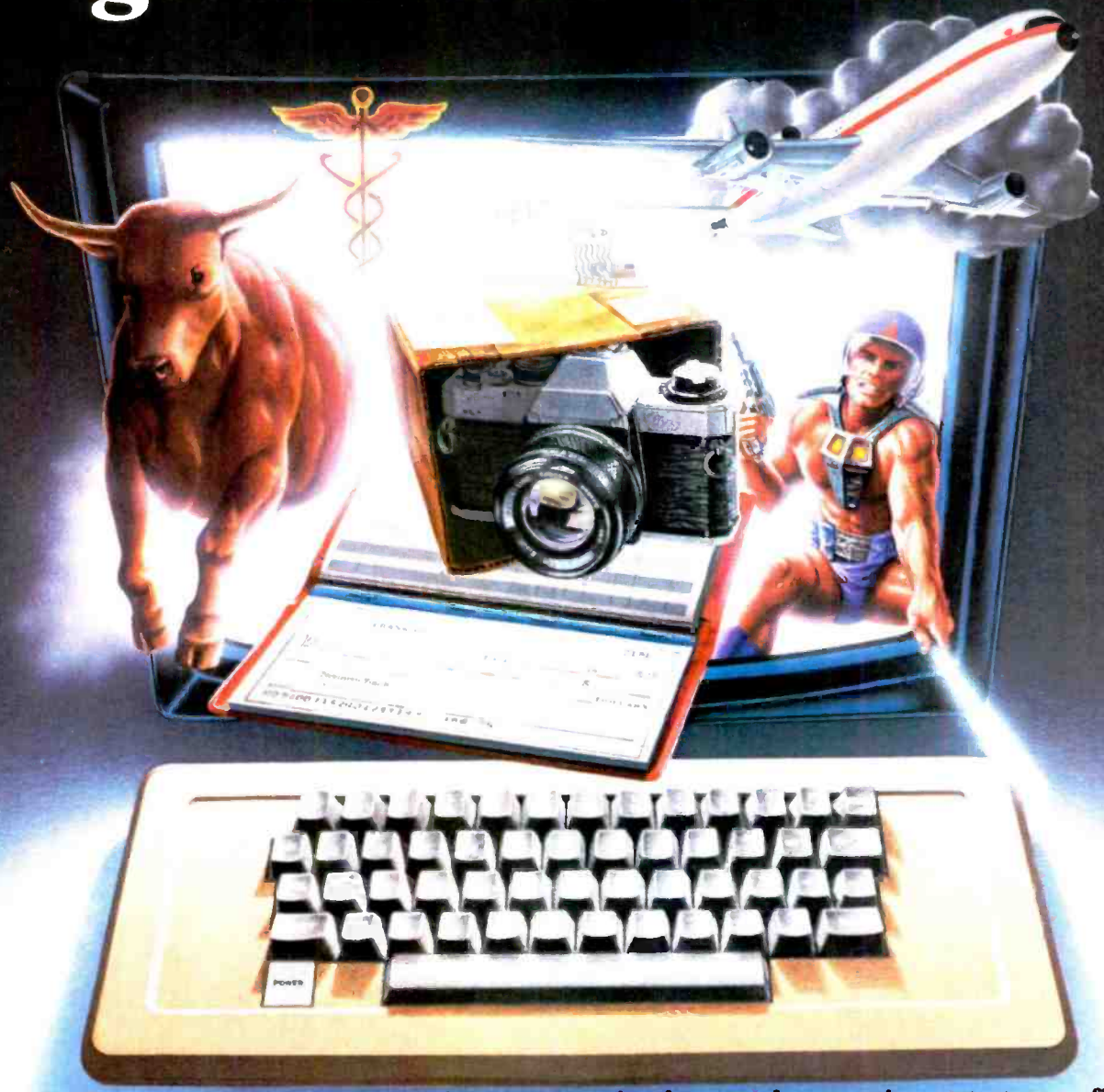

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At which point, naturally, it'll cost you to change your mind.

IT'S EASY TO TELL THE DIFFERENCE.

Fortunately, you don't have to be a computer engineer to tell what makes the Commodore VIC 20™ superior to the competition. All you have to do is take advantage of three of your five senses.

Use your sense of vision and read this comparison chart. You can see in black and white where two of our major competitors have skimped. Use your sense of touch in the store. You'll feel the VIC 20's superiority immediately. It feels a lot more expensive than it is.

If these two senses don't convince you that the VIC 20 offers more for the money than any other home computer, simply rely on common sense.

NOW THAT YOU KNOW HOW EASY A COMMODORE HOME COMPUTER IS TO OWN, FIND OUT HOW EASY IT IS TO EXPAND.

One thing about home computers that you're bound to discover at home is that, once you learn what they can do, you'll want them to do more and more. To do this, you may need accessories called peripherals. These let you get more out of a home computer by letting you put more into it.

They include items like cassette recorders and disk drives to input data, modems for telecomputing and printers. And all VIC 20 peripherals are fully compatible with the powerful Commodore 64™ personal computer.

PLAN AHEAD.

When you start looking at your first home computer, you may think it's too early to start planning to add peripherals. If that's what you think, you're once again playing right into the hands of our competitors.

Because once they've gotten you to buy their home computer, for what seems to be a reasonable price, they have you hooked on their system.

The costs of which, if you'll examine the chart below, can really start getting unreasonable. For example, while these computers may seem to be close to the same price to start, an expanded system can cost you twice as much with TI or Atari as with the Commodore VIC 20 or Commodore 64.

EXPANSION COSTS	VIC 20™ or COMMODORE 64™	TI99/4A®	ATARI 400®
BASIC	Included	Included	$59.95
Peripheral Expansion System	Not Necessary	$249.95	Not Necessary
Disk Drive	$399.00	399.95	599.95
Disk Controller Card	Included	249.95	Included
Modem	109.95	224.95	199.95
Modem Interface	Included	174.95	219.95
TOTAL	**$508.95**	**$1299.75**	**$1079.80**

Manufacturer's suggested list prices. Prices per TI June-December 1982 U.S. Consumer Products Suggested Price List. Atari prices effective July 1, 1982 Suggested Retail Price List.

THINK OF IT AS BUYING A TOASTER.

It's easy to fill up a computer ad with RAM's and ROM's, numbers and technical jargon. But when it comes right down to it, buying a home computer is just like buying anything else. It's important to know just what you're getting for your hard-earned money.

And we hope we've accomplished that here by telling you about the cost of expanding your Commodore VIC 20 or Commodore 64 computer.

COMPUTER FEATURES	VIC 20	TI 99/4A	ATARI 400
Typewriter Keys	**Yes**	Yes	No
Typewriter Feel	**Yes**	No	No
Color Control Keys	**Yes**	No	No
Graphics on Keys	**Yes**	No	No
Reverse Letters	**Yes**	No	Yes
Programmable Function Keys	**Yes**	No	No
Works with TV or Monitor	**Yes**	Yes	No
True Lower Case Letters	**Yes**	No	Yes
DISK FEATURES			
Capacity	**170K**	90K	88K

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