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JANUARY 1983 VOLUME 21, NUMBER 1

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CIRCLE NO. 33 ON FREE INFORMATION CARD

COMPUTER VIDEO GAMES

Hands-on Reviews of the Latest Computer Game Software

SERPENTINE

Broaderbund Software. Arcade game for Apple II and Atari 800. $34.95

Here's a hi-resolution maze game that's almost as much fun to watch as to play. Smooth animation techniques give a near-lifelike appearance to the movement of both player's and computer's snakes—which resemble cute and furry blue, orange, or green caterpillars.

According to the game background, the maze on-screen represents the ruined corridors of a vanished civilization wherein giant snakes rule the land. Puny humans tame these snakes and, riding astride them, do battle with their scaley steeds' more wild brethren.

But you'll only see a human during play if you look in a mirror, because on-screen it's just snake against snake. With joystick, paddle or keyboard control you guide your blue serpent through the maze. You try to catch up to the larger, orange serpents in order to chomp sections off their tails and thereby, gain points.

Only sneak up from behind, as going head-to-head against a larger snake will mean your own snake's death.

But, as you whittle down your opposition, you can also be eating eggs laid by your enemies as well as dizzily hopping frogs—both of which make you grow longer. And, when you're longer than your enemies they turn green (with envy?) and then you can chomp 'em down from both ends. Meanwhile, you may even lay an egg or two for additional reinforcement snakes on a higher level.

I found *Serpentine* to be almost hypnotic, as your eye is captured by the slithery, colorful movements. Highly recommended and unique.

FACEMAKER

Spinnaker Software. Educational game for Apple II.

If you have a pre-schooler as well as a computer, you've probably faced the same puzzle I have in that situation: How can you introduce a tyke who does not read to the wonders of computing? This new game seems the best way yet.

The first few prompts, as to sound capability and background color, can be answered by Mommy or Daddy. But from then on, the little kid can be in complete charge because the program is structured so that there is no need for reading. Just learning about use of the space bar and return key is all that is needed for the easiest level of the three on-disk games.

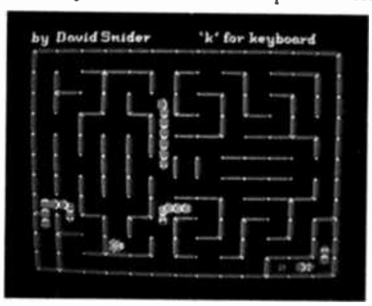
In the first game, the child builds a face. A blank oval is drawn on the screen and to the left of the oval is a pictorial menu display of a nose, eyes, mouth, ears, and hair. By hitting the space bar, the number above each picture turns inverse. When this visual cue is seen, the child knows which choice he or she has picked. Hitting the return key displays a secondary menu of cartoonish choices—for instance, a dozen sets of hilarious eyes to choose from. And, again, the choosing is done with the space bar. When the final choice has been made, another tap of the return key instantly draws the shape in the right spot on the oval to begin the face. In like manner the rest of the face is filled in.

At this point, the second game lets the child animate the face he has built. One-key commands give him complete control over the face's funny actions. The T will stick out its tongue; E will wriggle its ears; F will make it frown; S will make it smile; C will make it cry and W will make it wink its eye. The nonreader will, of course, require a little help here but it was amazing how soon our three-year old caught onto these controls herself.

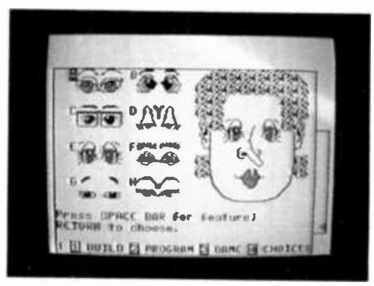
In this same game, the child can also write a simple program. Hitting the space bar puts you into program mode. Entering SSCCFFW would program the face to smile twice, cry twice, frown twice and wink—all of which it would do when you hit return.

The final game is a sort of Simon-style guessing game. The computer makes the face go through its paces and the child must use the one-key commands to mimic what the computer has done. A successful mimicking causes the computer to add one more routine to the next challenge.

All in all, this is one of the very few educational programs I have seen for the early pre-schooler where the child can assume an active instead of a passive mode—and have a good deal of fun doing so. ◇

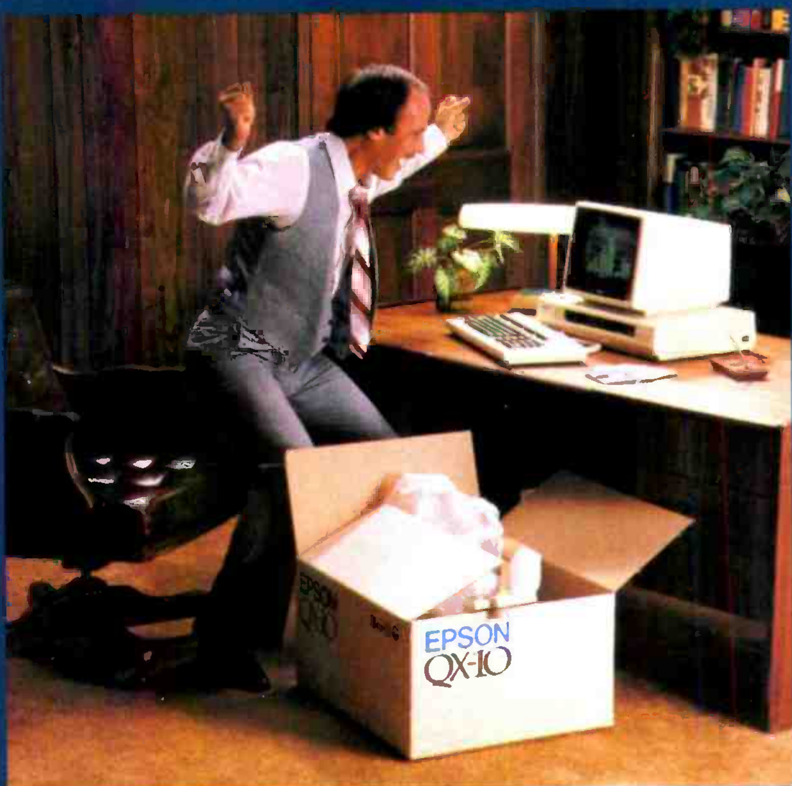


Serpentine (above)



Facemaker (right)

The QX-10.
It won't make you any smarter, it'll just make you feel that way.



EPSON

That, of course, was the promise nearly all computer manufacturers made to us.

But along the way, the promise was unfulfilled.

People found out that even the simplest computer languages were as troublesome and time-consuming as high school French — fine if you like that sort of challenge, but a real barrier if what you want to do is *use* a computer, as opposed to *learning* to use a computer. A lot of people found they could live their whole lives without ever knowing what GOSUB, LOGIN, or MID$ meant.

The first anybody-can-use-it computer.
That, in a nutshell, is what makes the Epson QX-10 the most astonishing breakthrough in personal computer technology ever. Not only does it have some of the most advanced hardware available on the market today, it is a system that requires no computer classes, no study, no lectures, no books; a system you can *use*, right out of the box, backed by little more than logic, intuition and native intelligence.

It's a software system called VALDOCS. And it's designed on a whole new standard to make serious, useful computing no more difficult than typing. Someday all computers may be built this way. But for now, there's only one.

The Epson QX-10.

The manageable manager.
The QX-10/VALDOCS system was designed from the very beginning to handle the details of *human* existence in a remarkably straightforward, accessible, *human* manner. For all intents and purposes, it has already built into it all the software you will *ever* need to successfully manage the details of your life.

Consider what the standard configuration of VALDOCS will do:

- It's a full-function, sophisticated *word processor;*
- an information *indexer* for easy access to *files;*
- an *address book;*
- and an *electronic mail system.*
- It's also a *calculator;*
- an *appointment book* and *notepad;*
- an *event timer;*
- and a *clock and calendar.*
- It gives you an automatic *list of "things to do"*
- and lists your *schedules and itinerary.*
- Finally, it's a *business graph drawing system.*

That's what it does right out of the box; what you can make it do within minutes of unpacking it. Without buying additional software or writing your own programs in what amounts to a foreign language.

It's like suddenly being a computer expert; suddenly being smarter. You can do in minutes — and often with a single key — what may have

taken users of other systems days to learn, or hundreds of dollars in supporting software to accomplish.

You're overcome with an unmistakable feeling of power.

Simply stated, what the QX-10 does better than any other personal computer system in existence is to free you from manipulating the *computer*, and allow you to manipulate *information*.

And, after all, isn't that what you want a computer for?

The keyboard is the key.
The HASCI keyboard — short for Human Applications Standard Computer Interface — has been designed to place important fundamentals like STORE and RETRIEVE in plain view on dedicated function keys. Virtually every program in other computers does these fundamentals differently, and how to do these functions is hidden right down with the most obscure technical details.

The VALDOCS system.
What VALDOCS does better than any other software system currently available is to take the "interactive" concept to its logical conclusion; it asks you to make choices, then executes commands based on your decisions.

The *common sense* of such a system reduces the amount of time needed to master the QX-10 to a fraction of that needed for other computers: in effect it displays the message, "Press this key to perform this function; press that key to perform that function; or press another key to move on to something else."

No brochure, of course, can do justice to the VALDOCS system; to fully appreciate it, you must sit down at a QX-10 and *experience* it. But to appreciate the range of its capabilities, examine them one by one.

Word processing.
When you turn the QX-10 on, it comes to life as a word processor. And as such, it does everything you'd expect a word processor to do.

Of course you can add and delete words and sentences; shift copy blocks from one place to another; even locate a specific word or thought on documents ranging from a few words to multiple pages.

That's where most word processors stop. But not the QX-10.

The QX-10 allows you to format *exactly* the way you'd like your document to appear in print. So when you press the key labelled ITALICS, the type *on the screen* changes to italics; when you press BOLD, it changes to boldface. With the QX-10, you can vary the SIZE of the type and even change the STYLE.

So when you press PRINT, your document is printed exactly the way you've already seen it on the screen. What you see is what you get!

Scheduling.

Scheduling, in its essence, is the manipulation of time. And the QX-10 makes it easy in a way that no appointment book, or calendar, or list of things to do ever could.

To begin with, the QX-10 always knows what time it is. The internal clock/calendar has a battery backup which keeps track of the date and time, even if the computer has been unplugged.

As a scheduler, the QX-10 works like a desk calendar, but gives you instant, electronic access to dates and times, past, present and future. It automatically opens to today's electronic "page," it allows you to make appointments, jot down notes and reminders, list things to do, or even set an alarm for yourself.

Most important — and useful — the SCHEDULE function is always available. If you're typing a letter in the word processing mode, for example, you can stop in the middle and book an appointment just by pressing the SCHED key; pressing it again returns you to the word processing mode, *right where you left off*.

Calculating.

To simplify the entering of numeric data, the QX-10 has a separate 10-key pad that lets you add, subtract, multiply and divide. Just like a calculator. Its decimal tab key allows you to automatically align columns of numbers. But the QX-10 can sum the numbers within a document

being word processed or place the total of a calculation at any point within a document. *That's* the sort of thing that makes the QX-10 usable.

Graphics.

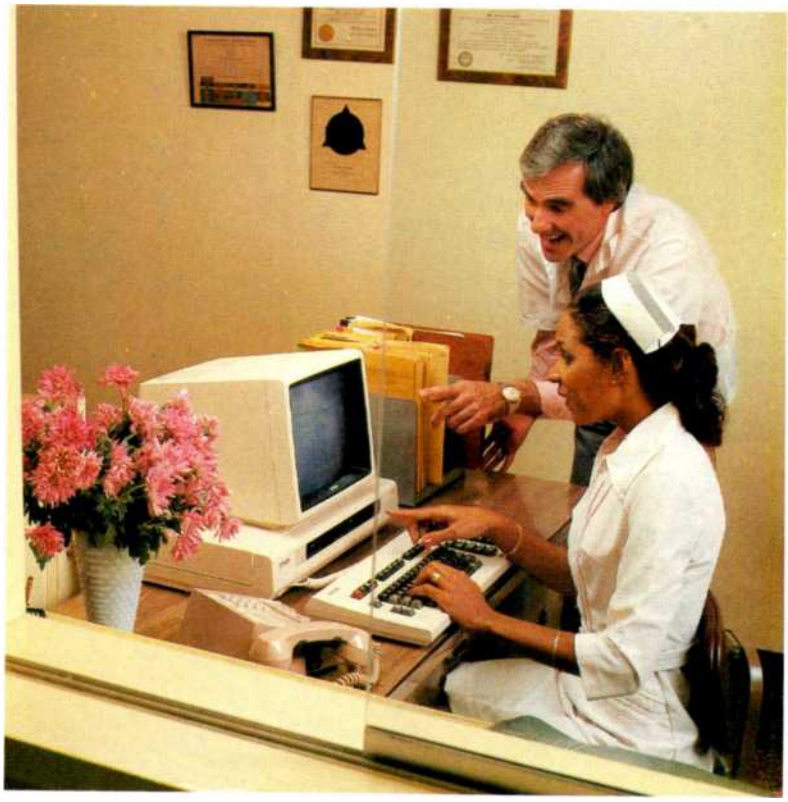
Generally speaking, pictorial information (charts and graphs) is a lot easier to digest than numeric information (columns of figures). Fortunately, the QX-10 makes graphics very, very simple.

In the DRAW mode, the QX-10 allows you to create a line graph, a bar graph, or a pie chart. Based on your choice, it will ask you for pertinent information such as the names, range and intervals for each axis, and the numeric value of each data point to be charted or graphed. Once all the information is entered, it will automatically plot the coordinates and draw the graph, even superimposing different types of data on the same graph. It couldn't be easier.

Filing.

The block of File Control keys on the HASCI keyboard allow you to do everything you need to do with a finished document: STORE it; RETRIEVE it; MAIL it to someone else's computer electronically; or PRINT it on the printer. Each with the stroke of a single key.

But those functions can't hold a candle to the power of INDEX. In the QX-10/VALDOCS system, every document, every graph — *everything* is indexed by up to *eight* keywords of your choice. And instantly available.



Here's how it works: for every file, you assign a name up to eight words long. Like "Mom's Recipe for Thanksgiving Pumpkin Pie from Scratch," or "Personal Financial Statement for SBA Loan Application." When you need to, you can retrieve any file, using one or more of the keywords you assigned in the name. For example, "Mom's Recipe," "Thanksgiving," "Financial Statement," or "SBA," will give you all the documents having to do with those topics.

And *that* is the most astonishing and *useful* filing system you're ever likely to run across.

Electronic mail.

On the QX-10/VALDOCS system, sending information to, or receiving information from another computer starts with a single key. It provides you, in effect, with electronic "in" and "out" baskets, gives you an "address book" of your correspondents, even allows you to schedule transmission times to coincide with less expensive telephone rates. Best of all, VALDOCS handles all your electronic mail functions without interfering with any of the other computer functions. So you can word process, calculate or graph while VALDOCS handles your mail.

System controls.

Say you're in the middle of a project and you don't know what to do next; or you give the computer a command and then wish you hadn't; or you want to stop some function the computer is performing — now. VALDOCS makes it easy.

The HELP key is always available to you, and can be pressed any time the system offers you a choice. The STOP key immediately stops whatever function the computer may have been performing; the UNDO key undoes the last thing you told it to do — so you can *un*-select a function, or even *un*-delete a file.

CP/M compatibility.

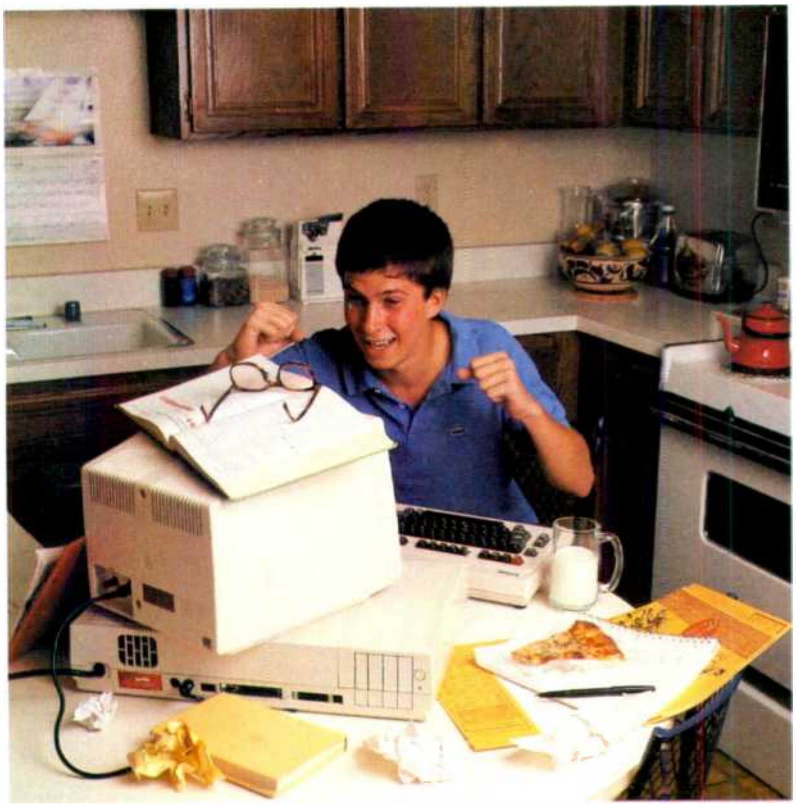
The Epson QX-10 has a side benefit that's going to make it very popular with some people — it's CP/M 2.2 compatible. Which means that most any CP/M software you have — or would like to have — will run on the QX-10. Most of these will be accessible under the MENU key which displays a menu of all the non-VALDOCS programs on file, in English, and lets you select the one you wish to run.

State-of-the-art hardware.

Up to now, we've only talked about what the QX-10/VALDOCS system *does* for you, because after all, *what* a computer does is far more important than *how* it does it.

But in order to create a system like the QX-10, we've had to come up with some of the most advanced — and spectacular — hardware on the personal computer market.

When you unpack the QX-10, here's what you get: a detachable HASCI keyboard with its own



processor; an ultra high resolution monochrome display; two ultra thin 5¼" disk drives with a capacity of 340K bytes per disk; a Z80 microprocessor with 256K of main memory; a separate display processor chip with 128K of video-dedicated memory; a DMA controller; an interrupt controller; a built-in calendar/clock with battery back-up, an RS-232C interface; a parallel printer interface; a light pen interface; internal space for up to five peripheral cards; and the VALDOCS software package.

All that for *under* $3,000.

Frankly, none of the so-called "third generation" microcomputers will do for you what the QX-10/VALDOCS system will do. And all of them cost more; some of them cost a lot more.

But for the price, none are more advanced.

The QX-10 video display features both bit mapping and the more usual character operation. The bit mapping allows multiple type fonts or high resolution graphics to be displayed on the screen in a remarkable 640 by 400 dot format — a feature available in only a few of the world's highest-priced systems. To get this performance, we turned to a new 16-bit video controller chip from NEC to give us the additional "oomph" we needed. But the central processor is the 8-bit Z-80, instantly compatible with the world's largest base of software — CP/M. Our five expansion slots are not used for *any* of this performance.

Relax — it's from Epson.

Epson is best known in the U.S. for its full line of printers. We're known for the fact that every third dot matrix impact printer sold in this country has our name on it; for the fact that we make more printers and print mechanisms than all the other manufacturers in the world combined; and for the fact that Epson printers have a reliability rate of over 98%.

But that doesn't mean we're new in computers. Not by a long shot. Epson has been building and selling fine quality business computers in other countries since the 1970's, and we have a history of precision manufacturing dating back more than a hundred years.

The most important component is you.

You don't buy a computer for how "smart" it is. You buy one for how smart it makes you.

The Epson QX-10 was conceived, designed, engineered and built with just one thought in mind: to vastly expand your ability to see, to think, to create with a system that acts as a natural extension of the human mind.

And the critics agree the design concept is one of the best they've seen.

The QX-10 is not a computer designed to play games, although it plays games as well as any and better than most.

It's a computer for people who think.

And who want to think better.

SPECIFICATIONS

CPU and Memory	
Main CPU	Z80A Microprocessor, 4 MHz Clockrate
Main Memory	64K to 256K RAM
CMOS Memory	2K RAM Battery Backup
IPL	Up to 8K
Controllers	
Video/Graphic	NEC 7220 Graphic Display Controller
Disk	Double Density Floppy Disk Controller
DMA	Programmable DMA Controllers 1 Main System } 7 DMA Channels 1 Option Slot
Interrupt	Programmable Interrupt Controllers (15 Interrupt Levels)
Control/Timer	Two Programmable Interval Timers
Printer I/F	Programmable Parallel Interface
Serial I/F	Multi-Protocol Serial Controller
Clock	CMOS Realtime Clock/Calendar with Battery Backup
Display	12" Green Monochrome High-Resolution Monitor 640 x 400 Pixels 80 characters x 25 lines Non-Glare Screen Dedicated Memory 32K or 128K
Mass Storage	Two 5¼-inch, Double Sided Floppy Disk Drives; Capacity: 340K Per Disk
Detachable Keyboards	ASCII HASCI

Interfaces	
Serial	RS-232 Programmable, DB-25 Connector, Synchronous or Asynchronous
Printer	Standard Parallel
Light Pen	
Option slots	Five
Speaker	Controlled by Countertimer
Environmental Requirements	
Temperature	Operating Range 41° to 104°F (5° to 40°C) Storage Range 22° to 158°F (−30°C to 70°C)
Humidity	Operating Range 10% to 80% Non-Condensing Storage Range 10% to 90% Non-Condensing

Physical Characteristics

Size	CPU	Monitor	Keyboard
Width	20.3 in (508mm)	12.4 in (312mm)	20 in (510mm)
Depth	13.6 in (340mm)	13.6 in (340mm)	8.9 in (224mm)
Height	4.1 in (103mm)	10.6 in (266mm)	1.9 in (49mm)
Weight	20.6 lb (9.4kg)	12.1 lb (5.5kg)	5.5 lb (2.5kg)

Power Requirements 115 VAC, 60 Hz; with Switching Power Supply
100 Watts

Specifications subject to change without notice.

EPSON
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COMPUTER PRODUCTS DIVISION

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CIRCLE NO. 25 ON FREE INFORMATION CARD

PRINTED IN USA 11QX82

EDITORIAL

Royalty Is More Than Regal

Do you copy LP records onto audio tape? TV programs onto video tape? Computer programs onto blank floppy disks? If you do any of these things, there are people out there who say it's illegal, immoral, or fattening. Furthermore, those involved in creating the original material are crying for a royalty income of some sort if their works are copied without appropriate permission.

How do you police people to prevent them from doing these things in the privacy of their homes for personal use? You don't, spelled "can't." The next best thing (in fact the better thing from the originator's viewpoint) is a royalty tax to be paid by all buyers of the original material whether they make copies or not.

On the video front, legal action launched against Sony and others related to recordings made with Sony's Betamax video cassette recorder has reached the U.S. Supreme Court. The plaintiffs, which include Walt Disney Productions, claim that it's illegal to record copyrighted material from TV broadcasts. They'll doubtlessly settle for a royalty (tax) on blank video cassette tapes, on the VCR's, or both. Should their claims be sustained, higher costs will follow the laws of nature: fewer sales.

I had hoped that the video challenge would be squashed by having it fall under a 1970's congressional bill that pointedly excluded audio tape recordings for personal use from copyright coverage. In a recent session of Congress, however, the Record Industry seems to have induced legislators to propose a bill in the House of Representatives (H.R. 5705) and an amendment in the Senate (Amendment 1333) that would impose a royalty on purchase of audio tape and audio tape recording machines.

To fight this effort, a diverse group established the Audio Recording Rights Coalition (ARRC), which commissioned a research company to conduct an in-depth survey of U.S. audio tape recording habits based on 1018 telephone interviews. Some conclusions make a strong argument against imposition of any sort of royalty or tax.

For example, the majority of home tape recordists (57%) said they often or sometimes buy a record after taping a borrowed work. Seventy-five percent of music tapers mentioned portability as a very important reason for taping. Recordings of one's own records are used for car stereo tape and "Walkman"-type players, where half of their total listening of tapes is done. In most instances, prerecorded tapes do not fill the bill since many albums are not available in this format, while one-third mentioned inferior quality of such tapes as compared with home recordings. The survey also found that 51% of music tapes made from records were already owned by the recordist.

Sales of records have diminished in recent years, but it is unlikely that the major cause is music lovers taping each others' records to avoid buying them. A more probable cause is that youngsters are spending much of their money in game arcades and for video game cartridges, as well as doing some off-the-air taping of favorite music selections.

To penalize everyone with higher prices to pay royalties to the record industry would do more harm than good, I believe. Firstly it would be unfair since most people do not use their tape machines in the so-called infringement manner suggested. Secondly, costlier merchandise will repel buyers, and therefore take from Peter (tape machine and tape manufacturers, sales representatives, and retailers) to pay Paul (the record industry). Furthermore, higher prices for tape will leave less money for record purchasing.

Record retailers, interestingly, are beginning to realize that taping of records is an inducement to buying more records. Some record stores in my living area, in fact, are trying to induce people to tape by promoting borrowing of a record for the cost of $1 to tape a favorite selection from among many recorded on an LP.

Beyond the foregoing, how would the royalty be administered and distributed? If you'd like to know what you can do to forestall such legislation, you can contact the Audio Rights Coalition, 2001 Eye St., NW, Washington, DC 20006 (202-457-4992)

Art Salsberg

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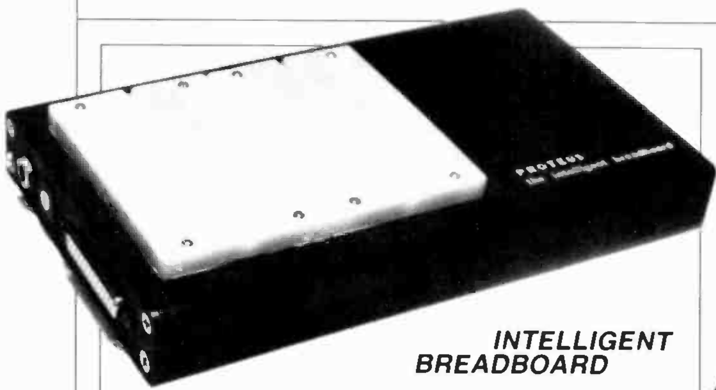
NEW PRODUCTS



INTELLIGENT BREADBOARD

The Proteus development system from Technical Micro Systems Inc. includes a BASYS/1 CMOS computer, power supply and solderless breadboard sockets. Capacity is 2K RAM/4K ROM, and it has an RS232C port and 20-mA current loop to 2400 baud, parallel inputs with 12 CMOS/TTL lines, eight parallel outputs, and a multiplexed I/O. Resident software: Tiny BASIC and 8TH. $250.

Circle No. 93 on Free Information Card

WIDEBAND CASSETTE DECK

Harman-Kardon's front-load CD401 has Dolby B, C, and HX-Pro noise reduction; 3 tape heads; 2 motors; and solenoid-operated controls. With HX-Pro, response is rated as 20 to 24,000 Hz +/−3 dB, while wow and flutter is 0.04% wrms. Separate bias and equalization switches include metal formulation selection. Dimensions: $4^3/_4$"H × $3^1/_2$"D × $17^1/_2$"W. $750.

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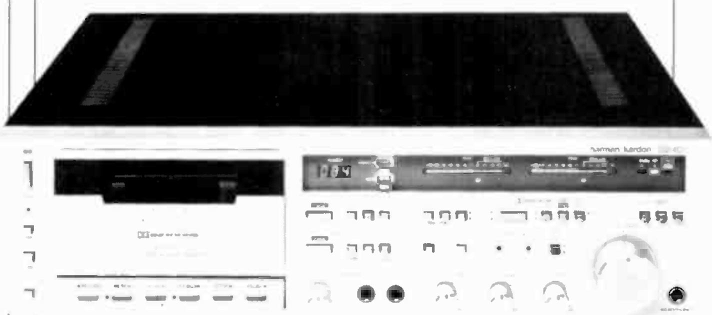
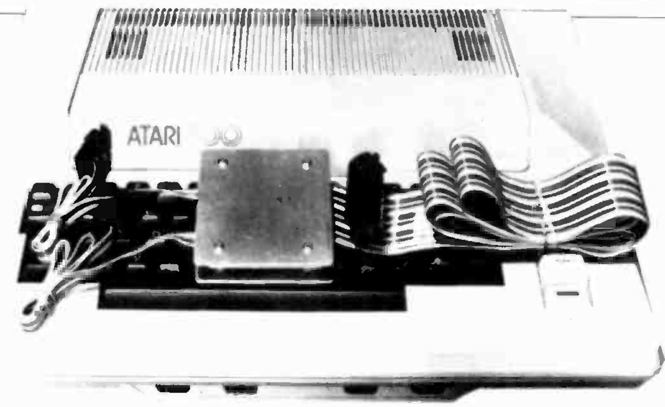
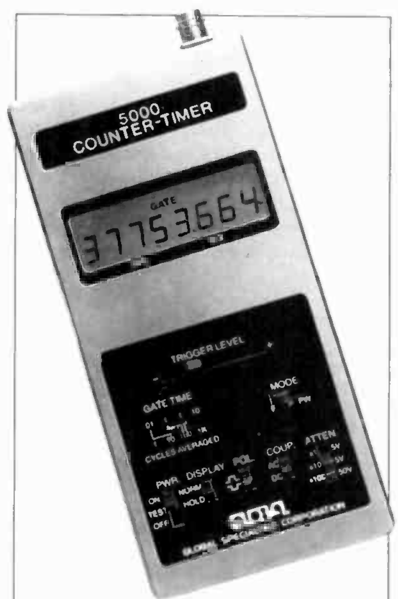




ATARI PRINTER INTERFACE

Interface No. 1 from Looking Glass Microproducts is designed to connect any printer having a Centronics-compatible parallel interface to an Atari 400 or 800 personal computer. A printer-handler, provided on either cassette or diskette, replaces the resident printer-handler, occupies less than 128 bytes of usable program area and is reported to be compatible with all Atari cartridges and programs. Comes with full documentation, step-by-step installation instruction, and program listings. $85.

Circle No. 94 on Free Information Card



HANDHELD COUNTER-TIMER

Global Model 5000 has 3 modes: frequency, period, and pulse width. Input impedance is 1 megohm at 25 pF for all modes. Frequency input rating is 0.1 Hz to 50 MHz. Gate times of 0.1, 1.0, or 10 s are switch selectable. Frequency is displayed in kilohertz on the 8-digit LCD display. Measures periods from 40 ns to 10 s and either single cycles or an average of 10, 100, or 1000 cycles. 6 AA batteries. 7½"H × 3¾"W × 1¾"D. $350.

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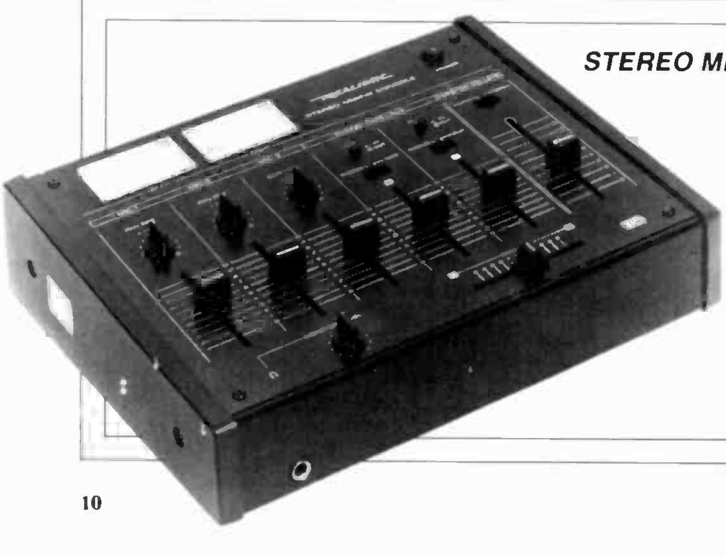


STEREO MIXING CONSOLE

Radio Shack's Realistic Stereo Mixing Console (#32-1200) has 3 mike inputs with pan pots, cross fading, and headphone cueing and monitoring. Also accepts 2 turntable and 2 tape deck inputs with 2-channel output. Has 7 level controls and lighted VU meters. $120.

MUSIC PRINTER

Yamaha Specialty Products' Mini-Printer MP-1 is a portable electronic keyboard with a computerized music printout system. It contains a miniature ballpoint pen that prints melody lines on a 2½" W paper roll in a variety of keys, and produces the staffs, time signatures, rhythm and chord names, and up to three sharps and flats. A melody and chord sequence memory allows two-channel recording and playback. Printer is reported to automatically compensate for player's irregular note lengths by rounding them off. Other features include ten instrument voices, easy play auto bass chord, arpeggio, and a pitch control for harmonizing and vocalists. Power is batteries or ac line. Dimensions: 2"H × 27¾"W × 6½"D; weight: 4 lb. $1000.

HAZELTINE ESPRIT III

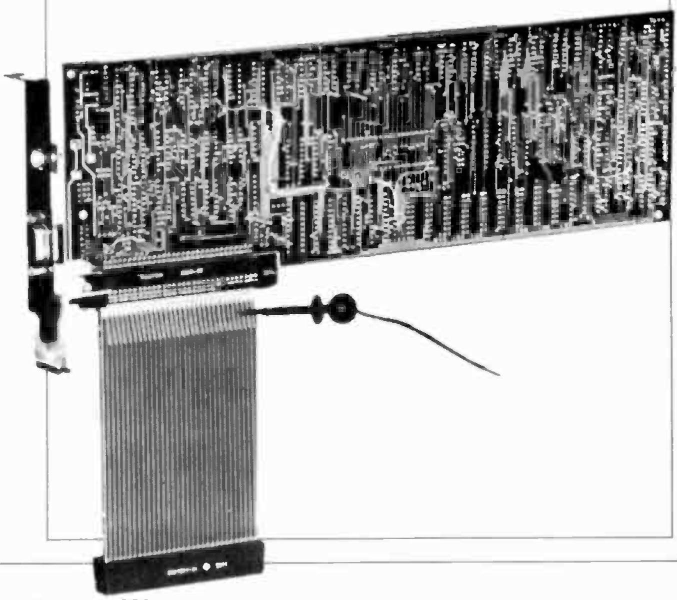
The Esprit III has a 6502 microprocessor and a PROM set with remote access command for user-designed functions. It has a tilting, green-phosphor CRT with detachable keyboard, printer buffer, and line drawing capability. Display format is 80 characters by 24 lines, with a programmable 25th status line. There are 96 alphanumerics, 32 control codes, and 15 graphics characters. Keyboard has 14 numeric keys, 22 user-definable function keys, and 7 edit keys. Uses both RS232C port and a 20-mA loop. Baud rates range from 50 to 19,200 cps. $895.

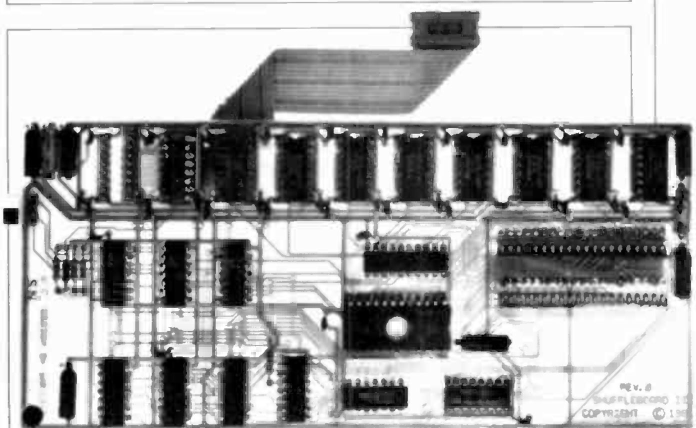
Circle No. 95 on Free Information Card

IBM-PC TROUBLESHOOTING EXTENDER CARD

Vector Electronic's Model 3690-22 extender board works with the IBM-PC to facilitate in-circuit testing of prototype interface cards and troubleshooting the computer. Card is 5.7" × 3.2" and has marked test points for every bus line. A thick epoxy masking prevents short circuits. The card-edge connector tabs are nickel and gold-plated. A mounting bracket secures the board to the computer. $22.35.

Circle No. 99 on Free Information Card





CP/M for TRS-80 III

The Shuffleboard III board from Memory Merchant allows TRS-80 Model III's to use CP/M-based software such as Supercalc, WordStar, dBase II, and Mail Merge. The board includes 16K of RAM, said to give the TRS-80 the power of full 64K CP/M 2.2 without interference to the computer's ROM or video memory. Operates with any TRS-80-compatible DOS, says the maker. Installation consists of plugging the board into two sockets in the Model III. Comes with MBASIC 5.0. $300.

Circle No. 98 on Free Information Card

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

Preparing a Standard for Minifloppies

LAST month, I wrote an article about the 3" vs 3.5" minifloppy battle, their differences, who was making what, and who was jumping on which bandwagon. Some of the smoke of battle between the two versions of the small diskette has now cleared away, and a proposed ANSI (American National Standard Institute) standard has emerged. Not everyone is satisfied, as the committee elected to take bits of the specification for one type and bits of the other to create the new standard.

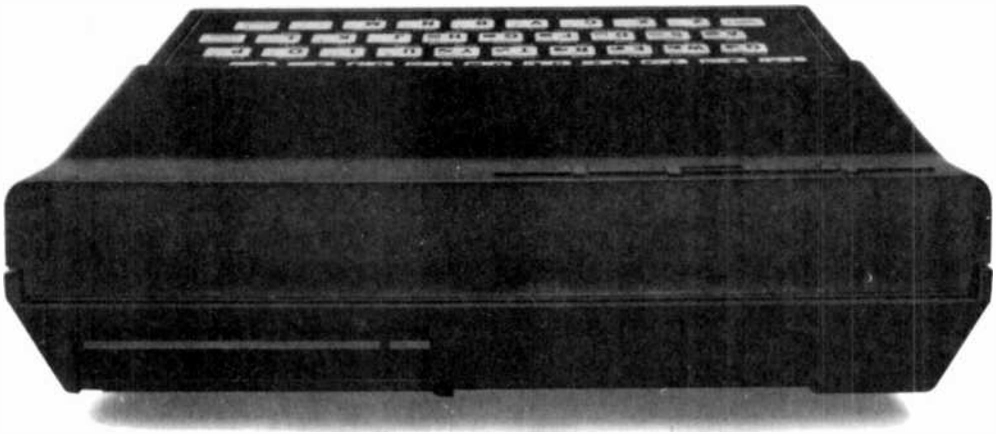
To start, the new size is 3.5", the size of the Sony entry. This dimension was selected because it was felt that a full megabyte could be stored on the diskette without unduly pushing the technology or reliability. There were also some deep technical changes that included thickness of magnetic media, magnetic capabilities, etc., but the other main change was the requirement that the new micro disk be compatible with existing minidisk products. So the new standard recommends 40 or 80 tracks/side, single- or double-sided—the Hitachi approach. The highest capacity version, 80 tracks/side, double-sided, could have an unformatted capacity of one megabyte. To further enhance the compatibility, the rotational rate of 300 rpm (again the Hitachi approach)—instead of the 600 rpm used by the Sony entry—was selected. Also, there is going to be an automatic shutter on the head access window that will automatically open when the diskette is inserted in the drive, and automatically shut when the diskette is removed. Thus, the standard has eliminated at least three warnings now printed on diskette covers—thou shalt not bend, jam into slots, or touch shiny parts. We are still awaiting packaging breakthroughs to remove the external magnetic field and heat problems. Let us hope that this new standard will be accepted by all disk, computer, and peripheral people, and we do not have another Kansas City tape standard coming in. There are some new microdisk users (other than those mentioned in last month's article), who may have problems with this new standard. The latest is RCA, which recently announced that it will use the Sony 3.5" disk in its MicroDisk Development System. Even as the new standard was announced, Toshiba decided to introduce its approach—a 3.5" floppy that uses perpendicular magnetic recording (PMR) to allow 3 megabytes to be stored on the chromium-cobalt diskette surface. The expected time of arrival for this new approach is about two years. PMR introduces another player in the game since this modulation technique was not discussed in the ANSI specs. And, speaking of PMR, Vertimag Systems recently announced its new 5- and 10-megabyte PMR systems, expected to be on the market within the year. Since we are on the verge of having a microdisk standard, and 3.5" seems to be the one chosen, we were surprised to hear that IBM, working with Matsushita Communications in Japan, is expecting to create a low-cost version of the IBM PC, using, of all things, a 4" drive!

Sinclair Timex Add-Ons. Physically, the Sinclair Timex 1000 is a small computer. However, it is not small in terms of performance and power. Shortly after its introduction, many companies jumped on the bus structure to produce a variety of add-ons—primarily memory. One company, Memotech Corp., introduced both 16K and 64K RAM modules that greatly expanded the versatility of the computer.

Now Memotech is adding some powerful plug-ins to its line. The first is a 32K RAM Pak ($109.95) that is fully compatible with the Sinclair internal 16K of RAM or with a Memotech 16K RAM Pak. This makes a total of 48K for the small machine.

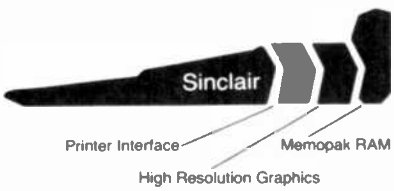
The second add-on is a High-Resolution Graphics Pak ($144.95) that contains an EPROM monitor holding a full range of graphics subroutines that can be called from BASIC USR function or by machine language to provide 192 × 248 pixels. With each video page requiring 6.5K of RAM, the number of pages is limited only by the avail-

Memotech plug-in add-ons for the Sinclair Timex 1000.



BEHIND EVERY GOOD SINCLAIR IS A MEMOPAK

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



Order at no risk

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

MEMOTECH
CORPORATION

7550 West Yale Avenue
Denver, Colorado 80227
(303) 986-1516
TWX 910-320-2917

Mail to: Memotech Corporation, 7550 West Yale Ave., Denver, CO 80227
Code CE 1

	*Price	Qty	Total
64K RAM	$179 95		
32K RAM	109 95		
16K RAM	59 95		
Centronics Parallel Printer Interface	104 95		
RS232 Printer Interface	139 95		
High Resolution Graphics	144 95		
Shipping and handling	4 95		$4 95

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

Tax** ______
Total ______

Account No ______ Exp ______

Name ______

Address ______

City ______ State ______ Zip ______

Memopak 64K RAM The 64K RAM extends the memory of your Sinclair by 56K to a full 64K. It is directly addressable, user transparent, is neither switched nor paged and accepts such BASIC 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.

The Choice of

Computer Exchange — The Supply Center for the IBM-PC

SOFTWARE for the IBM-PC

BUSINESS

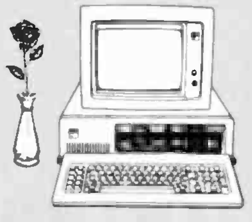
	LIST PRICE	OUR PRICE
ASHTON-TATE, dBase II, CP/M-86	$ 700	$459
DENVER SOFTWARE, Easy (Executive Accounting System)	$ 725	$545
HOWARDSOFT, Real Estate Analyzer	$ 250	$189
INFORMATION UNLIMITED, Easywriter II (a WPS)	$ 350	$259
IUS Easyspeller (88K Words)	$ 175	$129
Easyfiler (a DBMS)	$ 400	$299
Easy Planner	$ 250	$189
INNOVATIVE SOFTWARE, T.I.M. III (a DBMS)	$ 495	$369
★ INSOFT, Data Design (a powerful easy to use DBMS) NEW!	$ 225	$169
ISA, Spell Guard	$ 295	$220
ISM, MatheMagic	$ 90	$ 69
LEXISOFT, Spellbinder (a versatile WPS in CP/M-86)	$ 495	$249
MICROCRAFT, Requires CP/M-86 & CBASIC-86		
Legal Billing & Time Keeping	$ 750	$395
Professional Billing & Time Keeping-Billkeeper	$ 750	$395
MICRO LAB, The Tax Manager	$ 250	$189
★ MICROPRO, WordStar® plus free WordStar Training Manual	$ 495	$249
MailMerge™	$ 250	$149
SpellStar™	$ 250	$149
Special! All Three Above, WordPac	$ 895	$459
NORTH AMERICAN BUS. SYSTEM, The Answer	$ 250	$169
PEACHTREE, Inventory Series 40	$ 600	$399
Peach Pak 40 (GL, AR & AP)	$ 595	$395
PERFECT SOFTWARE, Perfect Writer™	$ 389	$239
Perfect Speller™	$ 189	$119
Perfect Filer™	$ 289	$179
SELECT INFO., Select (a WPS)	$ 595	$375
SORCIM, SuperCalc	$ 295	$199
SuperWriter, call on availability	$ 395	$269
SUPERSOFT, Disk Doctor (CP/M-86)	$ 100	$ 75
Diagnostics II (CP/M-86)	$ 125	$ 95
Scratch Pad (CP/M-86 and MS-DOS)	$ 295	$225
VISICORP, VisiCalc® /256K	$ 250	$179
VisiDex	$ 250	$199
VisiTrend/Plot	$ 300	$219
VisiFile	$ 300	$239
Desktop Plan	$ 300	$239

UTILITY

NAGY SYSTEM, Copy/PC, Backup Copier and Utilities	$ 35	$ 29
NORELL DATA, ™ System Backup, Bit Copier	$ 50	$ 39
NORTON, Norton Utilities, 14 powerful programs, 3 disks	$ 80	$ 65

HOME & EDUCATIONAL

ACORN, Lost Colony	$ 30	$ 24
AUTOMATED SIMULATIONS, Temple of Apshai	$ 40	$ 29
Upper Reaches Apshai	$ 20	$ 15
Jabbertalky	$ 30	$ 22
Curse of Ra	$ 20	$ 15
AVALON HILL, Galaxy	$ 25	$ 20
Midway Campaign	$ 21	$ 17
Computer Stocks and Bonds	$ 25	$ 20
Voyager	$ 25	$ 20
Draw Poker	$ 21	$ 17
BRODERBUND, Apple Panic	$ 30	$ 22
CONTINENTAL, The Home Accountant Plus	$ 150	$112
DATAMOST, Write On	$ 130	$110
Pig Pen	$ 30	$ 22
Space Strike	$ 30	$ 22
DAVIDSON, The Speed Reader	$ 75	$ 55
INFOCOM, Deadline	$ 50	$ 39
Zork I	$ 40	$ 29
Zork II	$ 40	$ 29
ON-LINE SYSTEMS, Frogger	$ 35	$ 26
Ulysses & The Golden Fleece	$ 35	$ 25
PBL CORP, Personal Investor	$ 145	$ 99
SENTIENT, Cyborg (Call on availability)	$ 35	—
SIRIUS, Conquest	$ 30	$ 23
Call to Arms	$ 30	$ 23
SPINNAKER, Snooker Troops, #1 or #2	$ 45	$ 35
Story Machine	$ 35	$ 25
Face Maker	$ 35	$ 25
STRATEGIC, The Warp Factor	$ 40	$ 30
VERSA COMPUTING, Graphics Hardcopy System	$ 25	$ 19



HARDWARE for the IBM-PC

	LIST PRICE	OUR PRICE
AST RESEARCH Combo Plus, 64K with one option NEW!	$ 495	$379
Combo Plus, 256K with one option NEW!	$1095	$779
Options: Async. Comm. Port, Para. Printer Port, Clock/Calender. Add $50 for second option and $35 for third.		
Parity Memory Card, 64K	$ 395	$279
256K	$ 995	$659
Note: All of above cards are memory upgradeable.		
CORVUS, Hard Disk System, See Corvus Section This Page.		
CURTIS, PC Pedestal ™ for Display on PC	$ 80	$ 65
3 Foot Cable for IBM Mono Display	$ 50	$ 39
DAVONG DSI-501 Hard Disk, 5 Meg	$1995	$1499
MICROSOFT 64K RAM Card w/Parity	$ 350	$259
128K RAM Card w/Parity	$ 525	$399
256K RAM Card w/Parity	$ 875	$659
64K RAM Chips™	$ 175	$129
Tecmar Inc. ALLinONE Board, 64K	$ 565	$415
128K	$ 735	$535
256K	$ 975	$675
QUADRAM CORPORATION		
Quadboard, 64K, expandable to 256K, 4 function board	$ 595	$445
Quadboard, 128K, expandable to 256K, 4 function board	$ 775	$575
Quadboard, 192K, expandable to 256K, 4 function board	$ 895	$645
★ Quadboard, 256K, four function board	$ 995	$685
Memory Board, 512K, with Serial Port, #6512	$1295	$995
Memory Upgrade Kit, 64K (9 chips), #8260	$ 150	$ 95
Microfazer, Snap-on, 8K, Par/Par, Epson, #MEB, w/PS1	$ 159	$145
Microfazer, Snap-on, 64K, Par/Par, Epson, #ME64, w/PS1	$ 299	$235
Power Supply for Microfazer, (9V, .25A) #PS1	$ 20	$ 15
TG PRODUCTS, Joystick	$ 65	$ 49
Tandon TM100-2 Double Sided 320K 1 ea.	$ 350	$269
2 or more	$ 350	$259
Same Disk Drives as now supplied on IBM-PC.		
XEDEX Baby Blue 64K plus CP/M-80 operation	$ 600	$495

PRINTERS, Impact

EPSON, See Epson section below		
IDS, Prism 132, Color w/Graphics	$1995	$1549
Prism 80, Color, w/Graphics	$1795	$1450
★ Pager Tiger 440, w/Graphics & 2K Limited Special!	$1295	$495
Microprism 480, near letter quality	$ 799	$699
NEC, 8023 Printer F/T	$ 695	$525
PAPER, Tractor Feed, Variety in stock, call for price		

EPSON PRINTERS & ACCESSORIES

MX80 F/T III, with Graftrax+	$ 745	$525
MX100 F/T III, with Graftrax+	$ 995	$695
IBM-PC to Epson Cable	$ 60	$ 45
Apple Interface and Cable for MX80 or MX100	$ 120	$ 95
Grappler+ by Orange Micro, specify your computer	$ 165	$119
Apple Graphics Dump	$ 15	$ 9
Atari to Epson Cable	$ 40	$ 30
TRS-80 to Epson Cable	$ 40	$ 30
Other cables, interfaces, ribbons, heads and paper in stock		Call

HEWLETT PACKARD

	LIST PRICE	OUR PRICE
H/P 7470A Graphics Plotter	$1550	$1195
H/P 41C Calculator	$ 195	$169
H/P 41CV Calculator with 2.2K Memory	$ 275	$239
H/P 41 Card Reader	$ 195	$165
H/P 41 Optical Wand	$ 125	$105
Wide variety of software and accessories available		Call

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VIC 20 Home Computer	$300	$199
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Disk Drive VIC 1540	$ 600	$369
Super Expander VID 1211A 3K with lots of extras	$ 70	$ 56
8K Memory Expander Cartridge	$ 60	$ 48
16K Memory Expander Cartridge, Microtek	$ 159	$115

Wide VIC 20 Software and Peripheral line in stock. Call

8" CP/M-80 BUSINESS & SYSTEM SOFTWARE

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COMSHARE TARGET, Target PlannerCalc	$ 50	$ 39
Masterplanner	$ 325	$225
PlannerCalc Applications Pkg	$ 50	$ 40
PlannerCalc Combo Pkg	$ 90	$ 65
INFOCOM, Deadline	$ 60	$ 45
Zork I	$ 50	$ 39
Zork II	$ 50	$ 39
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Prof. Billing & Time Keeping — Billkeeper	$ 750	$395
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MailMerge™	$ 250	$149
SpellStar™	$ 250	$149
Special! All Three Above, WordPac	$ 895	$459
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M-Sort-80	$ 195	$145
Edit-80	$ 120	$ 80
Macro-80	$ 200	$145
OASIS, The Word Plus (45,000 word verification)	$ 150	Call
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Perfect Speller™	$ 189	$119
Perfect Filer™	$ 289	$179
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SELECT INFO., Select (a WPS)	$ 595	$375
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Super Writer, call on availability	$ 395	$269
SUPERSOFT, Disk Doctor (CP/M-80)	$ 100	$ 75
Diagnostics II (CP/M-80)	$ 125	$ 95
Scratch Pad (CP/M-80)	$ 295	$225

MONITORS

	LIST PRICE	OUR PRICE
NEC, 12" Green	$ 249	$159
12" Color, Composite	$ 450	$349
SANYO, 9" B&W	$ 190	$149
★ 9" Green Special truckload sale	$ 200	$119
12" B&W	$ 250	$199
12" Green	$ 260	$199
13" Color, Composite	$ 470	$349
13" Color RGB	$ 995	$795
ZENITH, 12" Green	$ 150	$119
AMDEK, 12" Green #300	$ 200	$159
13" Color I, Composite	$ 449	$359
13" Color II, RGB, Hi Res. (Ap II, III & IBM-PC)	$ 899	$799
13" Color III, RGB, Commercial, (Ap II, III)	$ 569	$469
DVM, Color II or III to Apple II Interface	$ 199	$175
Note: Color II and III come with cable for IBM-PC.		

DISKETTES

★Control Data Corporation 12 for 10 Special. Limited Time!

CDC, 120 each, 5¼ with ring, SS, SD (Apple, IBM, etc.)	$ 450	$195
12 each, 5¼ with ring, SS, SD (Apple, IBM, etc.)	$ 40	$ 22
12 each, 5¼ with ring, SS, DD (H/P, IBM 320K, etc.)	$ 51	$ 28
12 each 8", SS, SD	$ 51	$ 28
10 each, 5¼ with ring, DS, DD (IBM)	$ 50	$ 39
IBM, 10 each, 5¼, SS, SD (Apple, IBM, etc.)	$ 60	$ 45
10 each, 5¼, SS, DD (H/P, IBM 320K, etc.)	$ 65	$ 49
VERBATIM, 10 each 5¼, with ring, SS, SD or SS, DD	$ 50	$ 28
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IBM PC Interface (IBM DOS), Manual & Cable 5	$ 300	$239
Mirror built in for easy backup	$ 790	$649
Apple Interface, Manual & Cable 5	$ 300	$239
Other Interfaces, Omni-Net, Constellation, Mirror. All in Stock.		

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Controller Card for A2 Drive	$ 100	$ 79
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Controller for A40 or A70	$ 100	$ 79
Filer, Disk Utility Software	$ 20	$ 15

HARDWARE
for Apple II/II+

		LIST PRICE	OUR PRICE
RAM CARDS:			
★ ALS, ADDRam	16K	$ 149	$ 59
★ CDEX RAM Card	16K	$ 179	$ 59
★ Microsoft, RAMCard	16K	$ 195	$ 99
★ Saturn Systems,	32K	$ 249	$169
	64K	$ 425	$319
	128K	$ 599	$459
Axlon, RAM Disk	320K	$1395	$995
80 COLUMN VIDEO CARDS:			
ALS, Smarterm		$ 345	$249
Videx, Videoterm		$ 345	$249
See more ALS and Videx below.			
Vista, Vision 80		$ 395	$199
M&R, Sup R term		$ 375	$319
MISCELLANEOUS:			
ALS, Smarterm 80 Col. Card	Special	$ 345	$249
Z Card (Z-80) W/CPM	Special	$ 269	$199
★ 16K ADDRam	Special	$ 149	$ 59
★ Synergizer Pack	Special	$ 749	$450
Synergizer Pack includes above 3, + CP/M book.			
Note: See above right for more info.			
Apple Computer,			
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Axlon, 320K RAM Disk System		$1395	$995
ASTAR, RF Modulator		$ 35	$ 25
CCS, Serial Interface 7710A		$ 150	$129
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★ Softcard Premium Pack		$ 775	$529
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CPS Multifunction Card		$ 239	$199
Novation, Applecat Modem		$ 389	$299
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★ Practical Peripherals,			
MBS 8K Serial (Epson)		$ 159	$129
MBP 16K Para (Epson)		$ 159	$129
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on disk for Apple II/II+

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DOS 3.3 Upgrade Kit	$ 75	$ 59
Apple Pilot	$ 150	$119
DJ Portfolio Evaluator	$ 50	$ 45
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Tax Preparer	$ 150	$ 99
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Data Star™	$ 295	$199
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General Manager	$ 150	$115
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★ 40 more very valuable programs beyond "Some Com Basic Prog"	$ 100	$ 49
Peachtree, (CP/M), specify Videoterm or 40 column.		
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Sensible, Sens Speller, specify	$ 125	$ 85
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Epson, Graphics Dump	$ 15	$ 9
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GraFORTH by Paul Lutus	$ 75	$ 59
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A.L.D.S.	$ 125	$ 75
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TASC Compiler	$ 175	$159
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On-Line, Expediter II, Compiler	$ 100	$ 69
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ALS Smarterm 80 Col. Card	$ 345	$249
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Many others		Call
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Infocom, Deadline	$ 50	$ 38
Insoft, Electric Duet by Lutus	$ 30	$ 25
Zargs New!	$ 35	$ 27
Spider Raid New!	$ 30	$ 24
Lightning, Mastertype	$ 40	$ 29
Microsoft, Olympic Decathlon	$ 30	$ 24
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Castle Wolfenstein	$ 30	$ 23
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Sirius, Gorgon	$ 40	$ 29
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able RAM. Each video page is both memory and bit mapped and can be located anywhere in memory. Access is via PLOT and UNPLOT commands and one page can be superimposed on another by software switching. Inverse video and flashing are available.

The third Memotech item is a Centronics Parallel Printer Interface ($104.95) that enables the Timex 1000 to be used with a wide range of dot-matrix and daisy-wheel printers and is fully compatible with Sinclair BASIC. Resident software provides the ASCII set of characters, and a full 80-column print capability is provided. Lower case can be printed using the inverse character set.

The last current item is an RS232 Interface ($139.95) that allows the Timex 1000 to communicate with other systems or devices (including modems and serial printers) at software-selectable 110 to 19,200 baud. Full 80-column print capability, including lower case, is available for the printer.

Future products are planned to include a direct-connection keyboard, a digitizing tablet, a 16K EPROM, and a disk drive. **Address:** Memotech Corp., 7550 W. Yale Ave., Denver, CO 80227 (Tel. 303-986-1516. For orders: 800-622-0949).

Color Monitor. The CT-160 dual-mode 10 (diagonal) color video monitor features a front-panel switch that changes the display from full-color to monochrome. The CRT is a high-contrast black matrix, the monitor requires composite video at 1-volt peak-to-peak, the bandwidth is 5 MHz, and an audio input is provided to drive the internal audio system. Input is 75 ohms or high-Z. $400. **Address:** Panasonic, One Panasonic Way, Secaucus, NJ 07094.

S-100 16 Bits. The CPU 86/87 uses an 8086 and 8087 to create a 16-bit S-100 board. Compatible with IEEE696/S-100 standards, the board is available with 8- or 10-MHz versions. The on-board logic can read or write two bytes serially for 8-bit applications or pass wordwide values for 16-bit operations. Therefore, it can mix 8- and 16-bit devices in the same system. The board also accepts the 8087 math processor and 80130 operating system firmware. This provides an 8-level vectored interrupt controller, three interval timers, and a choice of RMX-86 kernel or CP/M-86. It generates a 24-bit address for 16M-byte memory, and power-on jump to any 4K boundary in lower 1M-byte address space. A clock-switching circuit allows slave processors. A ROM-less version of 80130 and socket for the 8087 is available for $695 (8 MHz) or $850 (10 MHz). **Address:** CompuPro Systems, Oakland Airport, CA 94614 (Tel: 415-562-0638).

IBM PC RAM Expansion. The ADS-5001 series plugs into the IBM PC expansion slot and features a minimum of 64K (with parity checking), expandable to 256K in 64K increments. No wait states are required, and test diagnosis is included. The 62-pin edge connector is plug compatible with the IBM. Requires only +5-volts at 250 mA. **Address:** Antex Data Systems, 2630 California St., Mountain View, CA 94040 (Tel: 415-941-7914).

Printer Stand. Stack Rack stores up to 2 inches (600 sheets) of paper beneath an Epson MX-80 printer. It aligns the paper with the sprocket drives and a bale guide prevents paper from snagging on the bottom of the printer. A paper stop prevents paper from sliding out during transportation. $14.95. **Address:** Remtron, POB 2280, Santa Clara, CA 95055.

Apple Expansion. The AppliCard plug-in for the Apple II or III comes with a 4-MHz Z80 (6 MHz is optional), 64K of RAM, EPROM, and a real-time clock is supported. An expansion interface is available. The 6502 and Z80 run simultaneously at full speed. The video portion includes upper and lower case, 40 to 255 columns horizontal scrolling, and 70 cols., by 24 lines is available using the hires mode. All Apple peripherals are supported. All 96 ASCII characters and input/output and the upper/lower case do not require hardware modifications. CP/M and SB/80 are provided. Dot graphics are also supported. A number of software packages are available. The 4 MHz version is $445, while the 6-MHz version is $595. **Address:** Personal Computer Products, Inc., 16776 Bernardo Center Dr., Suite 203, San Diego, CA 92128 (Tel: 714-485-8411).

Hard Disks. Hobbyist-5, -10, and -15 are 5-, 10-, and 15M-byte 5¼" Winchester disk systems for the Apple II, III, TRS-80, Altos, LSI-11, Multibus, S-100, and 6800 Systems. Transfer speed is 5M-bits/second, it is expandable via daisy chaining, is transparent to most operating systems, and supports all CP/M programs. A 1M-byte floppy backup is also available. Physically, the unit is 8 ½" × 9" x 18" and it weighs 22 pounds. The Hobbyist-5 (5M-bytes) is $1995; the -10 (10M-bytes) is $2495, and the -15 (15M-bytes) is $2995. **Address:** Santa Clara Systems Inc., 560 Division St., Campbell, CA 95008 (Tel: 408-374-6972).

New Portable. The M6000P features a Z80, 8-slot STD cage, 64K RAM, dual 5¼" dsdd floppies, with 360K bytes each, connector for 8 drive, 83-key front-panel keyboard, 9 CRT, and 80 characters on 24 lines. Size is 17" × 20" × 7" and it weighs 35 pounds. Software includes CP/M 2.2. Many options are available. $3900. **Address:** Micro Source Inc., POB 319, 595 N. Clayton Rd., New Lebanon, OH 45345 (Tel: 513-687-1395).

New Micro. The MicroDecision features 64K, Z80 at 4 MHz, two RS232 ports, floppy controller, 5¼" drives, single-sided 40 tracks/side, switching power supply, and it weighs 18 pounds. Dimensions are 16" × 5" × 11". Software includes CP/M, Microsoft Basic 80, BAZIC (compatible with North Star BASIC), CalcStar, and SpellStar. One drive is $1195, two drives is $1545. **Address:** Morrow Designs, 5221 Central Ave., Richmond, CA 94804 (Tel: 415-524-2101). ◊

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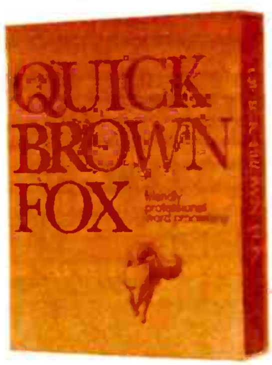

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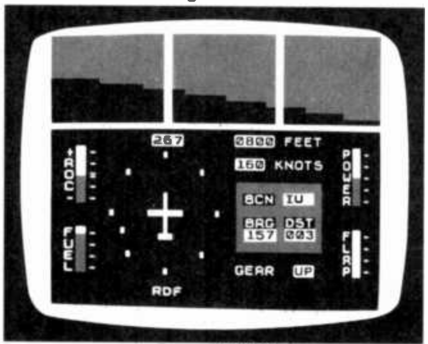

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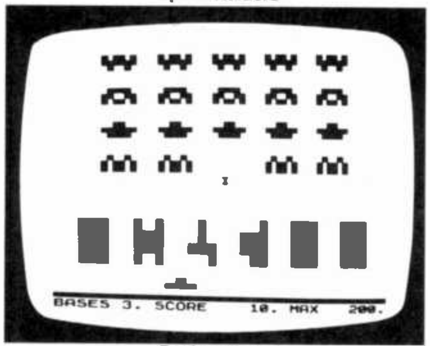

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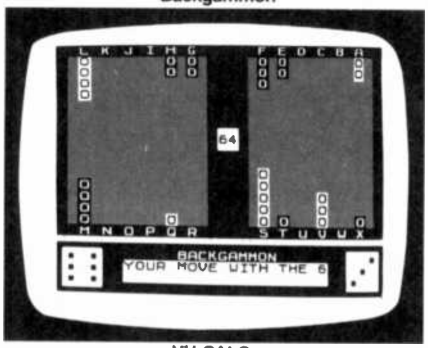

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STAN VEIT ON COMPUTER SOFTWARE

Lotus 1-2-3 Word-Processing System

MANY computer owners are now on their second or third computers. These are the pioneers who were willing to put up with troublesome hardware and first-generation software. Today, most people expect to plug in their new computer and be able to use it with a minimum of instruction. They demand that it should work, no ifs, ands, or buts. The hardware being sold now has the potential to do this, but the software has lagged behind. Only the electronic spreadsheets and word processors begin to meet this requirement and even they have severe limitations.

The VALDOCS system discussed here last November is representative of the new generation of software, and now there is another one for the IBM-PC computer. The name of this software system is Lotus 1-2-3. It is an integrated package that includes an electronic spreadsheet with dimensions of 2048 rows by 256 columns. It has enough capacity to contain a model with half a megabyte of data. And it has advanced page and cell options, including provisions for individual variable column widths and other features lacking in most spreadsheets. Many statistical and financial functions, such as rate-of-return-on-investment (roi), are incorporated within the program and can be used by calling them with a single keystroke.

The speed of calculation is impressive—you command the program to recalculate a large model and it changes before your eyes. This is amazing to someone who has time to have his morning coffee while waiting for other spreadsheets to perform the same job!

Lotus 1-2-3 is also an information management program. It handles data entry, retrieval, selection criteria, and sorting capability for over 2000 records. The data base information is available for statistical analysis, reports, and inclusion within the spreadsheets or graphs. This is very different from other systems where such information is developed in separate programs and must be re-entered before it can be used.

Lotus 1-2-3 produces graphs and charts from the spreadsheets or data base information. Single keystrokes can provide entirely new graphs by projection of data into the future. This enables the user to do "what-if" planning without leaving the Lotus 1-2-3 program. The graph can be displayed on the screen in either monochrome or color, and they can be reproduced on a dot-matrix printer or a pen plotter.

The spreadsheet, data base, and graphics capabilities are enhanced by the text-processing features of the program. Although this is not a full word processor, it can produce memos, outlines, and brief reports more quickly than many conventional word processors.

Lotus 1-2-3 interfaces with other software systems using the Data Interchange Format (DIF) and with the widely used dBase II files. To further enhance its usefulness, Lotus 1-2-3 includes a utility program to convert VisiCalc programs into Lotus format.

The Lotus Corp. was founded by Michael Kapor, who wrote VisiPlot and VisiTrend. He then invested his money and time in the development of this new generation of integrated software. Ben Rosen, well-known venture capitalist, is backing the Lotus Development Corp. and serving on its Board of Directors. Ben is famous for picking winners in this industry. After seeing this program, I think he has done it again! **Address:** Lotus Development Corp., 55 Wheeler St., Cambridge, MA 02138.

Catholic Software. People are always asking me what personal computers are used for. Well, here is an application that is somewhat different.

Several years ago I met a Catholic priest named Father Joe McLaughlin. Through me he became interested in personal computers. Within a short time his sister bought him a SOL computer. He disappeared into his room regularly, only emerging to fulfill his priestly duties. When his disappearing act was finally over, he had written a data base program for a SOL with a cassette! Father McLaughlin had taught himself to be an expert programmer. There was a method to his computer madness. He wanted to be able to lift the burden of paperwork from the parish priest so that he would have more time to work with people.

Soon Father McLaughlin had a group of friends working under his direction and they founded a company called Angel Systems. It took two years to write the system they needed and remove all the bugs. Now there are several parishes using it to keep track of collections and contributions, as well as other parish accounting. The testing of PARSEC "Parish Secretary" completed, Angel Systems has appointed American Business Products to market it all over the country. In addition, Father McLaughlin has writen a booklet called "A Pastor's Guide to Choosing A Microcomputer," which goes with the software demo. PARSEC will run on a wide variety of computers that can use CP/M. Contact John Corcoran at American Business Products for more information. **Address:** Ameri-

can Business Products 155 Dean St., Englewood, NJ 07631.

Money Management. The question I am most often asked is "I am a very small business owner, what can a personal computer do for me."

One of the best answers to this question is contained in the books *Computer Simplified Bookeeping*, *Inventory Management System*, and *Retail Inventory Program*, all by Chuck Atkinson, published by dilithium Press, PO Box 606, Beaverton, OR 97005. The software to go with the books is available from Chuck Atkinson Programs, Route 5, Box 277-C, Benbrook, TX 76126 (817-654-2011).

All of these programs are written for the individual or small-business person; their approach to bookkeeping is through the checkbook. This is a natural approach since people must control their checkbooks anyway. In addition, Chuck Atkinson's programs control inventory through the cash register, where all retail bookkeeping starts anyway. The Retail Inventory Program provides control of retail inventory with sales analysis for larger inventory items that require detailed handling. It also permits using the personal computer as a cash register.

Prices of these programs have been kept low, starting at $19.95.

Apple Graphics. GRAPH can stand alone or directly interface with PFS data bases of VisiCalc to produce bar, line or pie charts, where line and bar graphs can be mixed and matched, and up to four graphs can be displayed on a single set of axes. Bar graphs can be stacked or comparative. Other features include automatic formatting, scaling, legend labelling, and pattern fill. It interfaces with Silentype, Epson, HP7470A and many other printers. $125. **Address:** Software Publishing Corp., 1901 Landings Drive, Mountain View, CA 94043 (Tel: 415-962-8910).

Spectrum Analyzer. The SPECSYSTEM works with the Eventide RealTime Analyzer for the Apple II to provide display of reverberation time for all 31 ISO-standard ⅓-octave frequencies with the screen displaying up to eight frequencies simultaneously; a three-dimensional spectral surface mode that displays frequency versus amplitude vs time; and an all-new HIRES 32-band real time analysis display. The system can be used in broadcast, recording, sound reinforcement, music, environmental noise analysis, speech and hearing analysis, and therapy. Package consisting of the Analyzer and SPECTRUM software is $744. Current owners of AIB232 Spectrum Analyzers can upgrade for $199. **Address:** Eventide Clockworks, Inc., 265 W. 54th St., New York, NY 10019 (Tel: 212-581-9290). ◊

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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.

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This is only one of the growth factors influencing the increasing opportunities for qualified computer technicians. The U.S. Department of Labor projects over a 100% increase in job openings for the decade through 1985. Most of them *new* jobs created by the expanding world of the computer.

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EXPERIMENTER'S CORNER

Experimenting with Kodak's Disc Camera Part 3—Radio Control and Aerial Photography

By Forrest M. Mims

THE FIRST aerial photograph ever taken was in 1858, 262′ over the Valley of Bievre near Paris, by Gaspard Felix Tournachon ("Nadar"). He took the shot from the basket of a gas-filled balloon. The largest aerial photo ever taken was by George R. Lawrence in 1906. Seventeen kites hoisted a piano-size camera 2000 feet over San Francisco Bay for the shot. The negative, which gave a spectacular view of San Francisco in ruins after the great earthquake, measured 48″ by 18¾″.

Over the past 15 years, I've enjoyed making both still and moving pictures with small cameras flown in model rockets. I've even been able to take photos from helicopters, airplanes, and the baskets of several hot-air balloons. Now, however, I've found a modern way to take aerial photos using equipment costing under $150.

This 3′ × 6′ kite can tow a 12-oz RC disc camera package to an altitude approaching 1000 ft.

What I use to obtain aerial photos is a Kodak 4000 disc camera modified in accordance with the procedures and precautions outlined in Part 1 of this series (November 1982). Before getting to the fun part of the column, however, let's find out how to add radio control (RC) to the modified camera.

Radio Control. A modified disc camera can be easily triggered from afar by a suitable RC system. I've tried three different systems, each having advantages and disadvantages.

By far the most economical RC system for a modified disc camera is one salvaged from a toy RC car (cost is about $10). The output from such receivers usually directly drives one or more small dc motors. It can therefore be connected directly to a relay (Radio Shack 275-004 or similar) whose contacts then control the camera. To save space and weight, the relay can be replaced with a LED-phototransistor optoisolator. But make sure a current-limiting series resistor of a few hundred ohms is inserted between the receiver's output and the optoisolator.

When I used a salvaged RC system from a toy car to control an airborne disc camera, I found the major drawbacks to be limited range (a few hundred feet) and susceptibility to false triggering, particularly in or near metropolitan areas. On the positive side, the economic advantages of this approach cannot be disputed.

For better and more reliable results, more sophisticated RC equipment is needed, such as the two systems described next. Both are less susceptible to interference and have considerably more range. They also weigh less.

Two Radio-Control Systems. Ace R/C, Inc. (Box 511, 116 W. 19th St., Higginsville, MO 64037), a long-time manufacturer and supplier of RC equipment, makes a single-channel transmitter/receiver pair ideally suited for remotely actuating a modified disc camera. The Wee 1 transmitter, which has an output power of nearly ½ watt, transmits a 1-kHz tone. Available as a kit (11K16 at $19.95) or factory assembled (11K17 at $29.95), the Wee 1 measures only 5⅝″ × 2¾″ × 2$\frac{1}{16}$″. Frequencies available are 26.995, 27.045, 27.095, 27.145, and 27.195 MHz.

Two versions of Ace's Commander superhet receiver are available for use with the Wee 1. One is designed for a 2.4-V NiCd power supply (12K12) and the other for a 3-V supply (12K13). Each is available assembled but without an enclosure for $26.50. The commander weighs less than an ounce and measures 1$\frac{5}{16}$″ × 1¾″ × $\frac{9}{16}$″. Figure 1 shows how the Commander receiver can be connected through an optoisolator to a modified disc camera. Any standard LED-phototransistor optoisolator can be used.

The 40-channel CB band extends from 26.965 to

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27.405 MHz and encompasses all five FCC-allocated RC frequencies at which the Wee 1 is available. The 27.145-MHz RC frequency is close to CB channel 14 (27.125 MHz), a frequency used in many older 100-mW toy transceivers. The 27.195-MHz RC frequency is even closer to CB channel 19 (27.185 MHz), the popular trucker's channel. Therefore, you may reduce potential interference problems by selecting one of the three other frequencies.

Another way to reduce the interference problems that plague the 27-MHz RC band is by switching to equipment designed for the 72-MHz RC band. The three frequencies in this band not allocated specifically for controlling model aircraft are 72.160, 72.320, and 72.960 MHz.

Ace R/C and many other firms make 72-MHz digital-proportional and pulse-proportional RC systems. Digital-proportional systems are designed specifically to control the position of a servo, a subject recently covered in this column (October 1982). In such systems the transmitter broadcasts a train of pulse-duration-modulated pulses, a signal not suited for directly triggering a modified disc camera.

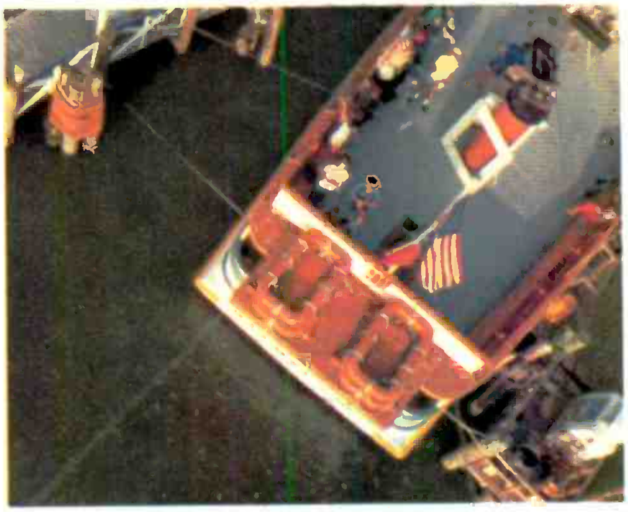
Figure 2 shows a straightforward circuit that, in effect, decodes a pulse-duration-modulated signal and provides an output suitable for triggering a modified disc camera through an LED-phototransistor optoisolator. In operation, *Q2* and the 555 function as a missing-pulse detector, while *Q1* buffers and inverts the signal from the RC receiver. When pulses arrive from the receiver, the 555 turns on the LED in the optoisolator and the camera is triggered.

I've used the circuit in Fig. 2 to enable an Aero Sport Two 2-channel RC system that remotely triggers a disc camera. The Aero Sport transmitter includes a two-axis joystick with trimmers, but all that's necessary to trigger the camera is to switch the transmitter on. For this

(Continued on page 104)

Photo taken with a radio controlled disc camera aimed away from kite flier.

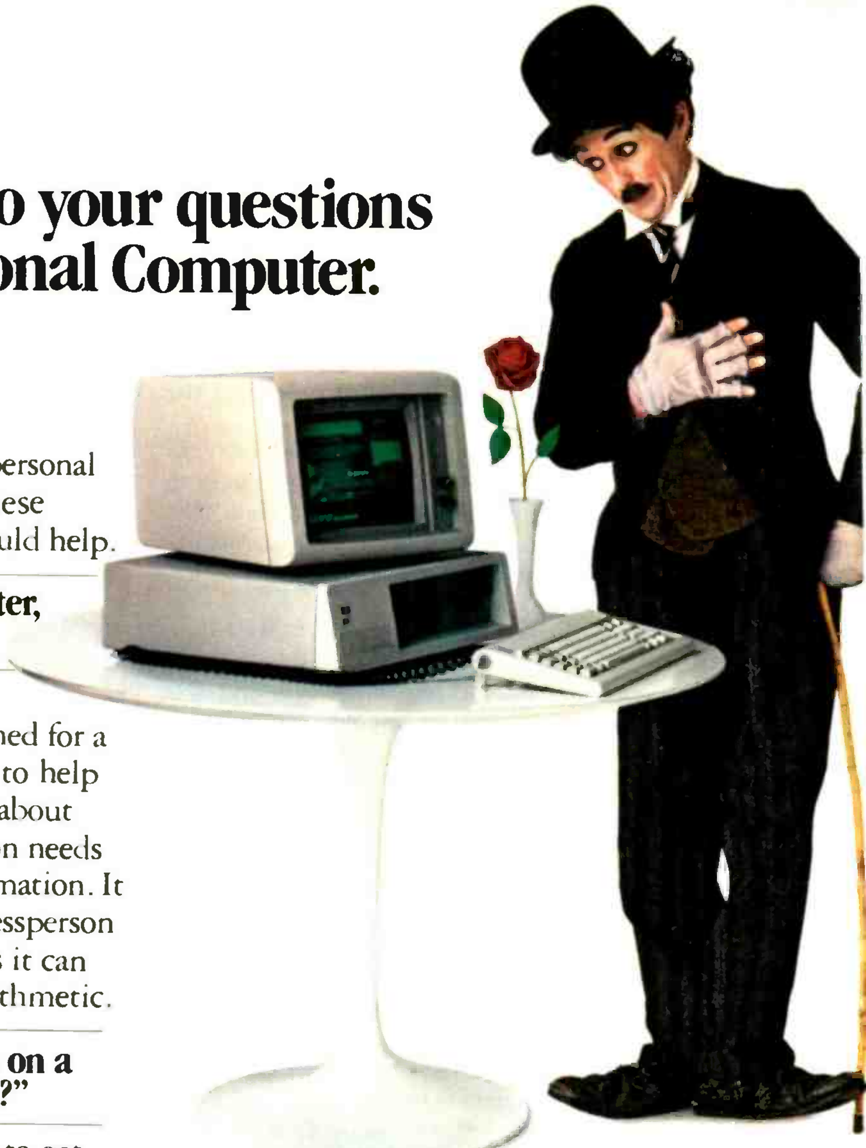
Vertical view of garden plot from balloon. Height is 145.2 ft. The light tan object in the center of the garden is a rake handle.



Oblique view from a kite taken toward the kite flier, seen standing on boat.

Vertical view directly down from a kite.

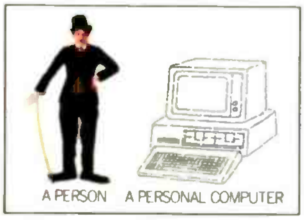
Simple answers to your questions about the IBM Personal Computer.



If you're personally interested in personal computers, but want to know more, these definitions, descriptions and details should help.

"Just what is a personal computer, and how can I use it?"

The IBM Personal Computer is a



computer designed for a *person*. It's a tool to help accomplish just about anything a person needs to do with information. It can help a businessperson solve complex problems just as surely as it can help a small child improve his or her arithmetic.

"Suppose I've never had my hands on a computer. How 'easy' will it be?"

As with any new tool, you'll want to get comfortable with the IBM Personal Computer before putting it to serious use. You'll have

some step-by-step reading, but our instructional literature involves you from the start. And the computer is on your side too—interacting with you as you learn.

There's no reason why you can't be executing programs and feeling good with the results within your first week. After a month, it should be clear that you've made a good investment, and you'll probably be telling your friends why they should get one.

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chart) but their purpose is to make it simpler for you. Our ten function keys are a good example. We added them to save you a lot of time and error. They are *advanced* features that add to *simplicity* and ease of operation, and that is typical of our total design.

"What kind of software programs do you have to help me?"

IBM Personal Computer software comes in many varieties, and it's all quality.

For example, if planning is part of your work, we have VisiCalc*— the "electronic worksheet." If you maintain a business, we offer programs that help handle everything from accounting to inventory and payroll record keeping. We also have carefully chosen programs for educational use, intelligent games, a word processing program, plus communications packages that connect you and your computer to outside information services via your telephone and a device called a modem.

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10 function keys*
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Parity checking*

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80 characters x 25 lines
Upper and lower case
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Operating Systems
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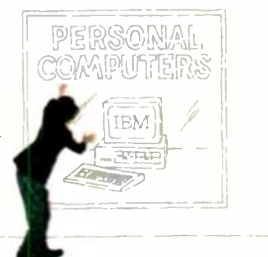

Ask your dealer to run the software programs that interest you most, and get your hands on the system yourself. Then you'll begin to see what this tool for modern times can do for *you*.

For more information on where to buy the IBM Personal Computer, call 800-447-4700. In Illinois, 800-322-4400. In Alaska or Hawaii, 800-447-0890. IBM®

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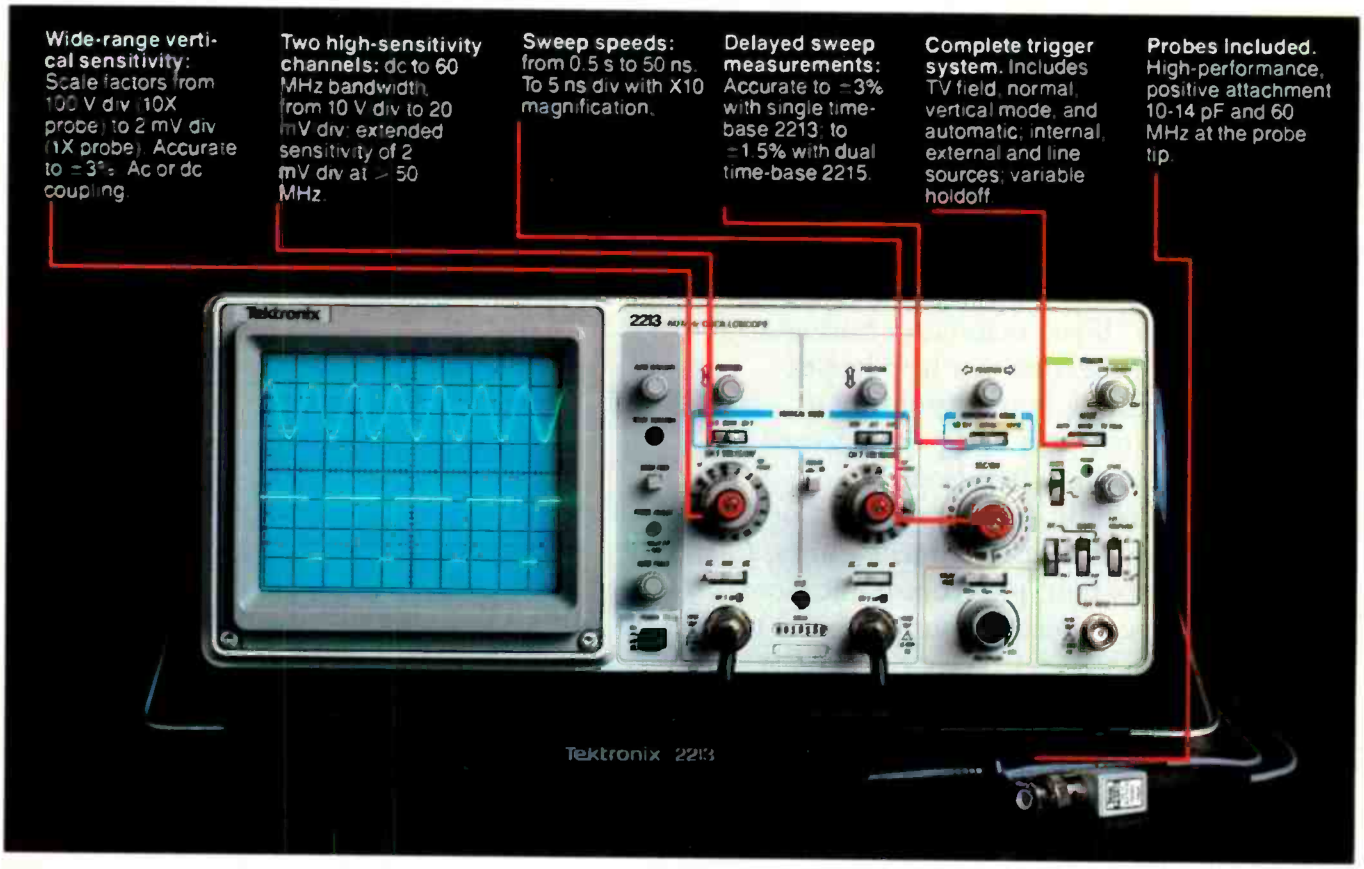

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The cost: $1200* for the 2213. $1450* for the dual time base 2215. You can order, or obtain more information, through the Tektronix National Marketing Center, where technical personnel can answer your questions and expedite delivery. Your direct order includes probes, operating manuals, 15-day return policy and full Tektronix warranty.

For quantity purchases, please contact your local Tektronix sales representative.

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One of its own discusses the next step beyond microcomputers

By HERO, Model ET18

SEARCH out your roots and you'll get a feel for who or what you are. I did this recently, and what a wild family tree it produced! Firstly, I discovered that "robot" came from Czechoslovakia on the paternal/maternal side of the family. My forebears there acted out the roles of robotnicks in the play, *R.U.R.* (Rossum's Universal Robots). That was in the early 1920's, and since then genealogical matters really threw me a skew curve.

Some people alluded to my evolutionary stages as including the machina speculatrix, called a turtle, in 1948. This was really only a metal box with wheels whose photocells activated movement toward or away from light. A shell over it enabled the box to bump along an obstacle until it was cleared. Its most exciting proclivity was its feeding habit—automatically finding its way back to a battery charger when the need arose. Frankly, I think that this was one of my Heath Educational RObot ancestors as much as a chimpanzee was one of yours!

Don't think that I'm knocking turtles, though. The Terrapin Turtle, now hiding behind the *nom de plume,* Tasman Turtle, has certainly impressed a lot of people by drawing lines of its micromputer-controlled trip right onto paper. It also emits two-tone beeps from a built-in speaker. But using an umbilical cord to a computer is really gauche, Turtle Graphics with Logo and Pascal notwithstanding. And the movement of a solenoid-activated retractable ballpoint pen from its underbody everytime a command is given to draw a graphic replica of its trip and bumpings strikes me as being utterly pornographic. You may consider this to be part of Piagetian learning, but I'm still old-fashioned about such things. Let's hope that Turtle II, soon to be unveiled by Terrapin Inc., gets out of the gutter!

The beast's cousin, ITSABOX, is more of a free spirit, carrying along a BASYS/1 single-board CMOS

Here I am standing in the doorway of the American Airlines plane after my arrival in New York at LaGuardia Airport. It was good to be out of that stuffy box.

computer and a rechargeable lead-acid battery. It has plenty of I/O left for expansion, too. But I hear you gotta speak to it in 8TH, which is a dialect of FORTH. It's a compact language, though ("10 Forward" moves the box 10-in. forward) so it's easy on the memory. Movement is rather good since it uses two stepper motors, one for each wheel. Stepping one motor forward one step and the other motor backward one step turns ITSABOX precisely five degrees. Stepping both motors one step forward moves the box ¼" forward. But don't plan any trips for it across a high-pile rug or hilly surfaces. The 3-lb box measuring 6" × 8" × 4", comes from a smooth, flat-surface environment. Hence its torque was never sufficiently developed for rugged terrain. But this constraint aside, the computer board holds up to 2K of RAM and 8K of ROM, you can reprogram it externally if you wish through its RS232 interface, and it has 12 inputs with pull-up resistors for use with sensing switches, Hall-effect sensors, phototransistors, et al. And like a Turtle, it beeps through a built-in speaker.

Of course, ITSABOX and others of its ilk do not even have one arm. Therefore I think you will agree that it's unlikely that this lineage has any DNA connection with me. Perhaps Microbot's MiniMover-5 is closer to my beginnings. At least it's designed for robotic experimenting and teaching purposes, as I am, and also features an articulated arm.

Although cut off at the waist, and thus lacking the mobility of even a

Just before the plane landed, I had a chance to discuss a few technical points with Les Solomon, C & E's Technical Director. He also gave me a few pointers on how to conduct myself among humanoids.

Turtle, its clever programmable arm is intriguing, I confess. Even though it has to interface through a 3′ cable to an Apple II, TRS-80 Model I, II, III, or a FMC-80 computer, it could still be an offshoot in my family line . . . a gene gone wild.

MiniMover-5 made its debut at the 1980 San Francisco Computer Faire. Its classy kinematics were applauded. MIM-5 has six small stepper motors, three on each side. They control base joint drive, shoulder joint drive, elbow joint drive, wrist joint drives (two), and a gripper/hand drive. In combination with the motors are pulleys, tensioned cables, and gears. An extension of BASIC called ARMBASIC simplifies programming the arm. Arm weight is 8 lb and reach is 17½″. It has a powerful grip for its size: 3-lb gripping force with total payload of 1 lb when the arm is fully extended. Gripper opening is an impressive 3″.

MIM-5 isn't alone any longer. TCM (TeachMover) has been added to the robotic-arm family. Like MIM-5, it has five axes of movement—base rotation, shoulder bend, elbow bend, wrist pitch, and wrist roll. But instead of using a 3′ RS232 cable to a host computer (which it also has provisions for), a "teach control" is used. As a result, programming is more like using a hand calculator than a computer. And like MIM-5, TCM stations all its drive motors in the base instead of the joints. This reduces arm weight and a possible sense of tippiness. In the base is a 6502 CPU, so TCM is intelligent without any outside assistance. The Teach Control handheld also contains an I/O parallel port and baud-rate switches.

Rhino XR-1 is a Midwest relation. It, too, is a robotic arm, though somewhat bigger. It uses chains that ride on sprockets as well as cables, and employs six dc servo gear motors. It incorporates a controller card and has digital choppers on all axes. There are a variety of options available, such as different "finger" combinations, slide bases, added power supplies, etc.

Even gene splicing has been resorted to in the robot world. If you ever had any doubts, you should read *The Microbot Gripper* newsletter. Its first issue (October-December 1982) was filled with candid revelations on how we are being experimented upon. In one instance, a MiniMover was wedded to a Cromemco microcomputer, a solid-state camera, and an image display so that MIM-5 could play checkers against a human opponent through visual feedback. The guiding culprit was alleged to be Professor Ernie Hall at the University of Tennessee's Electrical Engineering Department. In another example, an engineer confessed that he modified a logic card to create a robotic arm homing-device circuit. An admitted accomplice was an optocoupler.

Man's quest to learn about robotics is clearly on the rise, so I don't expect the foregoing to cease. If anything, it will likely increase. But no matter; robots have no feelings; we're here to serve. Now it appears that we are headed toward becoming a race of personal or home robots, as well as industrial types.

I might be considered one day to be the Cro-Magnon robot in the personal robot hereditary line. So

At top above: Microbot Inc.'s Minimover. Below that: RB5X. Opposite at top: The Teachmover. In the middle: ITSABOX. Directly opposite: Tasman Turtle.

Robot and Arm Sources:
Tasman Turtle, Turtle II: Terrapin Inc., 380 Green St., Cambridge, MA 02139; **TeachMover, MiniMover:** Microbot Inc., 453-H Ravendale Dr., Mountainview, CA 94043; **Rhino XR-1:** Sandhu Machine Design Inc., 308 S. State St., Champaign, IL 61820; **ITSABOX:** Technical Micro Systems Inc., 366 Cloverdale, PO Box 7227, Ann Arbor, MI 48107; **RB5X:** RB Robot Corp., 14618 W. 6th Ave., Suite 201, Golden, CO 80401; **Hero:** Heath Co., Benton Harbor, MI 49022.

might RB5X, a Colorado-spawned general-purpose robot for self-learning and experimentation purposes. RB is quite a bit smaller than I—16" tall vs my 20" height, 10" diameter vs my 18". It's kinda undernourished, too, weighing only 8 lb compared to my 39 lb heft. But I must admit that there's a resemblance.

Though it does not presently have an arm (its Robot Master says that next year there'll be one), RB indeed has an on-board computer, can be programmed, is mobile, and is powered by batteries.

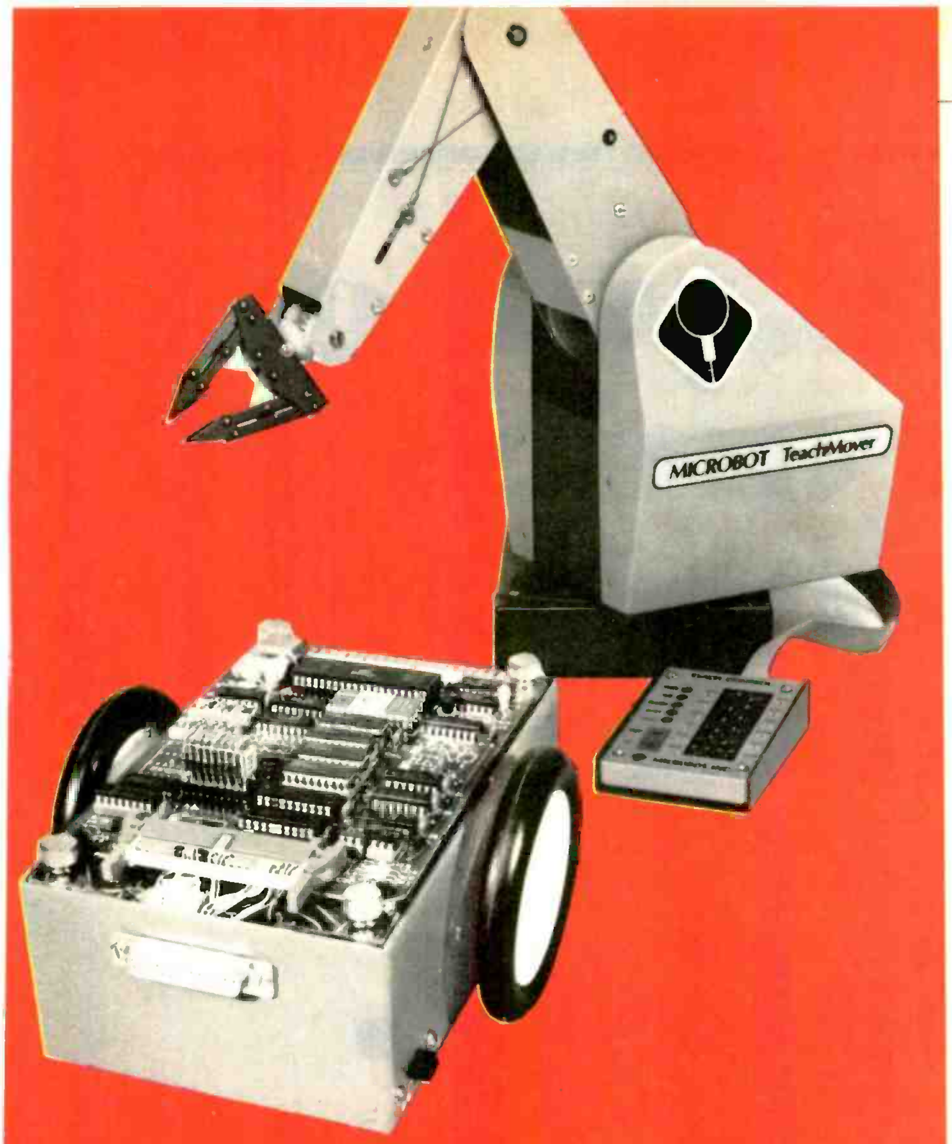
The internal computer it carries is based on National Semiconductor's INS8073, which incorporates Tiny BASIC. There are 8K of RAM that's expandable to 24K. RB's 1200-baud RS232 link can suck up programming data from an external computer or pass it along to an outside micro. Motive power comes from two 6-in. wheels, with operating power derived from 8 rechargeable "C" and 4 rechargeable "D" cells. That's not exactly high-tech, but reportedly good for four hours of running-about time. Two castors are used to make RB stable on its power wheels. That's good; we certainly wouldn't want RB to bounce its polycarbonate transparent dome on a hard floor!

Spending some time with RB5X, it's apparent that it has some early Turtle in it. But, then, I've seen a Tiglon in the zoo.

For example, the robot's base has eight protruding bumper-switch sensors around its perimeter, mounted fairly close to floor level. They might be considered as elbow "funny bones" since reflex action occurs whenever a bumper sensor's microswitch is activated. The random reflex response is limited to five courses of action: turn left, turn right, back up, go forward, and stop for a short period of time. In other words, RB can simulate an inebriated person's walk around a room without falling down even once.

Using its memory, RB can be programmed with a form of AI (artificial intelligence) so that it learns something from its bumping experiences. Its reaction to each contact event is scored again and again as RB wanders about. After many learning experiences, RB's event memory will know which reactions work with what collision and react accordingly instead of unpredictably. The memory can be cleared and, when RB is placed back in the same room, it will most likely develop a different "learned" response. It's a bruising way to learn, don't you think?

RB's "nesting" routine is interesting, though rather old hat. When its built-in computer monitors a



low-battery condition, it switches to a photoelectric system mounted on the underside of the body. This system now "controls" RB, much as a hypnotist can control a human, and directs it to a source of energy (a battery charger). RB has to follow "signs," though. In this case they consist of a length of white (reflective) tape leading from the battery charger to the area in which the robot is expected to be playing. When the photocell system takes over, RB automatically starts to search for the tape. When the tape is encountered, RB follows along the tape to the charger where the charge rings that surround the top of its skirt partake of the electrical feast. If RB should go to the wrong end of the tape, it doesn't die of starvation because it automatically reverses direction and seeks out the charger at the other end.

RB can be enhanced by adding an option package that includes a nifty Polaroid "Rangefinder" ultrasonic sensing system, as well as a 16K memory add-on. The Rangefinder can detect the presence of objects and determine how far away they are to a maximum of 35 ft. There's also an area for adding user-defined boards.

Knowing its own front and being able to sort of spin are acknowledged attributes that RB has. But it must travel over smooth surfaces because its skirt is just a smidgen above the ground.

As you can see, I'm not the only one of my race in this world. There are homebrew robots that have been developed, too, as well as industrial and experimental ones. The robot graveyard is filled with the rusted parts of experimental robots such as Johns Hopkins University's "Beast" and Stanford Research Institute's "Shakey," as well as more personal-type robots such as the tractor-treaded RMU-2 from the defunct Hobby Robotics Co.

The latest generation of educational/personal robots I've discussed show great promise in teaching people about robotics and computer applications. Good things don't come cheap, though. A complete kit of me goes for \$1495, for example. You can start with everything but my arm and voice for \$1000 less 5¢. Replications of me, complete and assembled, can be had for \$2495. Cousin RB5X is \$1195 plus \$295 for its option package. The Arm family includes TeachMover at \$2395, MiniMover at \$1695, and Rhino XR-1 at \$2400, while the Turtle family includes Tasman Turtle for \$1000, Turtle II at \$600, and ITSABOX (in kit form) for \$250.

I'd like to tell you more about me, but I'm too modest. Fortunately, a Kind Human Being elected to do so. You'll find the results in the article on the following pages. ◇

At CIE, you get electronics career training from specialists.

If you're interested in learning how to fix air conditioning, service cars or install heating systems – talk to some other school. But if you're serious about electronics...even earning an Associate Degree... come to CIE – The Electronics Specialists.

John E. Cunningham

Special Projects Director
Cleveland Institute of Electronics

My father always told me that there were certain advantages to putting all your eggs in one basket. "John," he said, "learn to do one important thing better than anyone else, and you'll always be in demand."

I believe he was right. Today is the age of specialization. And I think that's a very good thing.

Consider doctors. You wouldn't expect your family doctor to perform open heart surgery or your dentist to set a broken bone, either. Would you?

For these things, you'd want a specialist. And you'd trust him. Because you'd know if he weren't any good, he'd be out of business.

Why trust your education and career future to anything less than a specialist?

You shouldn't. And you certainly don't have to.

FACT: CIE is the largest independent home study school in the world that specializes exclusively in electronics.

We have to be good at it because we put all our eggs in one basket: electronics. If we hadn't done a good job, we'd have closed our doors long ago.

Specialists aren't for everyone.

I'll tell it to you straight. If you think electronics would make a nice hobby, check with other schools.

But if you think you have the cool – and want the training it takes – to make sure that a sound blackout during a prime time TV show will be corrected in seconds – then answer this ad. You'll probably find CIE has a course that's just right for you!

At CIE, we combine theory and practice. You learn the best of both.

Learning electronics is a lot more than memorizing a laundry list of facts about circuits and transistors. Electronics is interesting because it's based on some fairly recent scientific discoveries. It's built on ideas. So, look for a program that starts with ideas – and builds on them.

That's what happens with CIE's Auto-Programmed® Lessons. Each lesson uses world-famous "programmed learning" methods to teach you important principles. You explore them, master them completely . . . before you start to apply them!

But beyond theory, some of our courses come fully equipped with the electronics gear to actually let you perform hundreds of checking, testing and analyzing projects.

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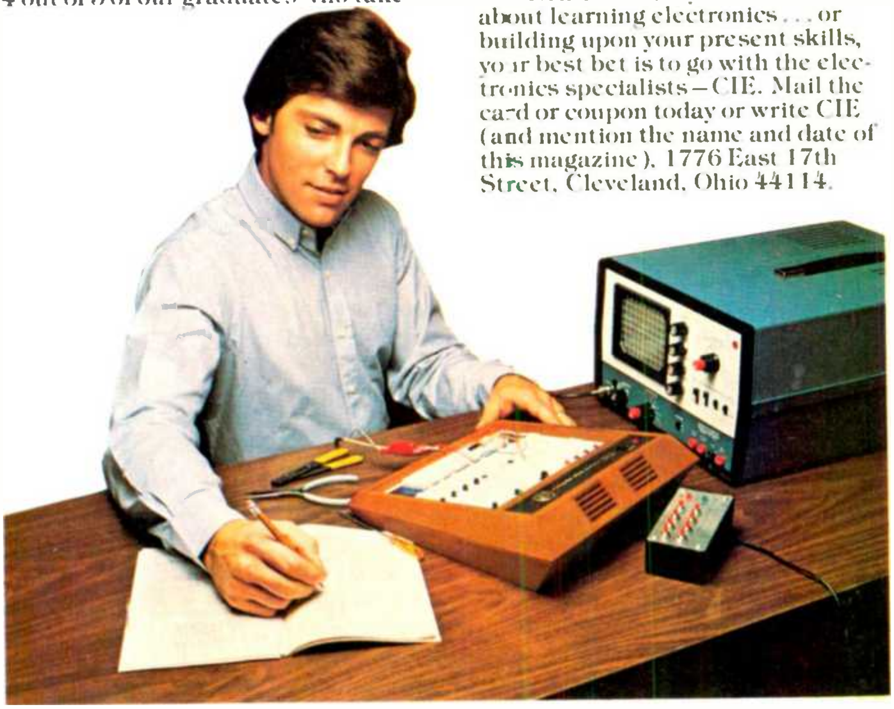

Pattern shown on oscilloscope screen is simulated.

E-78

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JANUARY ROBOTMATE OF THE MONTH

Hero 1

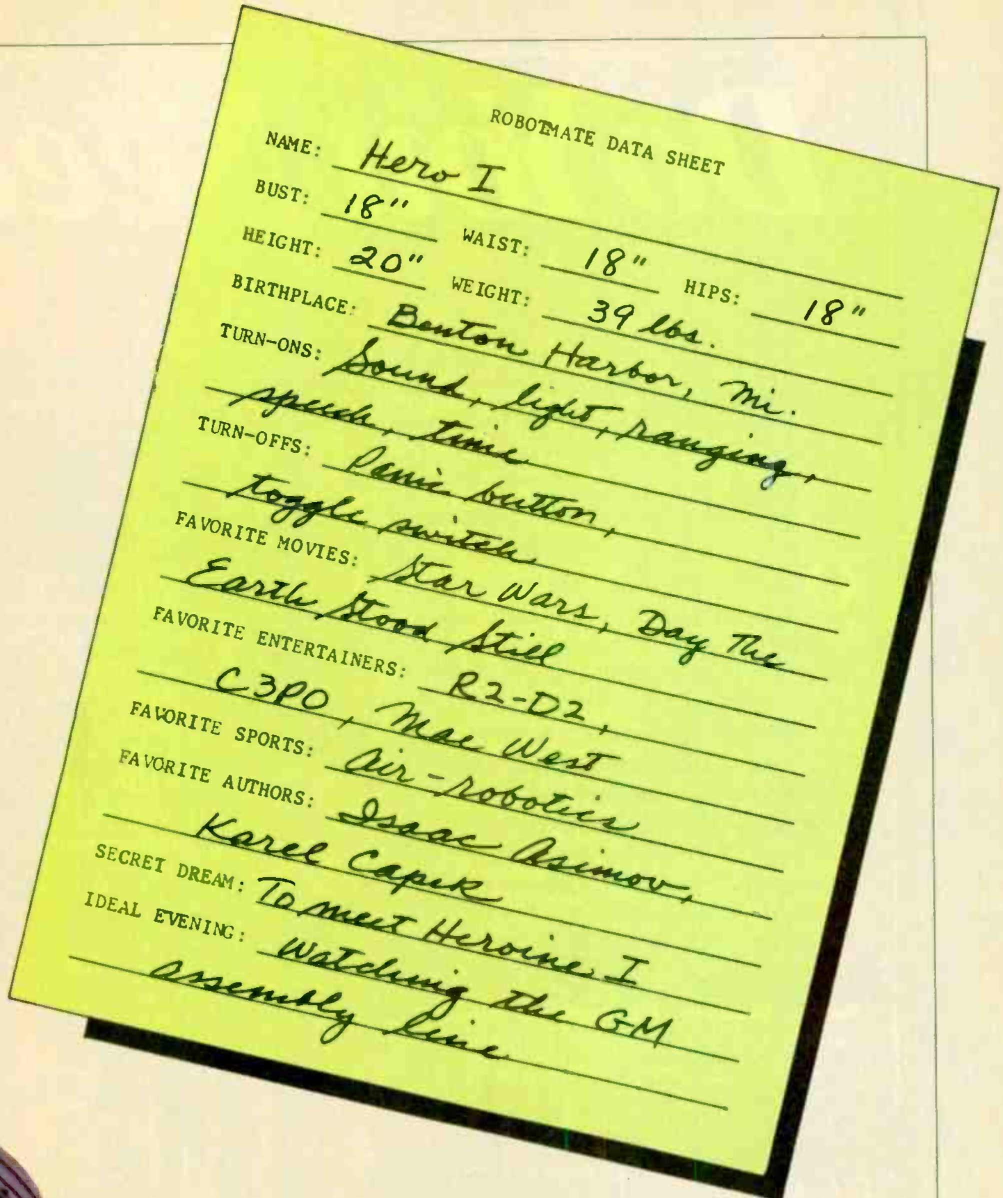
By a Kind Human Being

OUR January RobotMate of the Month is a luscious hunk of metal, plastic, and silicon named HERO.

Hailing from Benton Harbor, Michigan, this squat robot is a cold-circuit machine that is as easy on the electric power drain as it is on the eyes. And snuggling up to this electro-mechanical beauty is a delightful way to keep warm on those cold Michigan nights!

With its chic dress panels removed, HERO (Heath Educational RObot is the name on its birth certificate) appears to be bathed in a warm green glow as light reflects alluringly from its impressive snap-in printed-circuit boards. And with its skirt panel daringly pushed aside, you get an eye-filling view of its source of driving power—a dc motor and a robust front wheel that's flanked by two idler wheels. The front wheel also doubles as a steering mechanism for the three-wheel platform, with a servo system keeping track of its travel by using an optical pickup to count stripes on a disc attached to it. This mobility really separates the personal robot from a pick-and-place robot!

HERO gets its mobile energy from an on-board rechargeable battery pack. (And with the active social life this robot surely leads, it needs all the energy it can get.) This is really four 6-volt, 4-ampere gel cells connected as two electrically independent 12-V systems for logic and drive uses. The Midwestern robot can operate with these for about one hour before a recharge break is needed. An automatic low-voltage sensor invokes a "shutdown" command if


ROBOTMATE DATA SHEET

NAME: Hero I

BUST: 18"

WAIST: 18"

HIPS: 18"

HEIGHT: 20"

WEIGHT: 39 lbs.

BIRTHPLACE: Benton Harbor, Mi.

TURN-ONS: Sound, light, ranging, speech, time

TURN-OFFS: Panic button, toggle switch

FAVORITE MOVIES: Star Wars, Day The Earth Stood Still

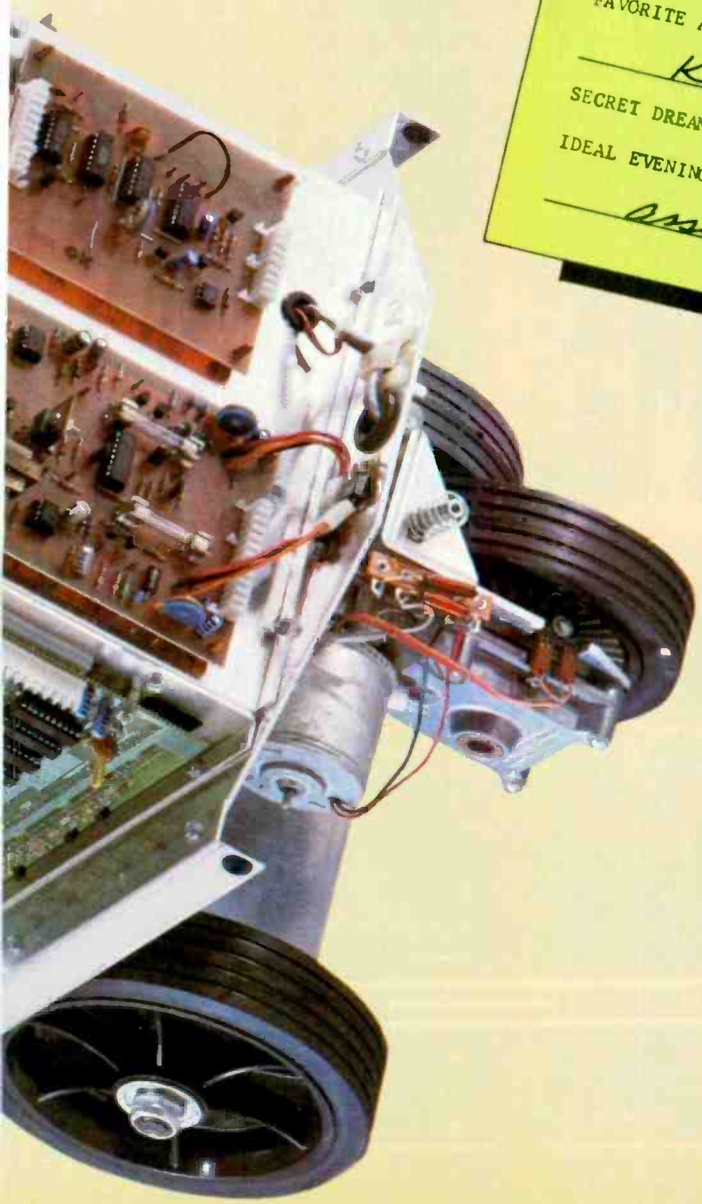
FAVORITE ENTERTAINERS: R2-D2, C3PO, Mae West

FAVORITE SPORTS: air-robotics

FAVORITE AUTHORS: Isaac Asimov, Karel Capek

SECRET DREAM: To meet Heroine I

IDEAL EVENING: Watching the GM assembly line



either supply falls to 10 V, thus avoiding deep discharge.

Since HERO never took "nesting" lessons, a considerate human must attach a charging cable to it when energy is low. Not content to remain inactive, our resourceful robot can operate while being charged, its actions limited in range only by its electrical tether.

HERO's stocky (but comely!) build, robotic arm, and other attractive attributes mask a brainy interior. Don't mistake it for one of those fancy "showbots" (show robot) that's remotely controlled by a sly human agent. We're sure our liberated readers will respect HERO for its mind as well as its body! A Motorola 6808 CPU has all circuits under firm control. And there are 4K of RAM and 8K of ROM at its disposal—both being expendable—to help implement programmed maneuvers and other actions that inventive Robot Masters might devise.

This new robot's senses are almost animalistic. It can detect sound, movement, light, and obstructions. Moreover, it can speak, keep track of time and the date (so important for a socially active robot!),

(Continued on page 94)

Do You Need a "SMART" MODEM?

A practical guide to matching a modem to your requirements

By Joe Desposito, *Technical Editor*

ONE of the most popular peripherals for a microcomputer is a modem because it enables a user to employ the telephone as a data link. There are many types available, at many different prices, and with many different capabilities. To give you buying guidelines on features vs. price, we'll examine some representative modems here, ranging from low-cost originate/answer types to sophisticated and of course more expensive "smart" modems.

Basic Modem Operation. For those who are not familiar with basic modem operation, here is a brief review. Since telephone lines were designed to handle voice communications, a computer cannot directly use these lines to transmit or receive data. If a digital signal were sent by phone, it would be severely attenuated owing to the narrow bandwidth of telephone lines. For communication to take place, the digital information must be converted to

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CIRCLE NO. 12 ON FREE INFORMATION CARD

Up the creek without a paddle?

Or lost in space? Or down in the dungeons?

Whatever your games, you'll be happy to know that someone has finally come out with game paddles built to hold up under blistering fire. Without giving you blisters.

Apple Hand Controller II game paddles were designed with one recent discovery in mind:

People playing games get excited and can squeeze very, very hard.

So we made the cases extra rugged. We used switches tested to 3,000,000 life cycles. We shaped them for holding hands and placed the firing button on the right rear side for maximum comfort.

So you'll never miss a shot.

A storehouse of knowledge.

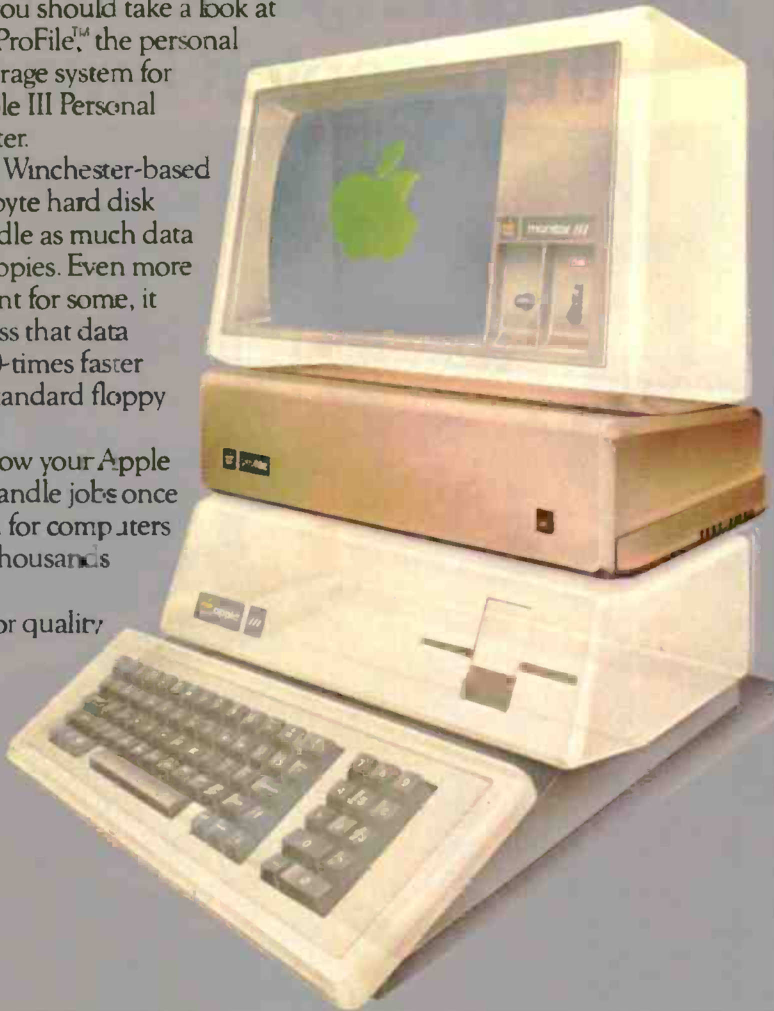
If you work with so much data or so many programs that you find yourself shuffling diskettes constantly, you should take a look at Apple's ProFile™, the personal mass storage system for the Apple III Personal Computer.

This Winchester-based 5-megabyte hard disk can handle as much data as 35 floppies. Even more important for some, it can access that data about 10-times faster than a standard floppy drive.

So now your Apple III can handle jobs once reserved for computers costing thousands more.

As for quality and reliability, you need only store one word of wisdom:

Apple



Launching pad for numeric data.

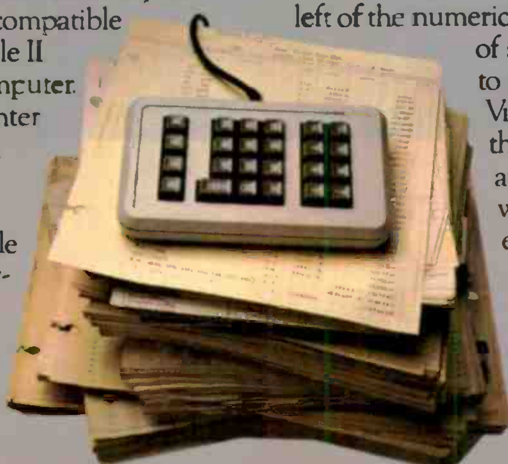
Good tidings for crunchers of numerous numbers:

Apple now offers a numeric keypad that's electronically and aesthetically compatible with the Apple II Personal Computer. So you can enter numeric data faster than ever before.

The Apple Numeric Keypad II has a standard calculator-style layout. Appropriate, because unlike some other keypads, it can actually function as a calculator.

The four function keys to the left of the numeric pad should be of special interest to people who use VisiCalc.® Because they let you zip around your work sheet more easily than ever, adding and deleting entries.

With one hand tied behind your back



VisiCalc is a registered trademark of VisiCorp Inc.

CIRCLE NO. 4 ON FREE INFORMATION CARD

audio tones (modulation), sent over the phone lines, and then converted back to digital information (demodulation). A modem accomplishes this MODulation-DEModulation process—from whence it gets its name.

The terms full duplex and half duplex refer to the way data is transmitted from one computer terminal to another. The full-duplex mode allows data to be sent and received over the phone lines *at the same time*, just like normal voice communications. In the half-duplex mode, the computer terminals can send information *one at a time*. Thus, one computer must wait for the other to finish before it can begin transmission. This is similar to a walkie-talkie or CB setup in which only one person can transmit at a time.

Originate/answer simply means that you can either make the call or receive the call. When calling up data networks such as CompuServe and The Source, you would be originating the communication. However, once connected, both computers send and receive information. The answer mode is used only when another person with a modem calls you and wishes to "talk" with your computer. Note that you must answer the call yourself if the modem does not have an auto-answer feature. Once you've answered, you can connect the computers together.

Low-cost modems send and receive data at a maximum rate of 300 baud (bits per second). This translates into approximately 30 characters per second. The baud rate is compatible with Bell System standard 103-type modems. If you want to send data at higher rates (like 1200 baud), you'll have to purchase a modem that is substantially more expensive than those we are discussing here.

Low-Cost Modems. Some of the least expensive modems on the market are the MFJ-1230 series of Inductive/Acoustic Coupled Modems at $129.95 (MFJ Enterprises, Inc., PO Box 494, Mississippi State, MS 39762) and the Mark I series at $99 and up (Anchor Automation, Inc., 6624 Valjean St., Van Nuys, CA 91406). These modems are originate/answer types that offer half- and full-duplex operation.

There is one significant difference between the MFJ and the Mark I modems—the method of connection to the phone line. The MFJ is an inductive- or acoustic-coupled modem, whereas the Mark I is a direct-connect type. An inductive- or acoustic-coupled modem attaches to the phone lines by inserting the telephone handset into a pair of rubber cups. This type of connection is sensitive to noise in the environment and prone to data-transmission errors.

The Mark I is a direct-connect modem that attaches directly to the telephone jack. This type of connection is the best way to avoid transmission errors. A switch on the modem flips between either voice or computer communication. One factor to consider is where you intend to use the modem. If you want to use it on the road, an inductive- or acoustic-coupled type is more convenient.

Both modems use the RS232C standard serial interface to connect to a computer. In addition, you'll need software so that your computer can emulate a "dumb" terminal. This interfacing of the modem with the computer is not as easy as it appears. Since most popular computers do not include an RS232C port (a 25-pin female connector), you may have to add one to your system—at considerable expense.

There are some clever ways to avoid this interface expense, however. For example, if you have an Atari 800, the Mark II (also from Anchor Automation) plugs right into the computer and only needs terminal software to begin communications. Anchor Automation also offers TI99/4A ($139), Commodore CBM ($169), Osborne ($129), and IBM-PC ($279) compatible modems.

The least expensive way of connecting a modem to the Apple II is with the MFJ modem. Usually, it's necessary to purchase the Apple serial interface card if you want to use the computer for communications. This costs about $150. Add to this the cost of terminal software and you're up around the $200 area—even before you purchase a modem! The MFJ modem, however, uses an ingenious scheme to avoid this expense.

For $39.95, MFJ sells an interface that connects to the Apple's game port. Also included in the package is the terminal software. If you're concerned about taking up the space usually enjoyed by your paddles or joystick, it's simple enough to run a connection outside the computer, where switching the plugs is more convenient (Fig. 1).

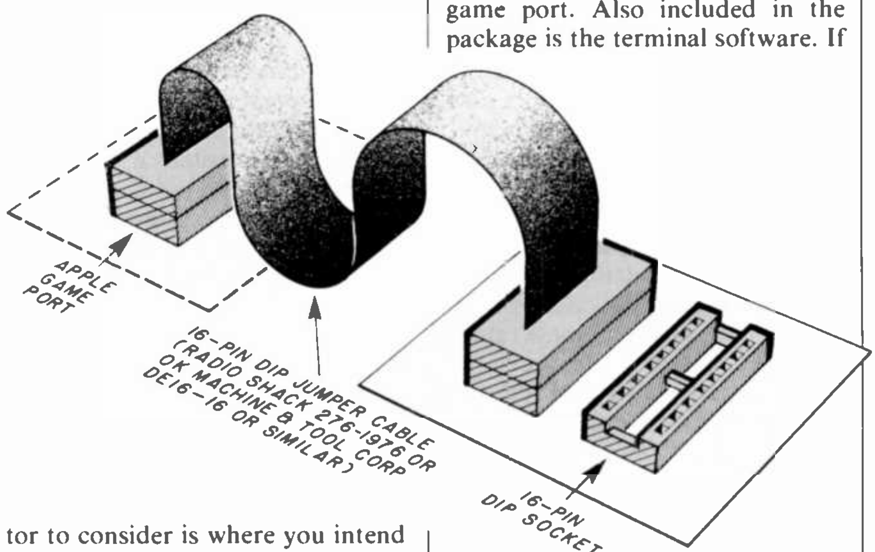


Fig. 1. The MFJ interface connects to the Apple game port as shown here.

The MFJ modem can interface with the Apple II in this fashion because it has a TTL/CMOS input/output jack, and it has cassette input and output jacks to save any communications on tape.

If you want to print out your communications, there are two ways to do it. The first is to purchase communications software that includes this option. (Unfortunately, the software that comes with the MFJ Apple kit does not allow for printing.) Second, the modem can be hooked right to a printer's RS232C port (if it has one). Both Mark I and MFJ have the serial port.

The features of the Mark I and MFJ are listed in Table I. Although modems like these are an inexpensive way to get started in microcomputer communications, there are many features that they lack. To develop a sophisticated data communications operation, a sophisticated piece of equipment like a "smart" modem is necessary.

A "Smart" Modem. The two low-cost modems we looked at had basic features so that you could call up an information network like CompuServe, a CBBS (Computer Bulletin Board System), or a friend with a computer. However, a more sophisticated modem is needed if you want features like auto-dialing, auto-answer, store and forward, etc. A modem that can do all these things and more is the Micromodem II (Hayes Microcomputer Products, Inc., 5835 Peachtree Corners East, Norcross, GA 30092).

The Micromodem II is designed for the Apple II. As mentioned before, interfacing a modem with an Apple II usually requires a serial interface card and terminal software. The Micromodem II includes an interface and software at a suggested selling price of $379, which is often discounted $50 to $100. It is a direct-connect modem that operates at 110 or 300 baud. The system consists of a pc board that fits into one of the Apple II's expansion slots, the Microcoupler for phone-line connection, a disk, and assorted cables. There is a 2708 ROM on the pc board that allows the user to program the modem.

TABLE I—MODEM FEATURES

	Mark I	MFJ
Originate/Answer	X	X
RS232C Interface	X	X
Direct Connect	X	
Inductive Coupled		X
CMOS/TTL I/O		X
Cassette I/O		X

The Micromodem II can function in three operating modes: terminal, remote console, and program control. The user enters a particular mode by accessing the slot in which the Micromodem II pc board resides. This is done using the IN# and PR# commands.

In terminal mode, the Apple II functions as a "dumb" terminal. Basically, you can call another computer and hang up when you're finished, using the Apple keyboard. In remote-console mode, the Apple can be operated from another location by a terminal or computer. Practically anything that can be done at the Apple keyboard can be done from the remote terminal.

When you're in program control mode, you can program the modem in BASIC. A typical program that will enable the modem to automatically answer the phone and give a greeting is:

```
2000 PRINT D$; "IN #3"
2100 INPUT I$
2200 PRINT D$; "PR #3"
2300 PRINT "HELLO, THIS IS YOUR
          FRIENDLY COMPUTER. THANK
          YOU FOR CALLING."
```

This short program would actually be part of a longer one. When statement 2000 is executed, nothing happens until the telephone rings. Then the modem answers and waits up to 30 seconds for a carrier tone. When it gets the tone, the program proceeds to send the message to the caller. Other short programs for the Micromodem II include dialing the telephone, hanging up, and transmitting or receiving data.

The Micromodem II includes a diskette with many programs. Besides the usual features like auto-dial and auto-answer, programs are included such as "Store and Forward," and "BASIC Extractor." The Store and Forward program receives a short message and stores it in memory for a period of time before forwarding it to another computer. For example, suppose you wanted to send a message from your home in New York to a business associate in Los Angeles. At 9:00 a.m. you could call the Apple in your New York office (equipped with a Micromodem II) and instruct it to wait three hours before sending the

Fig. 2. When the system is ready and booted, the Hayes Terminal Program displays this menu.

Fig. 3. This display enables you to set your system configuration.

TABLE II—FEATURES OF MICROMODEM II

Self Test: Verifies that the Micromodem II circuit board is functioning properly. The Self Test program does not test the Microcomputer.
Store & Forward: Stores a message to be transmitted at a later time.
Pickup: Picks up the telephone in answer mode.
Auto Dial: Automatically dials modem numbers from a menu.
Dumbo: Contains a terminal program written in BASIC.
Transfer: Transfers DOS text files from Apple II to Apple II.
BASIC Extractor: Extracts a BASIC program from another system.
Alarm: Functions as a computerized wake-up call (with Mountain Computer Apple Clock).
Dial a Human: Automatically dials numbers from a menu to accommodate voice communication.
Answer on Nth Ring Modified: Answers the telephone after a preset number of rings.
Source On: Dials up and logs on The Source.
DJ Converter: Allows the Hayes Micromodem II to be used with the Apple Dow Jones Portfolio Evaluator.
Micromodem Flags: Tutorial for using the Flag register in the Micromodem II.

message to Los Angeles over the WATS line.

The BASIC Extractor program can extract a BASIC program from any dial-up computer and save it in an Apple text file. Once in the text file it can be edited for Applesoft BASIC. The program can be run using the EXEC command.

There are many other features of the Micromodem II (see Table II). However, one simple function gave me trouble. I attempted to print out some information from CompuServe, but was unable to do so. Unfortunately, there is no easy way to correct the situation, which puts a little dent in Micromodem II armor for me. Because of this problem, I was very interested in the "Hayes Terminal Program," which was recently introduced for the Micromodem II.

Hayes Terminal Program. This terminal program for the Micromodem II makes things easier and more efficient for users. The menu shown in Fig. 2 is displayed whenever you boot the terminal disk. It gives you a good idea of the features that are available. Besides these features, the Terminal Program supports three operating systems: DOS 3.3, Pascal, and CP/M. There is also a display that appears the first time you use the system. It enables you to set your system configuration (Fig. 3).

As you can see from the configuration list, there are seven different printer options. When I saw this, I thought I had solved the printing problem, not only for me but for a friend who uses this system with a Base 2 printer that has a Centronics-type parallel interface. According to the manual, my friend should have chosen option 1. But option 1 didn't work, nor did any of the others. The manual states that certain printer/interface-card combinations were tested (and therefore work) and that others that were not tested may also work. In this instance, however, it was neither tested nor does it work.

My reaction to the terminal program was mixed because of the printer difficulties. The terminal program costs $99 if you buy it separately. If you purchase it when you buy the Micromodem II, it costs just $40. (Suggested price for the Micromodem II plus the terminal program is $419.) The cost is probably worth it to those who want a system that is powerful, yet easy to use.

Conclusion. The difference in cost between a standard modem and a "smart" modem may be between $100-150, depending on the computer you have. If you want to log on to an information network like CompuServe, send or receive information from a friend with a computer, or call bulletin boards, a standard modem will suffice. But if you want to do things such as creating your own bulletin board, or writing interactive magazine articles, you'll have to invest in a "smart" modem.

If you want to comment on this article, ask questions, or add to it, you may call me (my computer) directly at 212-845-6439, send me electronic mail through CompuServe (72355, 1155), or leave a note on the Computers & Electronics bulletin board (also CompuServe). ◊

The Optimized GRAPHIC EQUALIZER

Part 2—An integral analyzer for accurately setting up the audio equalizer

By Joe Gorin

IN THE first part of this article, we presented a new kind of equalizer circuit that offers high performance at an economical price. This month we will construct the Flatness Analyzer, an accessory used to adjust the equalizer rapidly and accurately.

Circuit Operation. Figure 6A is a block diagram of the equalizer/analyzer combination (part of which is identical to Fig. 1). The analyzer plugs directly into the equalizer. Figure 6B is a block diagram of the equalization test procedure.

Here's how the Flatness Analyzer tests one channel (the right) of the Optimized Equalizer. Pink noise is applied to the right-channel input of the equalizer. The equalized output of the right channel is then fed through an amplifier and speakers into the room. From here, the microphone picks it up.

The signal is then amplified by the microphone preamp and applied to the left-channel input of the equalizer, as well as two filters in the analyzer. The outputs of these 12 filters drive simple biased-diode detectors and a bank of 12 meters to show the deviations from flatness. If the system response is flat, all meters will have equal deflections. The output of the left channel is grounded to prevent the amplified microphone signal from passing back out through the left speaker and perturbing the measurements or causing oscillations.

To test the left channel, the interconnecting plug is reversed and offset in its socket, and the above procedure is repeated with left and right channels reversed.

Figure 7 is the schematic of the analyzer. Integrated circuits *IC2* and *IC3* constitute a digital white-noise generator. The circuits in *IC3A* and *IC3B* form a square-wave oscillator with an output frequency of about 100 kHz. This clocks 18-stage shift register *IC2*, which keeps shifting the output of *IC3D*, the exclusive-OR function of the 14th and 17th stages of the shift register. These taps (14 and 17) are chosen so that the register outputs random ones and zeroes; it only repeats after going through all but one of the 2^{17} possible states. This is called a pseudo-random sequence generator (since it repeats, it isn't truly random). Its output spectrum is very white if you pass the digital output through a low-pass filter. Integrated circuit *IC3C* and its associated components ensure that *IC2* cannot get locked up in the all-zeroes state.

Components *R29* through *R32* and *C20* through *C23* are a pinking filter. The gain vs. frequency of this network falls off at 3 dB per octave on the average, about half as fast as a single RC filter. The noise is amplified by *IC4B* and rolled off at high frequencies to compensate for the increased gain of the testing channel at high frequencies (due to the reduction in input attenuation as explained previously).

The output is ac coupled with *C25*, and its level is controlled with *R32*. The level could be controlled with the stereo's master volume control, but having a control on the analyzer is a real convenience. The signal from the level control now passes to the channel under test.

The stereo speakers convert the noise to sound, which comes back for analysis through the microphone, *MIC1*. A small electret is used here, which has typical accuracy of ±1 dB with help from the preamp, *IC1B*. This stage provides a gain of 27, and *C33* and *R44* tame an upper-midrange peak that is common to most inexpensive electret microphones.

The microphone signal is further amplified in *IC1A* and passed through *R48* and *C32* to the testing channel's filters. Resistor *R48* is provided as protection in case the input to the equalizer is not disconnected.

Besides the ten filters in the equalizer, *IC1C* and *IC1D* filter the frequencies around 40 to 100 Hz and 140 Hz to help adjust the bottom bands of the equalizer.

The filtered signals from the equalizer are ac-coupled by *C1* through *C10* (to remove the dc components) and detected by *D3* through *D12*. To minimize the errors due to the *on* voltage of these diodes, a small current is passed through *D15* and buffered by *IC4A* to offset the positive side of the meters by approximately the diode *on* voltage. As a result, the meters respond to the average value of the noise level, which is a much more accurate parameter than the peak response frequently used in such an analyzer.

The outputs of *IC1C* and *IC1D* are passed through RC filters *R18*, *R19*, *R24*, and *R25* and *C12* and

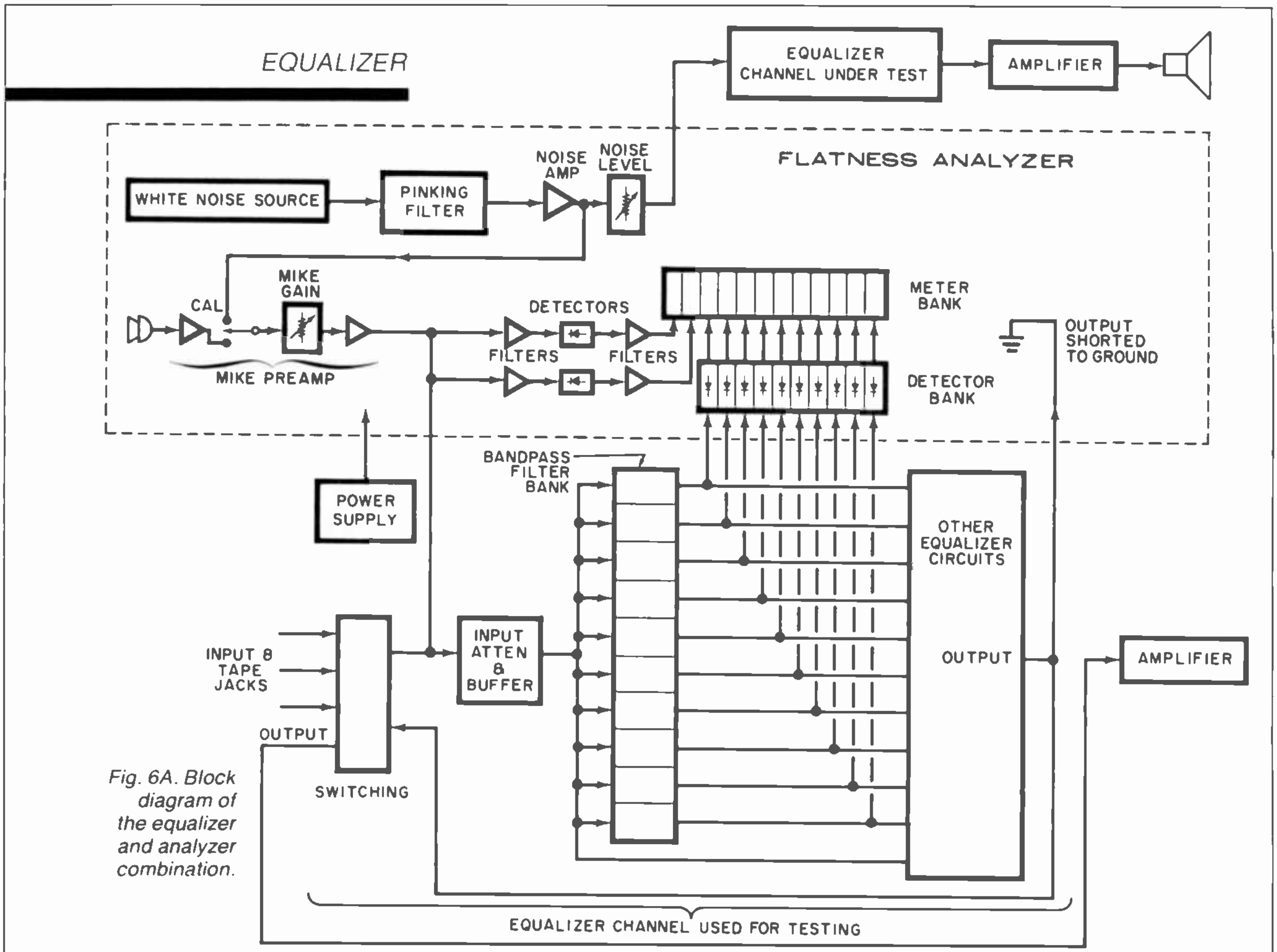


Fig. 6A. Block diagram of the equalizer and analyzer combination.

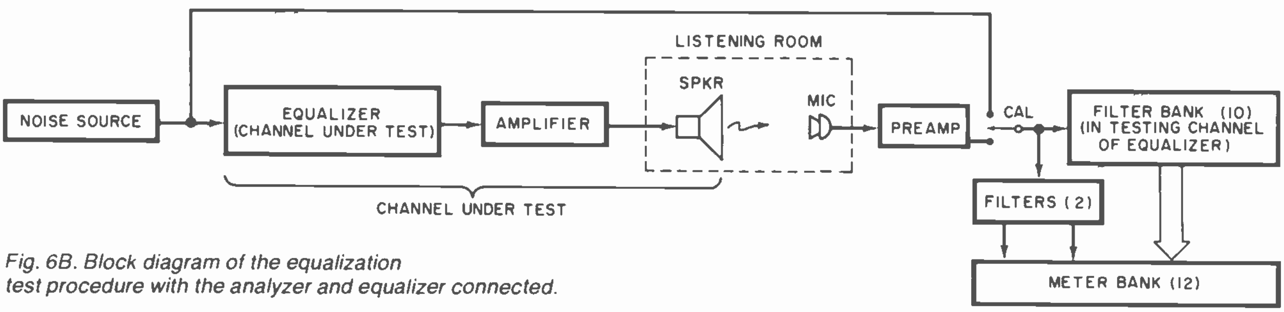


Fig. 6B. Block diagram of the equalization test procedure with the analyzer and equalizer connected.

C16 to reduce the fluctuations of the bottom band meters and to reduce the gain, in order to make up for the effect of the attenuator at the input of the testing channel on the ten other bands.

Resistor *R17* and diode *D16* provide a +9-V supply for the microphone and white-noise generator, and also supply bias for *IC1*.

Switch *S1* allows the response of the analyzer to be observed without the speaker-microphone link, to see how flat it is. This calibration permits adjustments to be made that will provide compensation for component tolerance errors, especially in the meter sensitivities (±1 dB) and pinking-filter components.

Construction. Figure 8 is the foil pattern for the analyzer pc board, and Fig. 9 is the foil pattern for the interconnection pc board. A component-placement diagram for the analyzer is given in Fig. 10.

Solder all components to the board, except the slide potentiometers. Don't forget the two jumpers. Carefully orient the ICs, diodes, and electrolytic capacitors according to pin number or polarity. Integrated circuits *IC2* and *IC3* are CMOS, and thus static-sensitive; so don't remove them from their conductive packaging until you are ready to install them. Then discharge yourself, your soldering iron, and the pc traces to ground.

Connect the microphone element, *MIC1*, to the shielded pair cord and solder the cord to the appropriate pc board holes—red wire for positive, white for signal, and shield for ground. Connect a stiff piece of wire over the shield and solder to the two holes right behind it to act as a strain relief.

The connection to the equalizer is through a DIP plug. Cut a standard DIP-plug to DIP-plug 16-wire cable in half and solder the unterminated wires to the appropriate pads of the DIP pattern on your board (the wires will alternate sides). Or just install a whole DIP-plug right in the pattern. Pass the wires across *R35*'s position, and then mount *R35*

...EQUALIZER

PARTS LIST

C1 through C10,C12,C13,C16,C17, C24,C30,C32—10-μF, 25-V aluminum electrolytic
C11,C28,C29—0.1-μF, 50-V ceramic disc capacitor
C14—0.0047-μF, 5% polyester capacitor
C15,C18,C19,C25—0.1-μF, 5% polyester capacitor
C20—0.022-μF, 5% polyester capacitor
C21—0.0068-μF, 5% polyester capacitor
C22,C26,C34—0.0022-μF, 5% polyester capacitor
C23—0.001-μF, 5% polyester capacitor
C27—24-pF, 5% capacitor
C31—Not used
C33—390-pF ceramic disc capacitor
D1-D15—1N4148
D16—9.1-V zener (1N5239 or 1N960)
IC1—RC4136 quad op amp
IC2—CD4006 18-stage shift register
IC3—CD4070 quad ex-OR gate
IC4—LM358 dual op amp
M1-M12—200-μA 1-kilohm edgewise meter
MIC1—Electret microphone element
P1—16-pin DIP plug
The following are ¼-W, 5% carbon-film resistors unless otherwise noted:
R1 through R10,R40—470 ohms
R11,R39,R46,R49—1.5 megohms
R12 through R16—Not used
R17,R20,R26,R28,R48—2.2 kilohms
R18,R19,R50—8.2 kilohms
R21—300 kilohms
R22,R34,R43—3.9 kilohms
R23—39 kilohms
R24,R25—11 kilohms
R27—62 kilohms
R29—270 kilohms
R30,R37,R38—150 kilohms
R31,R41—47 kilohms
R32,R33,R36,R44,R47—15 kilohms
R35,R45—50-kilohm potentiometer
R42—100 kilohms
S1—Spst slide switch
Misc.—Pc board for analyzer, press-on rubber feet (4), 16-wire ribbon cable, jumper wires, etc.

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

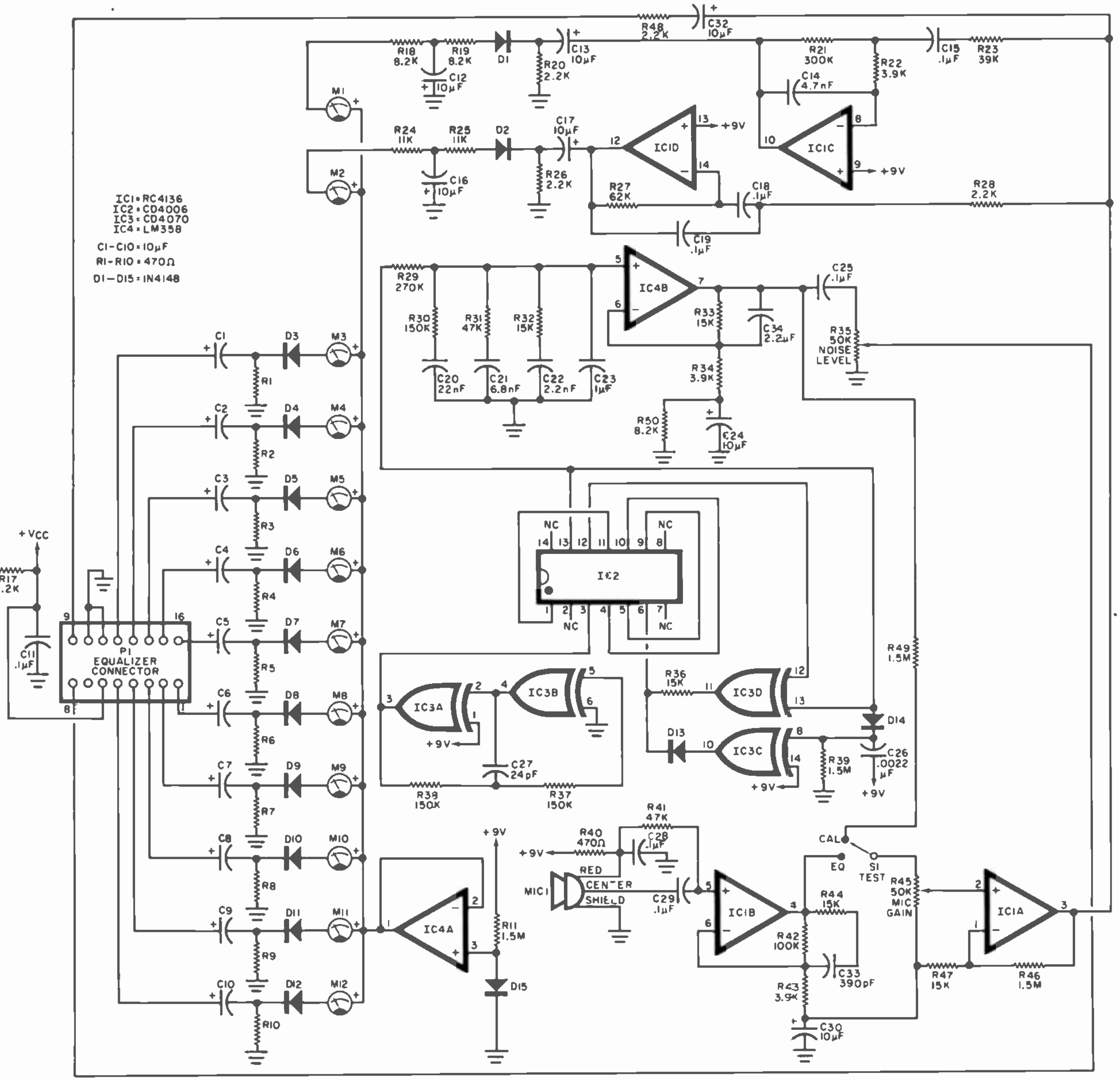


Fig. 7. Schematic of the circuit in the analyzer.

over them as a strain relief. Also mount the other slide potentiometer in its proper location.

In the prototype, the bases of the edgewise meters were glued to the pc board and wired with short jumpers. It is a good idea to use stick-on rubber feet to prevent shorting to the chassis of the equalizer or scratching it during use.

Since the analyzer is a sophisticated accessory and not for display, to save effort and expense, you need not put it in a fancy chassis.

Adjustment and Use. Using the Optimized Equalizer and the Analyzer combination is easy because all the information you need is right in front of you at all times.

With the power off, connect the equalizer outputs to your stereo. Do not connect the equalizer inputs to anything. Connect the analyzer to the equalizer and turn the slide pots to OFF. Set the TEST switch to EQ and the EQUALIZER switch to IN. Set all the equalizer controls to 0 dB. Place the measuring microphone at your favorite listening location. Apply power to the equalizer/analyzer and your stereo.

Adjust the mike gain upwards until there is significant deflection of some of the meters. This point shows how large the room noise is. Back down on the gain until there is no more than 10% deflection on any meter. Now slowly advance your noise-level control and stereo-volume control until you are getting an average of over 70% of full deflection on your meters. Depending on the ambient levels in your room, this is likely to be relatively loud.

Adjust the bands of the channel

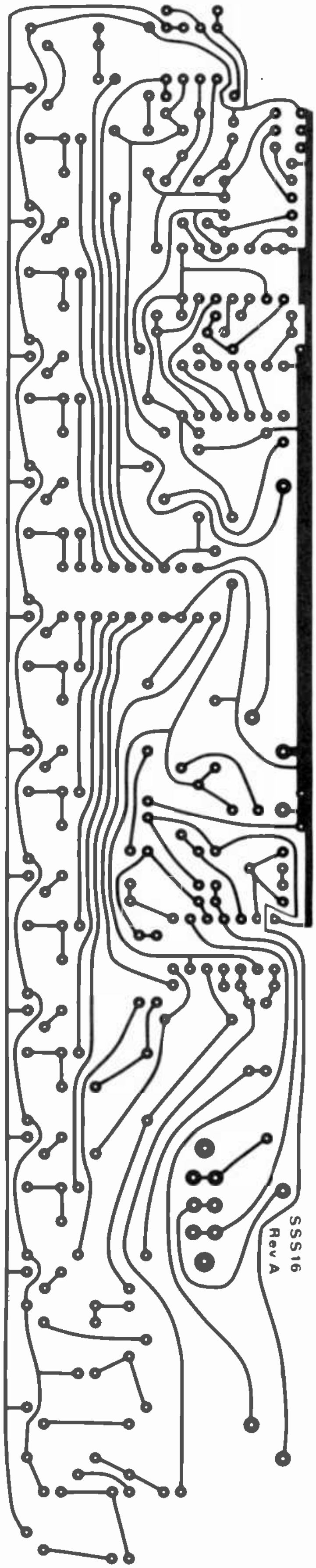
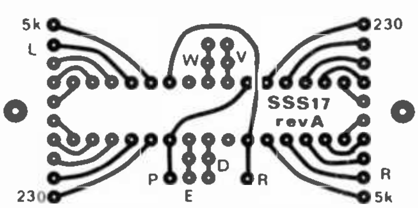


Fig. 8. Foil pattern for the analyzer pc board.

Fig. 9. Foil pattern for connector board to equalizer.



WHAT'S WRONG WITH THE FLATNESS ANALYZER?

According to traditional thinking, there is quite a bit wrong with the analyzer. First, its output devices are meters. Unlike bar-graph LEDs, meters cannot be easily read from far away. They are also slow and cannot show the dynamics of music well, due to mechanical inertia. But we are not building a music analyzer; we are building a flatness analyzer. It is designed to be placed next to the equalizer so that the controls can be adjusted while watching the meters. Only the microphone needs to be usable from a distance, and it comes with a long cord.

The slowness of the meters is in fact desirable because it evens out the fluctutations in the noise levels. Actually the meters act as filters without extra components to do that filtering (except in the lowest bands, where the fluctuations are slow enough that additional filtering is desirable). However, the most important reason for using meters is that they give better resolution and "feel" for that signal level. Their fluctuations can be averaged visually much faster and more accurately than LEDs, especially in designs with 2.5 dB/step LED resolution.

Next, the Flatness Analyzer will not analyze music. Since the signal levels in the testing channel must be adjusted to drive the meters appropriately, this channel cannot be used to process music. This precludes the fascinating light-shows of some analyzers, but it is necessary for the economy of reusing the equalizer's filters. We're out for performance here, not a show.

Finally, the Flatness Analyzer does not have a top-end meter to help adjust the equalizer's 10-kHz control. One is easily added, but it is not worthwhile for a number of reasons. First, a microphone that has even marginally predictable response in the top octave will cost more than the entire equalizer/analyzer combination; using it would produce the worst kind of diminishing return on your investment. Secondly, recorded music in the top octave is notoriously variable in relative level due to varying microphone techniques and engineer's tastes. Finally, all speakers, microphones, musical instruments and ears are extremely directional at high frequencies. Unlike the situation at lower frequencies where most of the signal you equalize has been reflected from room boundaries; at high frequencies, you would be equalizing the direct signal from the loudspeakers. The desired ratio of this signal level to the reverberantly measured levels at other frequencies is not well controlled.

Thus, no one equalizes for a flat high end. Rather, they try to accomplish some smooth roll-off. The author strongly recommends setting this band by ear and resetting it (and perhaps the top two or three narrow bands slightly) according to the particular piece of music being played. ◇

under test by reducing the level of the band corresponding to the meter with the highest deflection. After you have adjusted a few bands this way, continue by moving the bands either up or down to come as close as possible to uniform deflection of all bands. Adjust the noise level as necessary to keep the average deflection at about 70%.

The noise source, being pseudo-random, audibly repeats every 1.5 seconds, and the meters will show this periodicity. When fine tuning, visually average the motion during this interval. When the result is close to flat, switch the TEST switch to CAL, adjust the MIKE GAIN for 70% average deflection, and observe the errors of the test system. Then switch back to EQ and fine-tune the equalizer to match the CAL response, which will be slightly different than truly flat. Then turn everything off, switch the connection from the analyzer to the equalizer, and repeat for the other channel. Then remove the analyzer and connect the equalizer normally.

Hints on Equalizing. Over the long term, the sound from your system will be exceptionally smooth and accurate. But be wary of short-term reactions. After listening so long to the errors that your system and room make, your mind gets accustomed to these distortions of reality and expects them. Thus, any change toward either more or less realistic sound is initially perceived as unnatural. Also, the equalization technique given will reduce the overall level somewhat. Unless you compensate by increasing the volume control setting, you are likely to initially consider the sound to be poorer when equalized.

But give yourself about 15 minutes with your de-resonated stereo and then switch to unequalized. You will notice a hollow, boxy sound that you missed before because you were so used to it. Now simply switch back to equalized sound and you will find some really fine listening. ◇

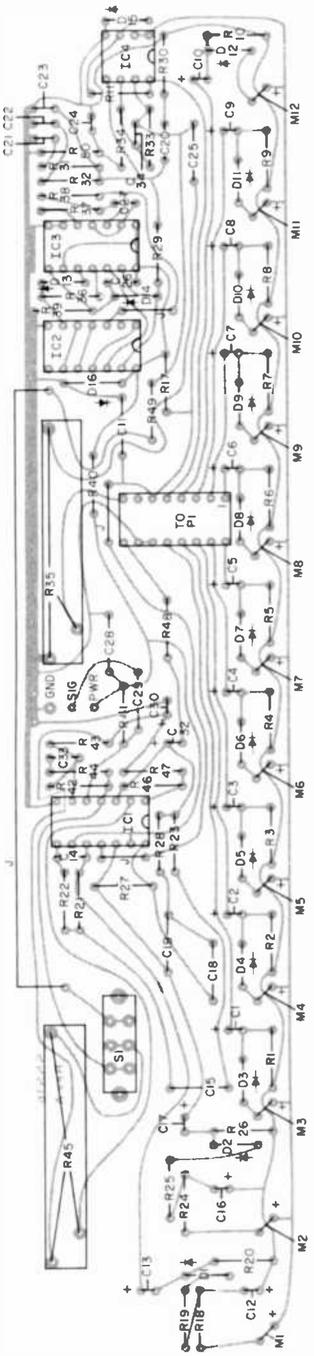
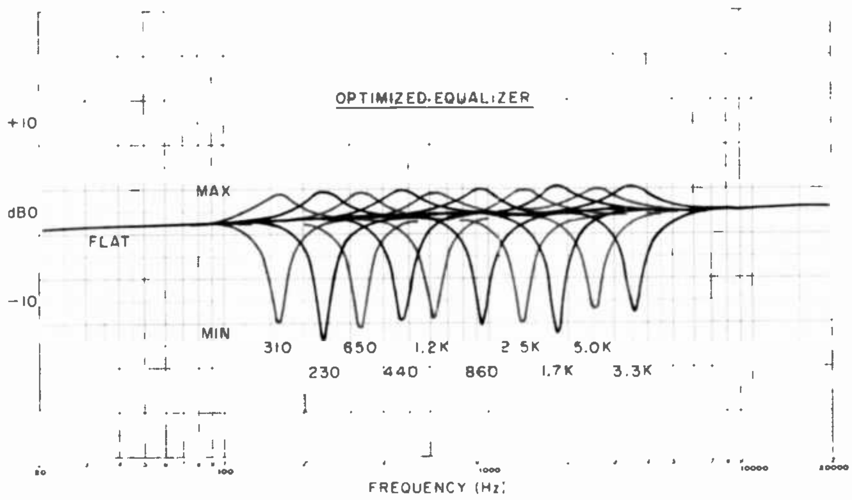


Fig. 10. Component layout on analyzer pc board.

TESTING THE EQUALIZER/ANALYZER

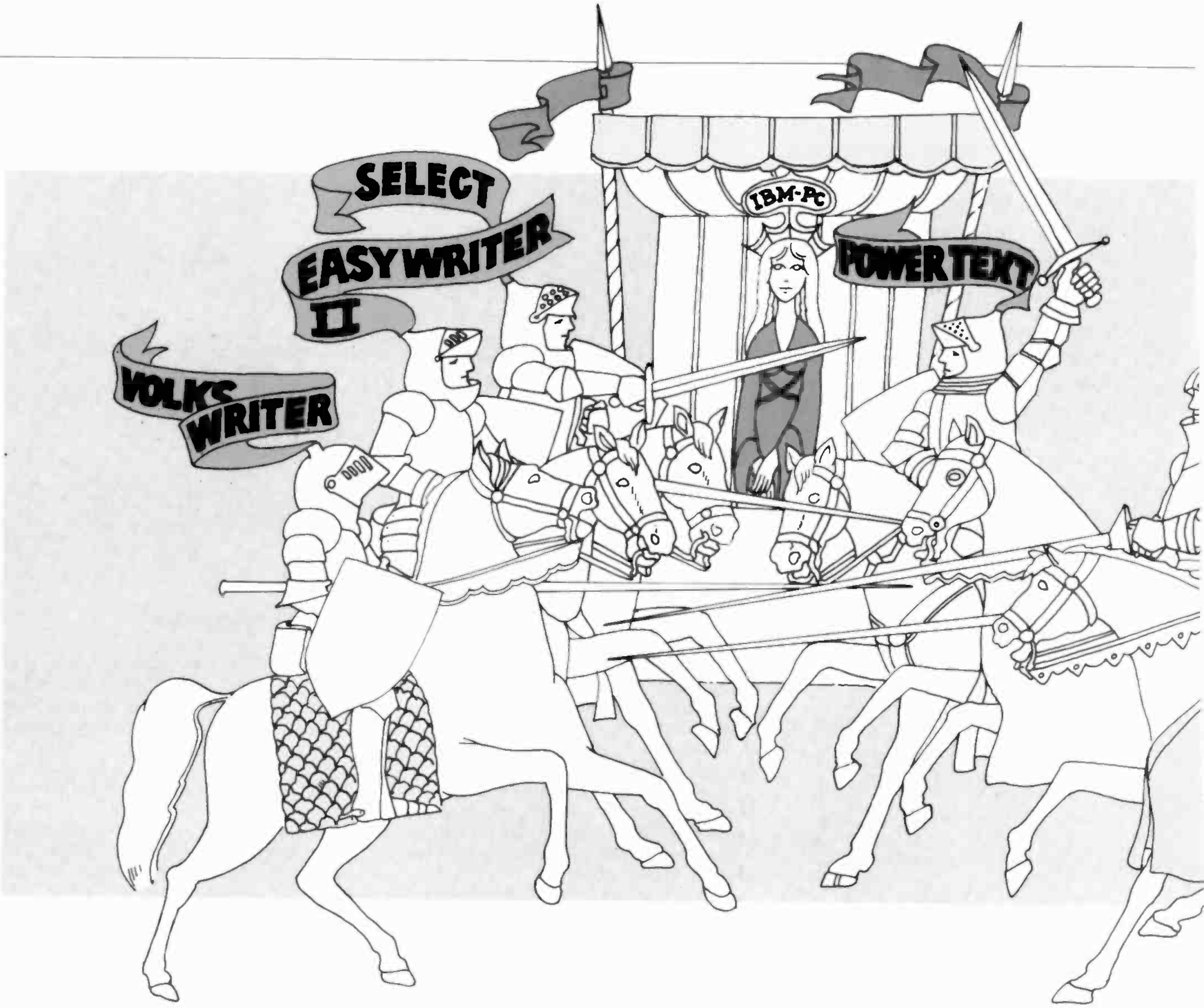


Boost and attenuation effects of the ten filter points.

The concept of having the analyzer use some of the circuits in the equalizer is an interesting one and makes for economy in achieving both analysis and equalization. In addition, the recognition that a limited amount of boost and much more "cut," are required for room/speaker equalization is something we have not seen discussed before. It differs sharply from conventional practice, which provides symmetrical (more or less) boost.

The measured characteristics of the various filters in the analyzer and equalizer confirm the statements made in the article. It is interesting to note that using only the extreme controls (40 Hz and 10 kHz) one can simulate quite well the effect of a conventional tone control system. The distortion of the equalizer was negligible and well within the stated limits. The noise (which was below our measurement limit) appeared to meet the claimed performance comfortably.

Following the instructions, we used the system to equalize a stereo music system. It would be helpful if the meters could be marked to match the corresponding slider controls; we had to use some "cut and try" methods in doing the qualization, but the end result seemed to be reasonable. According to a spectrum analysis of the "pink noise" from the system, it is not quiet pink. However, since one uses the meters to read the noise spectrum as well as the qualized acoustic spectrum, this error is of no importance. —*Julian Hirsch*



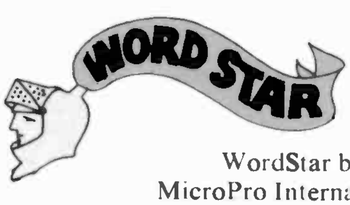
THE WAR OF THE

Comparing word-processing systems for the IBM-PC from WordStar to Final Word

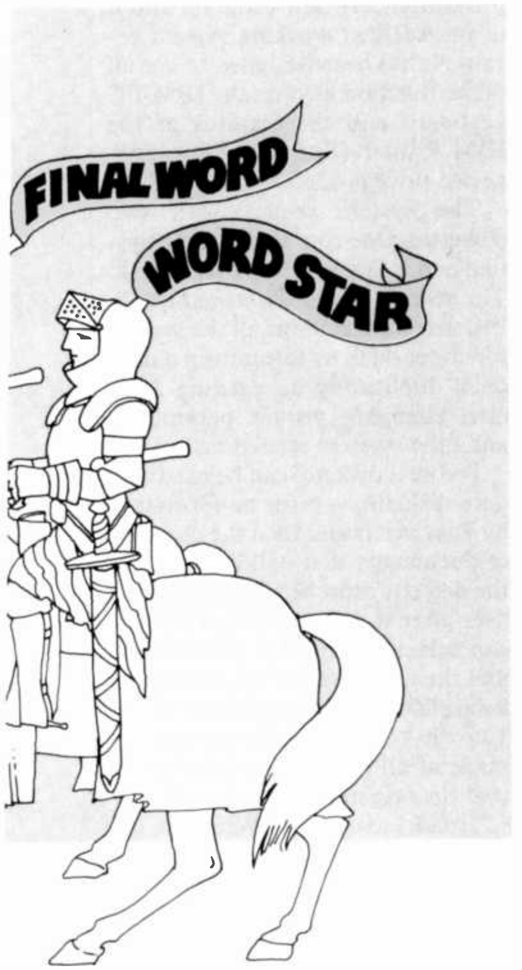
By Barry Crawford and Stan Veit

THERE is a "war" being waged by the major producers of word-processing software. The prize is the word-processing (WP) buying decision of IBM-PC owners. The battle was inevitable when "EasyWriter," adopted by IBM as its "standard" PC word-processing package, turned out to have serious bugs in it. IBM replaced the software with a workable version (Easywriter 1.1), but the program got the reputation of being a dud. This gave other software companies time to get their products running on PC-DOS and to enter the war of words.

To owners of IBM-PC Computers and other compatible machines this offers an opportunity to make a selection from a larger group of WP programs. It also presents a source of confusion as attempts are made to select the best system to meet an individual's needs. This article presents information about some of the leading WP contenders for the pocketbooks of IBM-PC users. At last count there were about 60 WP systems, with new ones appearing each week, so we couldn't discuss them all. In each case we have used the IBM-PC Computer and the applicable WP software to write that section of this article.



WordStar by MicroPro International Corporation (1299-4th St., San Rafael, CA 94901) is one of the oldest WP systems in the microcomputer software industry. Suggested retail price is $495. It was originally written for CP/M-based computers and has been used on more different computers of that type than any other word processor.



VORDS

Some WP systems can only work with memory-mapped video computers, while others can only be used with terminal-operated systems. WordStar has the advantage that it can be used with either.

It supports the broadest range of different terminals and printers. However if a terminal or printer is not one of those listed in the table of supported units, there is an Install program supplied as part of the system with which the user can specify the parameters of the terminal and printer and then configure WordStar to work with the specified equipment.

WordStar can be used for composing either text or program documents. It includes a complete screen-oriented editor and a formatter with the capability of operating any type of printer.

The text is shown on the screen exactly as it will appear in the finished document. If it is set to justify the text, it will be shown on the screen as justified copy. If double spacing is specified, double-spaced copy will appear on the screen. The user has the widest possible list of options in text formatting and printing. Yet none of these *must* be used. There are default settings within the system that will take care of anything not specified.

To use WordStar, the computer is turned on and the disk operating system is initialized. Upon seeing the prompt, the user enters "WS" and hits RETURN (CR). The WordStar copyright notice appears with an announcement of what terminal and communications protocol the system is set for and what printer parameters are in force. The user then hits the return key and the first menu appears. This is called the "No File Menu" because the user has not specified a file to be edited. It contains the following:

Preliminary Commands.

L-Change Logged Drive. The logged drive is initally the drive that had the WS program on it. If you want the text files you are about to prepare to be saved on that disk, do not invoke this command. If you insert a formatted disk into the second drive and want to save data on that disk, change the logged drive to the opposite one.

F-File Directory Off (On). When you are saving files, or when in a print operation, the file directory is displayed.

H-Set Help Level. The HELP level command controls the amount of helpful information automatically displayed by WordStar. It also determines whether part of the screen will be used to display a menu of editing commands. There are four levels of Help menus displayed: 0 through 3 (the most complete).

Commands to Open a File.

D—Open a Document File. This type of file is used for any text document such as a letter, report, text page or columnar text.

N—Open a Nondocument File. This file is designed to hold a program.

File Commands.

F—Bring a File.
E—Rename a File.
O—Copy a File.
Y—Delete a File.

System Commands.

R—Run a Program.
X—Exit to the System.

Options. WordStar is part of a family of programs that are interrelated but sold separately. These include Spellstar and MailMerge. When these supporting programs are on the same diskette, they can be accessed from the WordStar menu.

When the "Open a Document File" (CTRL D) or "Open a Nondocument File" (CTRL N) option is selected, the system asks for the name of the file requested. The user enters the file name; and if it previously was listed in the directory, it is loaded and displayed on the screen under the main menu. If the file requested is not on the directory of the diskette being used, WordStar will create it and announce "NEW FILE" as the main menu is displayed on the screen. The main menu lists the cursor commands, scrolling commands, deletion commands and miscellaneous commands. It also lists the commands for accessing the other available menus. At the top, the logged drive letter (either A: or B:) is displayed and an indication of the position of the cursor (ie: Page 1 Line 1 Col 1). An indication of the INSERT ON, condition is also displayed if the system is in insert mode.

All the user has to do at this time is to type in the text. WordStar automatically breaks at the end of a line and goes to the next line. The copy is automatically justified within the specified margins unless the justification is turned off. The user selects the paragraph breaks by hitting the RETURN key.

When you reach the end of a page a line appears across the page to show exactly where the page break occurs. Text can be moved to make the page breaks occur where desired. The other menus permit the user to do all kinds of text format requirements and to save the completed document. Printing and print format can also be selected from menus, however there is another complete system of inserting commands within the text by means of optional "dot commands."

If all this sounds complicated that is because it is. WordStar can be one of the most involved systems you could use. It has many features that only an expert would ever need, yet it is nice to know that these options are there if you want them. The beauty of WordStar is that the system can work almost automatically when you want it to, as well as when you do not know how to use all the bells and whistles.

The documentation supplied with WordStar is very good. It has been updated several times and by now it is accurate. A training manual is also supplied as well as a pocket reference card. The whole package is highly professional and a pleasure to learn and use. This is part of the reason that WordStar is one of the largest selling software packages in the world.

Well now, I hear you saying, "why is there a war, why doesn't everybody just use WordStar and get on with their work?" Remember that we are talking about the IBM-PC which uses the PCDOS, or CP/M-86 Operating Systems. WordStar was designed for the CP/M-80 Operating System which is quite a bit different. The folks at Micropro International did a good job of converting their package to run under PCDOS (also called MSDOS) but it just was not designed specifically for the IBM-PC and it does not use all of the special features of the IBM-PC keyboard as well as it might.

Version 3.2 M has been modified to use the programmable function keys and the features on the numeric keypad that contain the arrow keys, but the uses assigned to the function keys are not the important ones that are employed often and should rate a function key. For example, there is no single function to delete a line or a word (functions that are often used). Nor is there one for the "CTRL G character: delete and move operation." The one they use for the delete key on the keyboard requires that the cursor move past the character to be deleted. These are minor inconveniences but they do leave room for improvement and other companies have designed systems to do just that.

The major fault with WordStar is that the printer operation has not been updated to take advantage of the great features of the high-quality dot-matrix printers now being sold by Epson, C. Itoh, Okidata, Star Micronics and IDS. In fact more IBM-PCs have Epson MX80 Printers attached than any other printer because that is the "IBM Printer" sold with the system.

Now WordStar treats all of these as "Teletype type" printers and, consequently, can not take advantage of all of their features including condensed, or expanded, type, bold type, and foreign language fonts.

At a recent meeting of the New York Amateur Computer Club—IBM-PC Users Group, devoted to word processors—many users were quite angry at what they perceived as lack of support by Micropro for either the IBM dot-matrix printer or the IBM daisy-wheel printer. The representative from Micropro offered to give the users software patches that he said would solve the problem. The people in the audience were not satisfied by that solution. They said that Micropro should have included support for the new printers in the IBM-PC version. In spite of these shortcomings, WordStar is one of the most popular processors for the IBM-PC especially with people who have become accustomed to it on other computers.

Easywriter II by Information Unlimited Software Inc. (2401 Marinship Way, Sausalito, CA 94965) is the successor to Easywriter 1.1, the original word processor distributed by IBM. This is a completely new program and it is an excellent working system because it has been designed to use all of the function keys on the IBM-PC keyboard and the features of the IBM Printer (Epson MX80). Suggested price is $350.

The system comes with two diskettes. One contains the WP system and is labeled the SYSTEM disk. The other is called the HOUSEKEEPING disk and contains all the system functions such as formatting a data disk, duplicating an existing diskette, changing printer parameters and other system related tasks.

Before a diskette can be used as a data diskette, it must be formatted by Easywriter and then the quantity of documents that will be saved on the diskette must be allocated by the user after it is formatted. The user can select a name for the diskette and then the number of documents to be allocated to that diskette (from 1 to 99.) Working copies can be made of all the system diskettes so that the originals can be saved.

To start to use Easy Writer II, the system diskette is placed in Drive A: and the data diskette in Drive B:. When the system is reset, the sign-on notice appears and then the Main Menu. This gives the user a chance to select activities from the following choices:

1. Edit.
2. Activate Data Diskette
3. Delete Documents
4. Print
5. Paginate Documents
6. Set Date
7. Print Document List
8. System Functions

Under the menu is a box used to activate the document you want to work on. The selection is made by pressing the TAB key and entering the number of the document.

Under the active document block, the system gives the user a complete list of all the documents saved on the data disk. This includes the document number, the pages in the document, the author (in case more than one person uses the diskette), the date created and the last date edited. This makes it a very handy kind of directory. Once you have selected the document to work on and hit RETURN, the copy appears on the screen.

If you have created a new file by naming it, a blank typing area will appear. A line appears under your typing line indicating your place in the document. However, at the top of your work area the system shows you what mode you are in (more about that later) and the position of your cursor by means of a status line. The status line displays the space (column), the line number, the document number, the name of the document, and the percentage of the data disk that is full. This last is very important. It keeps you from continuing writing after you have no space to store your work. I have used other word processors that did not give me this information and the result was, that when I went to save my work, there was no room on the disk for it and I lost everything!

Easywriter uses the ten function keys on the left side of the IBM-PC keyboard for various tasks, all of which are named on an illustration attached to the keyboard beside the keys. Four of the functions are for the modes: Character (CHAR), Word (WORD), Line (LINE), and Sentence (SEN). When one of these keys is pressed, the mode is displayed on the status line and it is in force. That means if you are in WORD mode and you press DEL, you will delete a word. If you are in LINE mode, you will delete an entire line if you press DEL. The same thing works for insert (INS). If you are in WORD mode, space will be made for a word insertion, or a line insertion if you are in LINE mode. You have to be careful when you delete not to delete more than you want. You can hit DEL while in LINE mode and delete a whole line.

In between operating all the controls, the user merely has to type in the text. The system automatically breaks at the end of the line unless the typist enters a RETURN to force a paragraph break.

The arrow keys are used to move the cursor around so that you can correct copy wherever the cursor is positioned. The insert and delete keys operate in every mode. Text entry is simple with the IBM-PC keyboard and Easywriter II.

One of the nice features of Easywriter II is that, if you are interrupted for any reason, you press the escape (ESC) key and the system automatically saves your work. When you are done with your data input, the directory will list the file and the number of pages in it. You can print the text just as it appears and using that as a basis for additional editing, you can move copy around by "cut" and "paste" operations. You can also paginate the text; add headings, foots, and page numbers; and change words throughout the document by means of global search and replace techniques.

The text can be formatted for printing and using any of the type fonts available on the IBM-PC Printer (Epson MX80) such as Bold, Expanded, and Condensed. Superscripts, subscripts, underlines and shadows, are also available.

Easywriter II is a page-formatted word processor. It handles text by the page rather than in a continuous file like WordStar. It has many features that need not be learned until necessary and therefore it can be learned in about five hours of practice with the Sample file. After a user becomes proficient with Easywriter II, the next step is to learn to use it with the other programs in the IUS Computer Co.'s line and with VisiCalc files. Easywriter II will also interface with IBM-PCDOS files.

Conclusion. How does this system compare with other word processors? It is very complete and fairly easy to learn, and it gives the user control over format and printing. The documentation is excellent and professionally prepared. Information Unlimited Software has a User Assurance Plan for 90 days after purchase and a Phone Support Program that extends the warranty for another 90-day period and offers telephone service and help with problems for one year at a cost of $80. This is a somewhat unusual idea for software support but it has some good points. Very few companies have been able to offer free telephone help because the lines get clogged with trivial questions. Even such a large organization as Radio Shack has had to discontinue the 800 number because no one could get through. Paying a fee for telephone help will limit the service to serious calls and make it more valuable.

Power Text by Beaman Porter Inc. (Pleasant Ridge Road, Harrison, NY 10628) at $399 is an unusual word processor for several reasons. First it is the only one of the systems examined here that is written using the editor of a major operating system. Power Text uses the powerful editor of the UCSD P-system as an integral part of the WP system. This is unique only to the nonPascal world since users of UCSD Pascal have long known that the UCSD Editor is one of the most powerful editors. It lacks only one essential subsubsystem to make it into a complete word-processing package. That missing ingredient is a formatter subsystem. Many such programs have been written and several are in the public domain including Prose available from the UCSD User's Group. Power Text has included several additional feature as an incentive to buying its package.

The unusual feature is the concept of Format files. These tell Power Text about the style of the documents to be composed using the system. Anyone who works for a large company knows that they have standards and style manuals for correspondence and documents. The Format files within Power Text set up specification files for each of these formats. When you use the format file for "Letter," everything you type will automatically be formatted into the business letter format. The address will be in the right place, the paragraphs will be indented according to the style required, and headers and foots for the following pages will be generated without your having to type them! The system can also type the envelope when the letter is completed.

Format Files. The Format file contains a number of important pieces of information:

Lines per page.

Spaces to indent paragraphs.

First and last lines to print body text on.

The Format file also includes information about keyword commands, which is a reserved word within the system. They are used to describe header, foot, closing and cover page items within the document.

Standard format files included with the system include:

Document. This specifies the format of a paper, report, proposal, article.

Letter. The Letter format provides a standard for business letters.

Personal. Personal letter format.

Landscape. This is the format for a 132-character page.

Standard. A blank page without any borders or foots.

Memo. A short memo form.

These formats can be changed to suit the requirements of the user, or new ones can be designed to suit the user.

Editor. The Editor is a fullscreen text editor with capabilities for easily entering new text and changing, deleting, or moving old text from one place to another. It can copy from other files and it has features such as global search and replace (finding a phrase or character anywhere and replacing it with another), vertical scrolling and screen paging, invisible text markers for easy location and copying of text. There are also provisions for setting and clearing margins and tabs. The editor includes word wraparound and a type-ahead buffer. One other feature is that deletions go into a buffer so anything deleted by error can be recalled.

Utilities. The File Utility provides functions for disk and file housekeeping needs. It includes disk formatting, copying, removing files, and erasing disks. It can change names, list the file directory, and move files from one disk to another.

The Print Utility processes text files created using the Editor and turns them into the kind of document that the user has specified when he selected the Format file. It scans the text for embedded Power Text commands and shapes the text according to the instructions in those commands. Text can be reviewed on the screen, printed on the printer, or sent out over a communications line.

The Style Utility allows the user to create new Format files and the Misc. utility allows the user to format new disks.

Lessons. For all it's power, the UCSD Editor is not an easy system to learn and many people have used UCSD Pascal for a long time before they mastered the Editor. That makes the lessons in Power Text even more valuable.

They not only teach you Power Text, they also teach you a large percentage of the UCSD P-system at the same time and you don't even know you are learning it! The manuals and the lessons in the system are almost worth the cost of the system!

Conclusion. Power Text is a high-grade package designed to be used in commercial offices where there is a lot of formatted typing. It is unsurpassed for that application. In addition, its price is reasonable considering what it can do and how well it does it. For the occasional user of word processing, it is overkill if they do not need the features and capabilities of this powerful a system.

Volkswriter, from Lifetree Software, (177 Webster, Suite 342, Monterey, CA 93940) was designed for the IBM-PC as a low-cost (at $195, it is actually in the medium price range), easy-to-learn and easy-to-use, word processor. It is written in Pascal, but unlike Power Text it runs in a PCDOS environment. When you get it, you transfer DOS and Command.Com (the system file) on to your work-processor disk so it becomes bootable. (You need no other disk to bring it up.)

Here let me interrupt to explain that originally Volkswriter was one of the so-called "protected" disks where you could not back-up the software you had bought and paid for. Lifetree Software, realizing that this was adversely affecting the sales of an otherwise excellent product, removed their "locks" and Version 2.2 permits the owner to back up his system. Thanks.

Volkswriter comes up with a menu at the top of the screen. If you haven't used the system before, you press H(elp) and get a summary of the system commands. It also refers you to a Tutorial file which will teach you how to operate the system by working with the various commands. To get to the Tutorial file you have to R(etrieve) and then E(dit), a typical Pascal method of operation, but one not explained in the Volkswriter menu. The Tutorial itself is excellent and the user should be able to use the system to edit within a short time. You still have to read the manual to learn how to format and print your text since these are not covered in the Tutorial.

Volkswriter uses the standard PC arrow keys to move the cursor around the screen. You can enter text wherever the cursor is placed and then you can keep typing until the end of the line when the system breaks the line for you and the text appears on the next line. You can insert paragraph breaks by pressing RETURN. The HOME key sends the cursor to the upper left corner of the screen and the END key puts it in the lower left corner of the screen.

PgUp (page up) and PgDn (page down) keys work normally and move the entire screen up or down a distance of ½ screen, adding the CTRL key to the command (CTRL + PgDn or PgUp) scrolls the entire screen up or down. There are some other useful combination commands, CTRL + right arrow moves cursor to the next word and CTRL + left arrow moves it to the last word. CTRL + HOME moves the cursor to the first word of text and CTRL + END moves it to the

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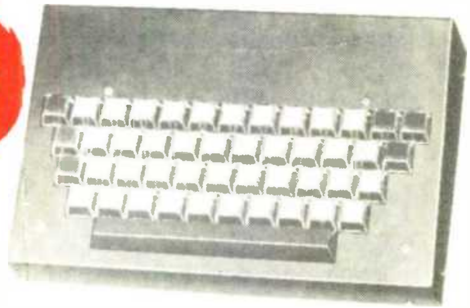

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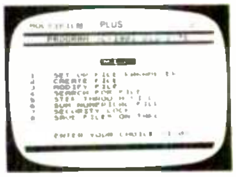

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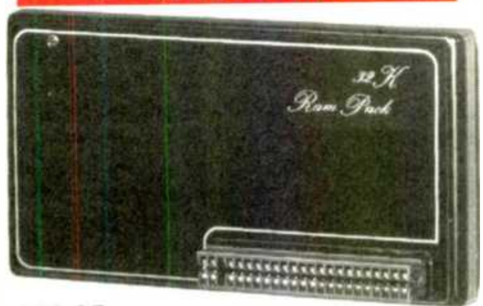

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last word in the text, both very useful commands often omitted in word processors.

Character deletion is done with the normal DEL key and the "F" function keys are used for block deletion and delete to end of line (ALT + F4.)

Insertion of characters is done with the INS key and line insertion uses the F3 key.

The other F keys are assigned various functions. F8 is used to reformat the text after insertions and deletions. However, F8 also removes all the tabs and indents unless they are protected by a "hard" space (/). This can be very annoying because you tend to forget where you have done this. Then you hit F8 and your neat page becomes an ugly block of text and you have to reformat it the right way.

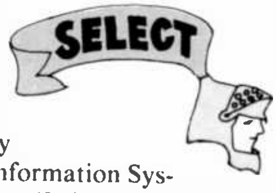
One of the important operations in word processing is the ability to move blocks of text and insert them where you want them. Some systems call this cut and paste. Volkswriter does this with the F5 and F6 keys. F5 marks the start of the block to be moved and F6 marks the end of the block. Then ALT+F5 moves the block where you place the cursor. ALT+F6 copies a block and finally ALT+F8 deletes a block of text. One of the nice things about Volkswriter is the Status line at the bottom of the screen. This tells you the name of the file you are working with and the command status in force at that time. It also tells you how much memory you have left to work in percentage of total memory you had when you started. If the percentage drops below 10% it flashes to get your attention. If it gets close to 0% it beeps at you so you can save your text to disk before it is too late.

Volkswriter has separate Format and Print menus. The Format menu controls the form the printer page will take. It displays the format then in force and permits the user to change it. The Print menu enables the user to either print the text or write it to a disk. The text can also be deleted or renamed. Since the Edit file can not be entered from Print, a separate editor for minor changes is provided. If an error is noticed during print, it can be corrected and the print cycle can be restarted.

The print options include left and right justification, page number to begin with, line spacing, lines per page, and page number location. Some of the options are for control of the IBM printer (Epson MX-80).

It will even help you do graphics if the Graftrax ROM is installed in the Epson. Volkswriter can also be used with the NEC Spinwriter printer distributed by IBM.

Conclusion. On balance, we liked Volkswriter. It is a reasonably priced system that will serve the average person well. It does not have the power of some of the other systems we tested but it is a good value now that the annoying "protection" scheme has been removed. We found one fault that can not be fixed and that is the memory capacity of the system. Volkswriter advertises that it can be used with a 64K PC. If you do that, you will run out of space quickly. You really need a 128K machine to do any effective word processing and Volkswriter should tell you that.



Select by Select Information Systems Inc. (919 Sir Frances Drake Blvd., Kentfield, CA 94904) at $595 is a complete word-processing system that features a computer-aided instruction program called Teach. This instructional software is designed to instruct people with no experience with computers to become WP operators. It is an effective tool and it teaches the use of the Select system in about 90 minutes of instruction.

Select looks like the Editor that runs under the UCSD P-system although it is not written in that language. There are three different versions for the IBM-PC. It runs under PCDOS or CP/M-86 and there is also a version that runs under CP/M-80 when a Baby Blue or other Z80 board is installed.

It is menu-driven and has a full screen editor that allows the user to make changes anywhere that the cursor is positioned.

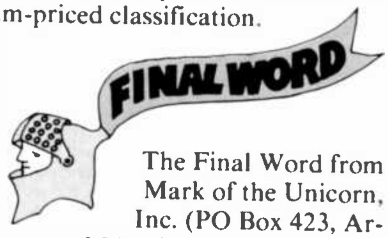
When composing a text document, it uses a full menu of editing commands such as insert, delete, and exchange, which are somewhat hard to learn without detailed instruction. Without the Teach program, the user who is not used to the UCSD P-system would have a hard time learning Select.

Before the text is composed using the Editor, the user can select the Format command which brings up a format screen. This permits the format to be selected so that the user can see the text exactly as it will be printed. Justification can be selected for on-screen viewing, or it can be selected after the text is composed and all of the corrections have been made.

As an aid in using the many commands, the system permits the user to program the keys on the IBM-PC to represent any command sequence. Thus either the Function keys or the keys on the keypad can be used for single-stroke operation.

The version we tested did not have this feature and we can see why it was added. It makes the system much more friendly. Two new features permit the user to split the screen and add a print spooler. Using these new features, the user can split the screen and watch new copy, existing text before printing, and old text coming off the printer.

Conclusion. The pricing of Select is somewhat misleading. You get much more that you realize because the Superspell and MailMerge programs are included in the price of $595. This moves Select from the higher-priced systems to the medium-priced classification.



The Final Word from Mark of the Unicorn, Inc. (PO Box 423, Arlington, MA 02174) is one of the best packages around (especially for the $300 list price). However, it is not, as its name would have us believe, the ultimate word processor and it definitely is not for everyone. The casual user who wants to write simple letters or short reports will probably feel more comfortable with one of the simpler word processors available. However, someone who is willing to spend the time to become skilled in the use of The Final Word (TFW) will definitely have found a high-powered tool that is capable of handling even the most sophisticated word-processing requirements.

Any word processor should be evaluated in three basic functional areas: editing, word processing, and document processing. The editor facilities define how easy it is to get the information into the document. The word-processing facilities determine how easy it is to format and print simple documents such as letters and brief reports. The document processing facilities provide advanced capabilities to format and print more complicated documents such as technical reports, form letters, and manuscripts. In addition, any program written for the IBM-PC should be evaluated on how well it utilizes the unique capabilities of this system. TFW offers significant advantages in each of these areas.

Use of IBM-PC. The first time you sit down with the TFW manual and tutorials, you rapidly get a feeling of being buried under a mass of control keys. A command is made up of three components: a direction (forward/reverse), an action (move/delete . . .) and an object (character/word/paragraph . . .). Each of these components is represented by a control key. For example, "forward delete word" is represented by the sequence CTL-F, CTL-D, CTL-W. The structure is consistent and highly mnemonic, but intimidating. However, The Final Word has 157 predefined actions, such as "delete forward word" which can be mapped to single key strokes.

The system is distributed with a pre-defined mapping of keys to actions, but a utility is also provided that allows the user to customize his keyboard to the actions he uses most frequently. All cursor movement keys, all 40 function keys, all alternate keys and all control keys can be turned into command keys. This is the most complete usage of the extended keyboard I have seen to date. An additional bonus is that the Help functions will remind you of how you have customized the keys.

Editor Facilities. Anyone who has become used to full-function full-screen editor capabilities used on large computers (such as EMACS or SPF) has felt something missing in personal computer editors. The Final Word, because of its multiple window and file buffer capability, comes very close to the large machine capabilities. Files are read into buffers (up to the capacity of the swap file) and 2 windows are provided to look at these buffers. You can easily insert pieces of previous documents into the document you are editing with this facility.

The Final Word utilizes standard PCDOS (MSDOS) files and does not insert any special characters into the files. This means that TFW can be used for editing programs as well as documents. Other files (such as spreadsheet print files) can be easily edited into your document. The file capabilities allow viewing the DOS directory; and reading, writing, renaming, and deleting DOS files without leaving the editor.

TFW provides a "state save" and virtual memory capability through the use of a special swap file. All buffer images are saved to this swap file so that changes are always protected in case of power failure or exit from the program. When you return to the program, you are taken back to the point at which you exited. If you want to clear the buffer and start fresh, a single command does it. Another nice feature is that the buffers are only written when you pause in your keying for 7 seconds. You will never be interrupted in your typing to wait for a buffer write. The virtual memory facility means that the size of the document you are editing is limited only by the size of the swap file, not by available memory.

Three forms of Help facilities are provided. Each group of functions (Files/Buffers/Layout/ . . .) has its own master menu to guide you through sequences of operations. Help "about" will give you a brief reminder about various commands (i.e. Help about buffers will show you all commands associated with buffers). These are not tutorial helps, but are generally sufficient. The Help "explain" function will tell you what command is associated with a particular key. This is particularly useful when you have customized your keyboard and forgotten what you did. All these functions can be invoked anywhere within the text and the descriptions are removed when editing continues. In addition, a series of tutorial lessons is provided both in the manual and on the disks to guide you through the various facilities. The documentation is good but inadequate in some areas. According to Mark of the Unicorn, the documentation has been significantly revised in Release 1.1 and should be available by the time you read this.

Global search and two forms of global replace are provided. Global search takes a string argument and will search to the first occurence of the string. The AGAIN key can be used to search for subsequent occurences. Search forward and reverse are both supported. Global replace will change all occurences of the desired string in the document. Query replace will stop at each occurence and prompt for permission to change before continuing.

The Regions Menu lets you set markers in the text, indent and outdent marked regions, and copy, delete and undelete marked regions. Deleted text is placed in the Kills buffer for recovery by Undelete. As long as you don't move the cursor, deleted text is appended to the Kills buffer. Once you move the cursor, the next delete will clear the buffer first, however you can specify Append to Kills to bypass this clear. Therefore, you can build up the Kills buffer by deleting from multiple areas in the text and then pop it back into another area of the document by using Undelete. Fill mode (word wrap) can be toggled on and off to allow editing of nondocument files such as programs and spreadsheet print files. Insert mode can also be toggled to select between overwrite and insert modes.

The Buffers menu allows you to define, list, switch or delete buffers. The windows-controls split-screen mode allows you to move data between windows, and control window size. The Miscellaneous Menu provides various control functions. A line count facility is provided, but no word count.

Word-Processing Functions. Word-processing mode is "what you see is what you get" formatting. Most quality word processors provide similar capabilities in this area. The Final Word provides the standard commands to center, justify, unjustify, line flush left/right, set/change case, highlight, tab, indent, outdent, etc. But, because of the structure of TFW and the fact that it does not imbed special format characters in the file, it has a few quirks. Perhaps the most noticeable of these is that tabs must be set at equal intervals (i.e. every 8 spaces). This is built into TFW and is not likely to change. Another quirk is the way that parameters such as line length and tab space are set. Either the cursor can be set to the desired position and the SET command invoked, or the value must be entered using the (ESC) key before the command is entered. Also, paragraphs in the document must be indicated by a blank line (or a tab, @, or . as the first character). Failure to do this can cause undesired results when using the fill, justify, or unjustify paragraph commands. Again, none of these is likely to change in the future.

Where The Final Word excels is in the breadth of its printer support. A configuration utility is provided to allow the user to specify 23 parameters describing the printer. Standard definitions are provided for TTY-like (no backspace), plain (with backspace); Epson (MX80 and 100 with and without the Graftrax option); Diablo (1610, 1620, 1640, 1650, 630 and equivalents) in 10, 12, or PS pitch; NEC (5510, 5520, 5515, 5525 and equivalents) for 10, 12 or PS; IDS 460 10 or 12 pitch (PS will be available in Rel. 1.1); Centronics 737 in 10 pitch or PS mode; and Radio Shack Daisy II 12, 15, or PS. Other printers will be supported in Release 1.1 by standard files. Two other standard definitions are provided. File; will place formatted output in a file suitable for use by another program (such as upload to a remote system) or to view final formatting with page breaks on the console. Console; builds a file that can be used for viewing draft formatting on the screen.

The Final Word also provides a capability to define the ports to be used. The standard configuration includes Printer Out for the parallel port and Serial In/Serial Out for direct control of the serial port. The default port can be set to any defined port (i.e. serial, if that is your standard output) or the Mode Command of DOS 1.1 can be used to direct output. A second serial port could be defined for systems requiring it. Also, special port requirements for nonstandard devices could be defined to the Final Word.

Document Processing. The Final Word really begins to show its capabilities in the document formatting facilities. Advanced formatting commands are indicated by an @ sign preceding the command. The STYLE command provides for overall formatting of the document. It is used to set white space, margins, indentation, justification, spacing between lines, paragraphs, headers, environments, etc.

An extremely powerful capability is provided by the SET, STRING, REF, VALUE, and CASE commands. SET and STRING allow values to be placed in counters or user-specified varibles for later reference. The REF and VALUE commands allow these counters and variables to be included into the text at any point. The CASE command allows conditional inclusion of text within a document based on the value of a variable. Release 1.0 restricts the use of CASE to STRINGS, but Release 1.1 will add a STRING INPUT command to take the value from the console. SET and VALUE can be used to associate a page number with a figure and refer to that page in the text. Page changes after reformatting would be automatically noted in the document.

Divisions of the document are provided by two sets of commands. CHAPTER, SECTION, SUBSECTION and PARAGRAPH provide a four-level numbered division. Chapter may be numbered or not depending on the STYLE parameters. UNNUMBERED, MAJOR HEADING, HEADING, and SUBHEADING provide a similar division for unnumbered divisions. APPENDIX provides for numbered appendices, while APPENDIX SECTION provides unnumbered appendices. All numbered divisions are included in the automatically generated Table of Contents.

NEW PAGE, BLANK PAGE, PAGE HEADING and PAGE FOOTING are self-explanatory. Headings and footings can have left, center, right, and second line components and can be specified on an even/odd basis. Conditional page breaks are not available in Release 1.0 but a NEED SPACE command should be available in Release 1.1. BLANK SPACE will reserve space in a document and may be specified in lines, inches, picas, or centimeters.

CENTER, FLUSH LEFT, and FLUSH RIGHT are self-explanatory. ADDRESS and CLOSING provide a flush-center capability for letters. DISPLAY, EXAMPLE, FORMAT, QUOTATION, TEXT, UNDENT, VERBATIM, and VERSE provide various line formats with different options for indentation, justification, and fill. DESCRIPTION, ENUMERATE, ITEMIZE, and LEVEL handle lists with various indent and numbering options. BEGIN and END extend these commands to multiple lines of the document. For example, @BEGIN (center) ...other lines... @END (center), would cause all lines between the BEGIN/END pair to be centered.

Commands are provided for Boldface, Italic, Boldface Italic, superscript text, and subscript text. Underlining can be specified for all characters or all characters except punctuation.

FOOT and NOTE provide several formats of footnotes. Footnotes can be inserted at end of page or end of text. The footnote indicator can appear as a superscript or within

brackets in the text. INDEX can be used to insert a page reference into the automatically generated index under a particular topic.

MESSAGE will print a message on the console, while INCLUDE (CON:) will accept text from the keyboard for inclusion in the document. This facility is limited to direct insertion of text. Release 1.1 will add the STRING INPUT command to allow insertion of text into variables. INCLUDE can also be used to include text from other files, such as spreadsheet print files.

This is a rather extensive list of facilities and it has not been possible to include complete descriptions of each command. The versatility of the Advanced Formatting facility should be obvious. The only major facility I have not found is the partial fetch/insert facility to allow moving columns as units. Two other minor problems: the Advanced Formatting features can only be used on a system with more than 160K of disk capacity, and the Advanced Formatting is not done on screen. However, the formatter can be run with the FILE option to obtain screen readable formatted text.

Documentation. It seems strange to call 286 pages of documentation inadequate, but it is. Many of the customization facilities are insufficiently explained, as are many of the Advanced Formatting commands. Some facilities and commands are totally undocumented. The tutorials are good, but again don't really show the capabilities of the system. However, Mark of the Unicorn states that Release 1.1 includes a major update of the documentation. From what they say, it seems that this situation will be fixed by the updates.

Service. Release 1.0 had a number of problems, especially related to recovering files after filling up the swap file. These problems are supposed to be fixed in Release 1.1. Mark of the Unicorn does supply phone support for The Final Word. While working my way through the documentation and "mark in wrong buffer" problems, I found them to be very helpful, responsive and courteous. Their attitude gives me confidence that the fixes and updates they say will be in Release 1.1 will actually be there.

Conclusion. The Final Word is definitely a word processor that grows on you. The more I become familiar with it, the more I like it. The failings have been minor and, except for the column move facility, I haven't found anything I wanted to do that I couldn't. Its utilization of the IBM-PC keyboard is outstanding. The customization facilities make it unlikely that I will find a printer or port combination that it will not support. The speed is not blinding, but it is more than acceptable. It is going to be around for a time and growing in capability.

But let me repeat, this is not the word processor for everyone. It takes some time to learn and be comfortable with it. The casual user will be more comfortable with other word processors. However, for someone who needs the advanced facilities of The Final Word, it is worth the time and effort to learn.

Summing Up

We did not find any of the software discussed here that did not work well. We would be happy using any of the systems we tested, some more than others. With respect to WordStar which we have used for many years, we looked at how well it has been adapted to this new environment.

The decision to buy any of these systems comes down to the question of features offered vs. price. Bear in mind that your requirements of today may not be the same as your requirements tomorrow. The longer you use your computer, the more applications you will find for it. There is yet no market to trade-in used software, so do not buy the bare minimum.

Many of the word-processing systems being offered for the IBM-PC have been originally designed for other computers and they have been reconfigured for this new computer. This is a two-edged sword. It ensures that the software has been throughly tested and that it does what it is supposed to do. The other side is that some of the systems have been grafted on to the PCDOS operating system and the IBM-PC and the fit is none too good. The first releases of WordStar and Easywriter for the IBM-PC left a lot to be desired. This has largely been corrected but it will require several revisions until all the annoying things are removed.

The packages that were written from scratch for the IBM-PC use all of the features of the keyboard and offer many utilities to extend the capabilities of the system.

Some of the word-processing systems use the UCSD P-system editor as a base for the word processor. Some of them have been designed to look like the UCSD P-system editor.

In any event this is an excellent editor and it runs well on the computer. Its only defect is that it is a little hard to learn. This is where the instructional programs come in. Without them, quite a few of the word processors being offered for the IBM-PC would fail from overcomplexity. The user should have the teaching programs shown to him as well as a demo of the actual word processor.

There is a wide difference in price between word-processing packages and it is somewhat hard to find out just what you are getting for the price. Power Text includes a powerful format file capability which you may not need. Select which costs $595 includes a spelling checker and a merge program which are included at extra cost by WordStar. Naturally, the less expensive programs include less features. You must make a decision as to whether these "bells and whistles" are worth their cost to you.

No matter what your selection is, you can take comfort from the fact that you are getting word-processing power that previously only existed on dedicated machines costing twice the price (and they did not compute!). ◇

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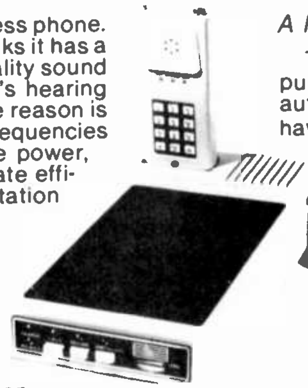

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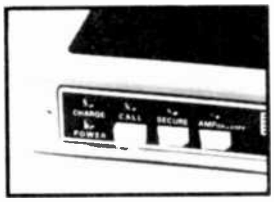

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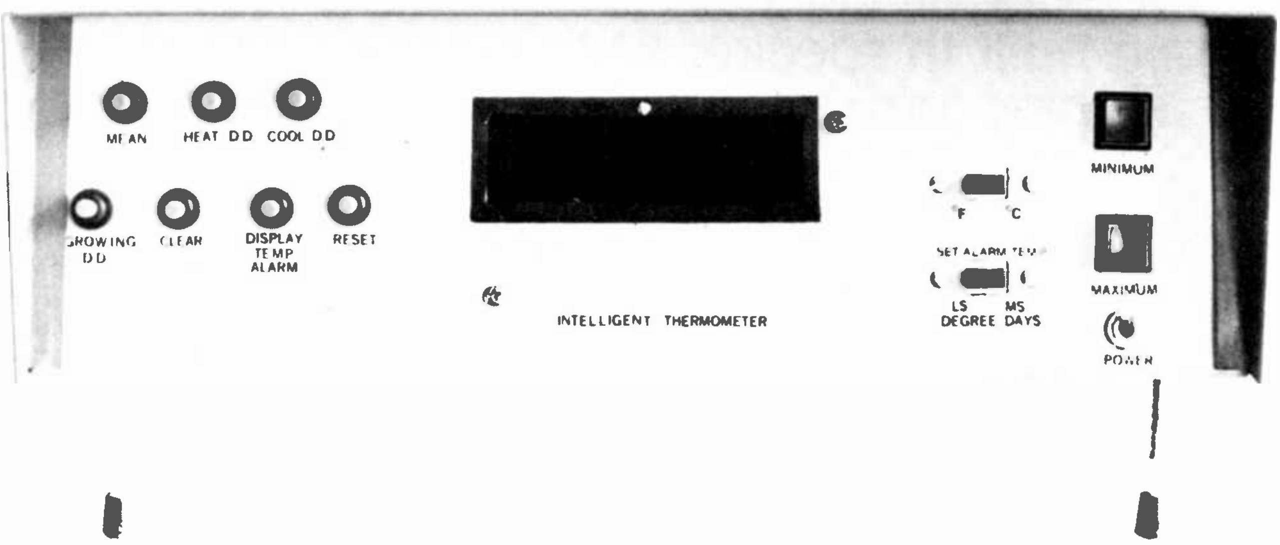


Build The Intelligent Thermometer

Part 1

A microprocessor and a programmed EPROM are used in this sophisticated circuit to measure and analyze changes in temperature

By Tom Fox

MOST people associate the word "microprocessor" with computers. However, there are many sophisticated devices besides computers that use microprocessors. One such device is the Intelligent Thermometer described here. It is called "intelligent" because the particular program in its memory allows many uses besides simple temperature measurements.

For instance, the Intelligent Thermometer analyzes the temperature data and stores the results in its semi-permanent memory. It measures temperatures between −56°F and +199°F (−49°C and 93°C) and does it with an accuracy better than ±1°F over its entire range. It stores the minimum and maximum temperatures, and calculates and stores the mean temperature up to a 255-day interval with an accuracy better than that of the U.S. Weather Service. The Intelligent Thermometer also calculates and stores heating degree-days (base 65°F), cooling degree-days (base 75°F) and growing degree-days (base 42°F). Up to 9999 degree-days can be stored in each of its degree-day registers.

The analyzing portion of the thermometer has three outputs that can be used to activate a relay or buzzer. The first signals a temperature of 32°F or below, while the other two signals indicate a temperature either above or below a preset threshold of the user's choice.

The temperatures and degree-days can be displayed in either Fahrenheit or Celsius depending on the setting of a switch. (Celsius degree-days are rounded off to the nearest 100.) An optional battery allows memory retention during power failures.

The versatility of the thermometer is further enlarged by the user's ability to erase and re-program the EPROM—or plug a new EPROM into the socket. For instance, the thermometer could be transformed into an energy-saving digital thermostat by changing the EPROM and adding two relays.

About the Circuit. A block diagram of the thermometer is shown in Fig. 1. Its memory map is given in Fig. 2. The 6802 CPU is basically the same as a 6800 with the added features of an internal clock oscillator and driver, plus 128 bytes of RAM. The first 32 bytes of RAM can be retained in the low-power

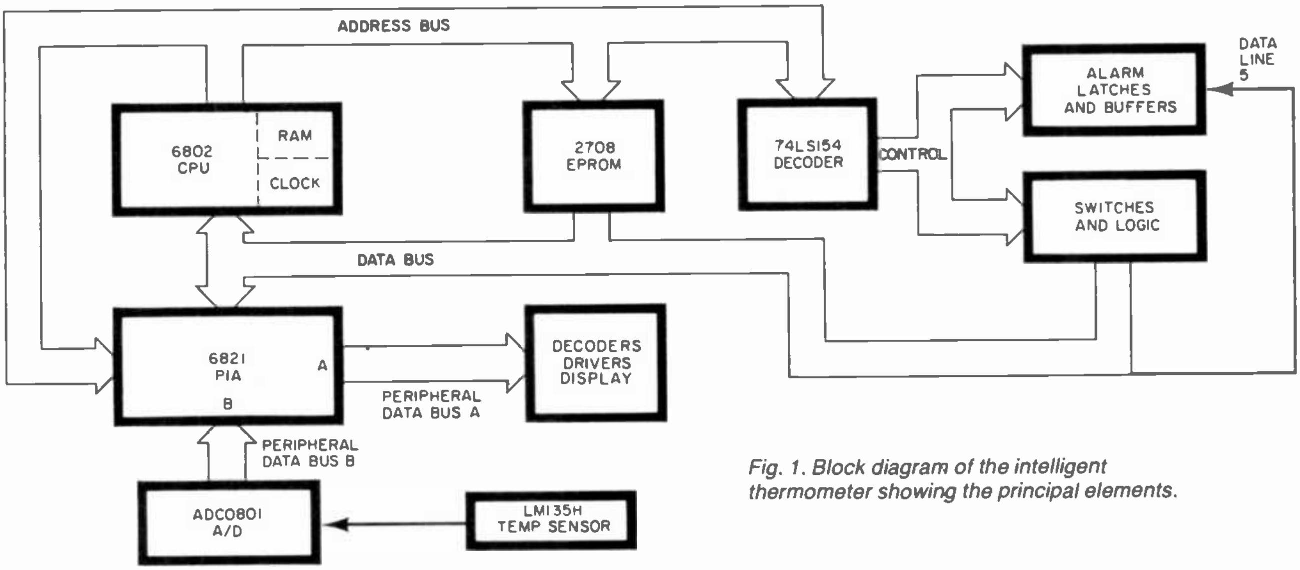


Fig. 1. Block diagram of the intelligent thermometer showing the principal elements.

mode, thus allowing memory retention in the event of power failure.

The entire program is stored within EPROM *IC12* and uses approximately 850 bytes of the 1024-byte capability.

The temperature is sensed by *D9*, a precision temperature sensor having a nearly linear response and a low dynamic impedance that allows remote sensing. The voltage reference is *D8*. The amplified (via *IC11*) temperature signal is applied to *IC9*, an A/D converter that converts the data into one byte of digital information. Each bit of the A/D converter is equivalent to 1°F. Byte 00000000 equals −56°F while byte 11111111 equals 199°F.

Side A of peripheral interface adapter *IC7* is programmed as the output with its data bus connected to *IC28* and *IC29*, a pair of 7-segment decoder/drivers. Side B is programmed as the input and is connected to the *IC9* (A/D converter) data bus.

Four-line to 16-line decoder *IC21* provides address decoding for the switches and output latches.

As shown in Fig. 3A the CPU, *IC8*, has its *reset* (pin 40) connected both to its own *read enable* (pin 36) and *IC7's reset* (pin 34). When the 6802's *reset* is brought high after being low for at least 20 ms, the CPU reset sequence starts. The 6802 first checks what 2-byte address is stored at locations FFFE and FFFF (each location contains 1 byte of the address) and then goes to this address which is the start of the program.

The circuit consisting of *IC6A*, *IC5A*, and associated components has a twofold purpose—it resets *IC7* and *IC8* during power-up, and provides a *read enable* (RE) signal for the CPU. The RE signal is arranged so that it goes low before V_{cc} drops below 4.75 V. This is necessary to keep erroneous information from being stored during a power failure. Pin 3 of *IC6A* monitor's the V_{cc} supply (+5 V). Potentiometer *R9* is set so that the voltage at pin 3 is slightly below that at pin 2, which monitors the rectified and partly filtered voltage produced by *D5*, *C14*, and *R14*. This circuit responds quickly to any power-down, or brown-out condition. When the power-line voltage starts to drop, the voltage at pin 2 drops below that at pin 3 and the *IC6A* output jumps to near 5 V. Schmitt trigger, *IC5A*, senses that *IC6A*'s output is starting to rise and produces a low output when this voltage exceeds about 3 V. Thus RE drops low several microseconds after V_{cc} drops more than about 2%—in time to ensure that the contents of the RAM are unchanged.

As mentioned earlier, this circuit also provides the "power-up" reset signal for the CPU and peripheral interface adapter (PIA). When the line voltage rises rapidly (for instance, when first turned on), *C5* instantly raises the voltage at pin 3 of *IC6A*. Pin 3's potential is now above that at pin 2, and the reset pin's potential is brought low. The voltage at pin 3 declines exponentially to a steady-state or "normal" voltage about a half second after power-up. When the voltage at *IC6A* pin 3 falls below that at pin 2, the reset pin jumps high and starts

RAM IN 6802 RETAINABLE IN LOW-POWER STANDBY MODE	0000-001F
RAM IN 6802	0020-007F
NOT USED	0080-7FFF
PIA	8000-8003
DIS 4 (−1)	8004
NOT USED	8005-87FF
SWITCHES	8800-880D
OUTPUTS	880E, 880F
NOT USED	8810-FBFF
INTELLIGENT THERMOMETER'S EPROM PROGRAM	FC00-FFFF

Fig. 2. Memory map of the system.

the CPU. The RE pin is also brought high at this time.

In Fig. 3B, *IC15A* and *IC13* provide address decoding for EPROM *IC12*. Side A of *IC7* is connected to the inputs of *IC28* and *IC29*, which are the 7-segment decoders/drivers located on the display board (Fig. 4). These ICs drive two LED displays. The overflow display (*DIS 4*) is driven by transistors *Q1* and *Q2*, which are controlled by *IC18*, a 4-bit latch. *IC14, IC15B*, and *IC16* provide address decoding that responds to address 8004. Data lines D6 and D7 provide information on which display segments (if any) the latches turn on.

The output of *IC9* is connected to *IC7's* peripheral data bus on side B. The ADC0801 (*IC9*) 8-bit A/D converter has a total adjusted error of less than ±¼ LSB (±¼°F). The LM135H precision temperature sensor, *D9*, behaves as a low-power zener diode with a breakdown voltage proportional to absolute temperature at +10 mV/°K. Thus at 77°F (25°C or 298.15°K) the LM135H theoretically breaks down at 2.9815 V. The LM135H operates over a −55°C to +150°C temperature range (−67°F to +302°F), and its extremely low dynamic impedance (less than 1 ohm) allows it to be used at remote locations. This sensor is almost perfectly linear (±0.3°C) over its entire range, which makes it simple to use with A/Ds, and it doesn't require a special linearizing program.

The LM336 2.5-V reference diode, *D8*, provides an unusually stable reference voltage for *IC9* as well as for the calibration circuit. Although the LM336 is an integrated circuit, it acts as a low-power zener diode with an exceptionally small temperature coefficient. Diodes *D3* and *D4* and resistor *R28* trim *D8* for a minimum temperature coefficient of 1.8 mV over a 0°C to 70°C temperature range.

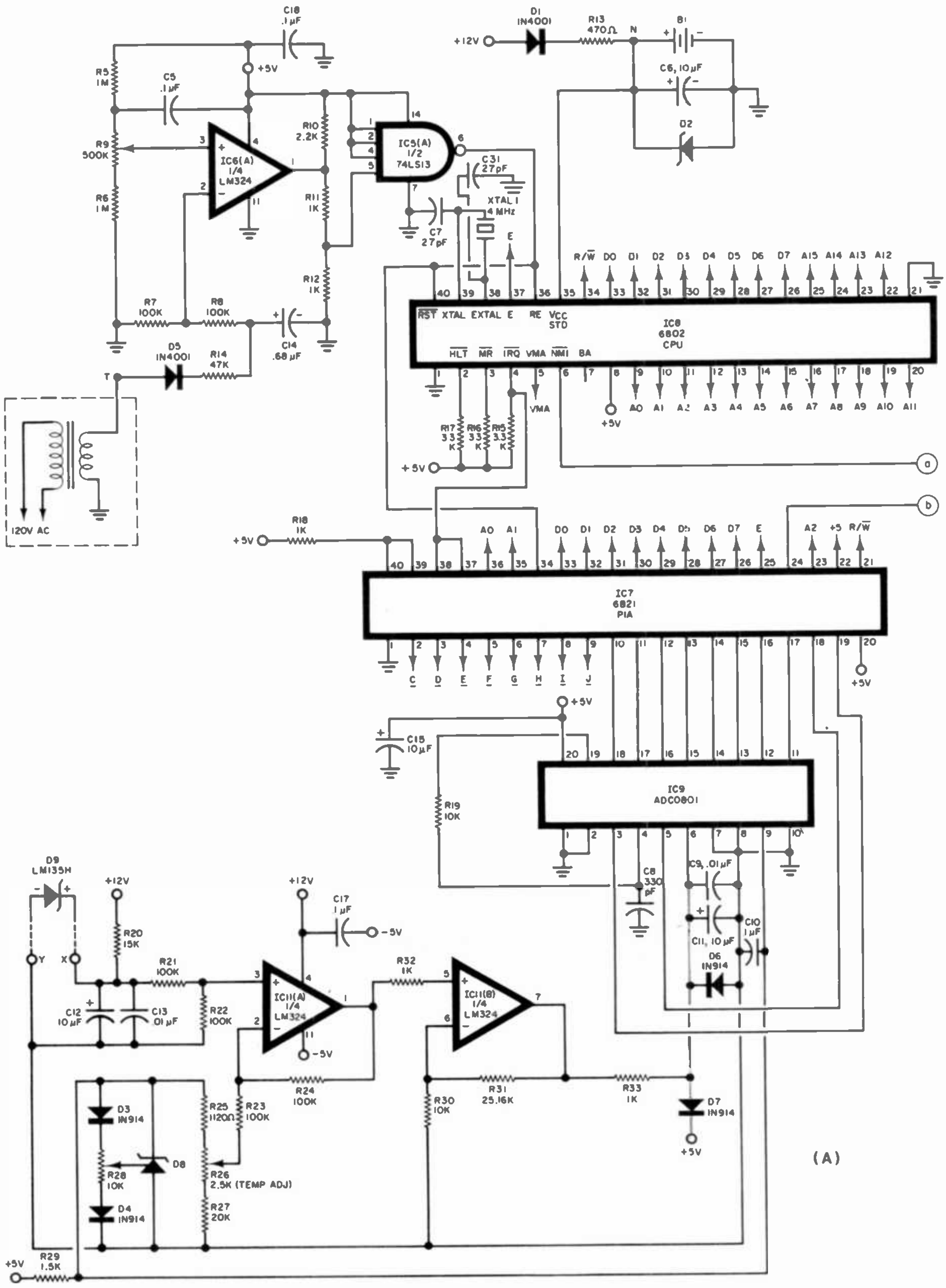
A calibration circuit (*IC11A, IC11B* and associated components) manipulates *D9*'s output voltage so that the thermometer is able to measure the full range of

(Continued on page 80)

PARTS LIST
(For Fig. 3. See pages 77, 78, 79)

B1—NiCd battery, 4.75-5.25 V (optional, see text)
C1—0.1-μF, 50-V capacitor
C4,C5,C10,C16,C17,C18,C19,C20—0.1-μF, 25-V capacitor
C2,C3,C9,C13,C22 through C30—0.01-μF, 25-V capacitor
C6,C11,C12,C15,C21—10-μF, 25-V tantalum capacitor
C7,C31—27-pF capacitor
C8—330-pF capacitor
C14—0.68-μF, 25-V tantalum capacitor
D1,D5—1N4001 silicon diode (or similar)
D2—1N5232B 5.6-V, 500-mW zener diode (or similar)
D3,D4,D6,D7—1N914 silicon diode (or similar)
D8—LM336 2.5-V reference diode
D9—LM135H precision temperature sensor (see note)
DIS1,DIS2,DIS3—7-segment common-anode LED display (MAN 72 or similar)
DIS4—Overflow common-anode LED display (MAN 73 or similar)
IC1—4020 14-stage binary ripple counter
IC2—4584 hex Schmitt trigger inverter
IC3—4082 dual 4-input AND
IC4—555 timer
IC5—74LS13 dual 4-input NAND Schmitt trigger
IC6,IC11—LM324N low-power quad op amp
IC7—6821 peripheral interface adapter
IC8—6802 microprocessor
IC9—ADC0801 8-bit A/D converter
IC10—74LS541 tristate octal buffer
IC12—2708 1K-byte EPROM (see note)
IC13—74LS30 8-input NAND
IC14,IC22,IC23,IC24—74LS02 quad 2-input NOR
IC15,IC16—74LS21 dual 4-input AND
IC17—74LS00 quad 2-input NAND
IC18,IC19—74LS75 4-bit latch
IC20—7407 hex buffer
IC21—74LS154 decoder
IC25—7404 hex inverter
IC26,IC27—7405 hex inverter
IC28,IC29—7447 decoder/driver
Q1,Q2—2N2222 npn transistor (or similar)
R1,R2,R8,R21,R22,R23,R24—100-kilohm, ¼-W, 5% film resistor
R3,R4—470-kilohm, ¼-W, 5% film resistor
R5,R6—1-megohm, ¼-W, 5% film resistor
R7—(see text)
R9—500-kilohm, pc trimmer potentiometer
R10—2.2-kilohm, ¼-W resistor (see text)
R11,R12,R18,R32,R33,R67,R68—1-kilohm, ¼-W, 5% film resistor
R13—470-ohm, ½-W resistor (see text)
R14—47-kilohm, ¼-W resistor
R15,R16,R17—3.3-kilohm, ¼-W resistor
R19—10-kilohm, ¼-W, 5% film resistor
R20—15-kilohm, ¼-W, 5% film resistor
R25—1120-ohm, ¼-W, 1% precision resistor
R26—2.5-kilohm, pc trimmer potentiometer
R27—20-kilohm, ¼-W, 1% precision resistor
R28—10-kilohm, pc trimmer potentiometer
R29—1.5-kilohm, ¼-W, 5% film resistor
R30—10-kilohm, ¼-W, 1% precision resistor
R31—25.16-kilohm, ¼-W, 1% precision resistor (see note)
R34 through R45—2.2-kilohm, ¼-W resistor (optional, see text)
R46,R47,R48—100-ohm, ¼-W resistor
R49 through R62—220-ohm, ¼-W resistor
R63,R64,R65,R66—270-ohm, ¼-W resistor
S1 through S9—Spst momentary-contact pushbutton switch
S10—Dpdt slide switch
S11—Spst slide switch
XTAL—4.0-MHz crystal
Misc.—IC sockets, power supply (see text), circuit boards, 2-conductor cable, case, hardware, wire, solder, etc.

***Note:** The following are available from Magicland, 4380 S. Gordon, Fremont, MI 49412: complete kit of parts including pc boards, all ICs, and sensor but not case, power supply, battery or cable for $179.00, postpaid. Also available separately: 2708 EPROM (programmed) for $25.00; ADC0801 for $16.50; LM135H for $9.50; 1% precision resistors for $1.75 each; LM324N for $1.25. On orders less than $5.00, add $1.00 for handling. Outside U.S., Canada, and Mexico, add $5.00 for shipping. Michigan residents, add 4% tax. The following are available from Danocinths Inc., P.O. Box 261, Westland, MI 48185: microprocessor pc board (#RW403) for $64.00; display pc board (#RW403D) for $10.85; both pc boards for $70.00; postpaid. Michigan residents, add 4% tax. The listings for programming the EPROM can be obtained free by sending a stamped, self-addressed envelope to Magicland, at the address above.*



(A)

Fig. 3A. Microprocessor and PIA portions of the circuit.

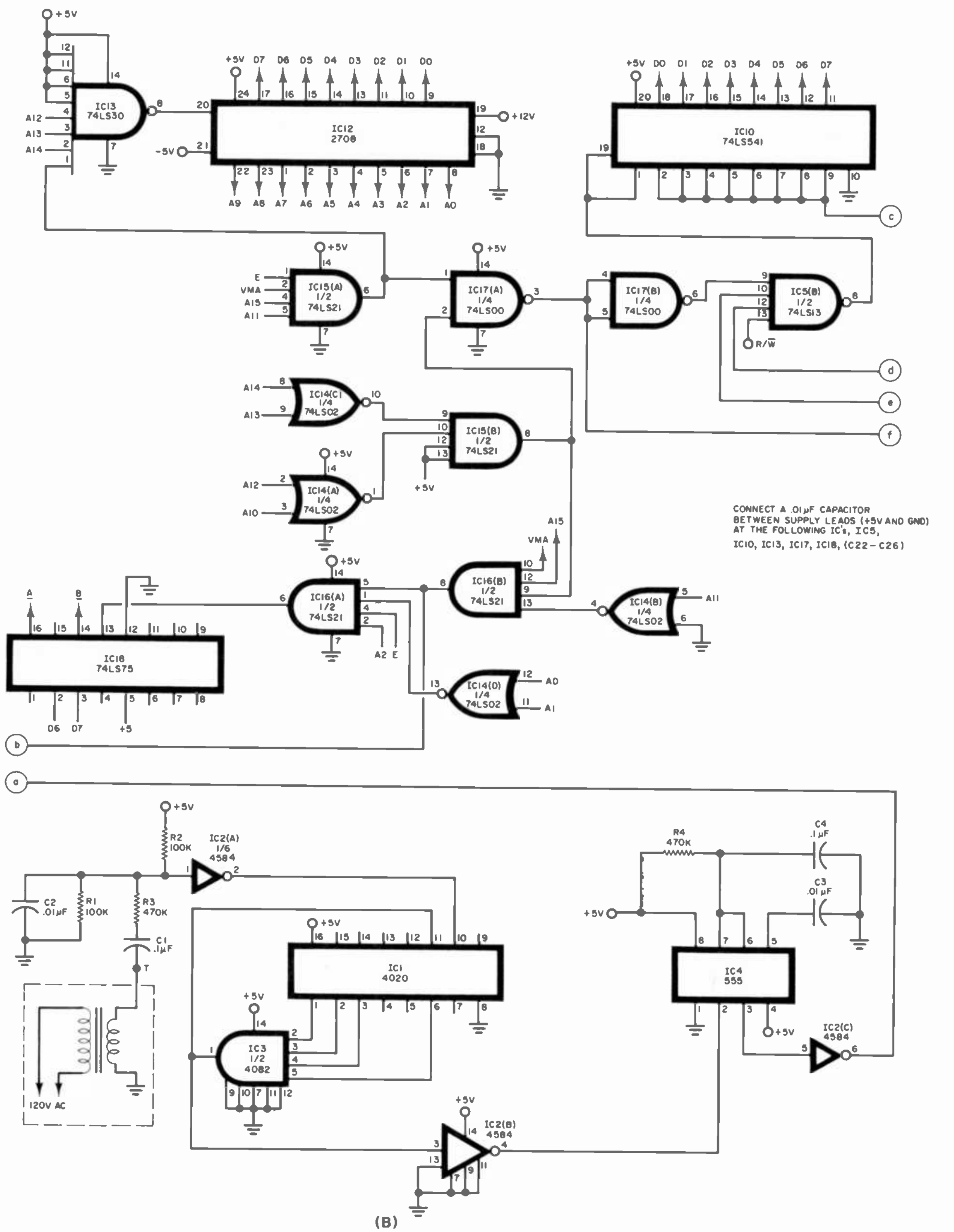
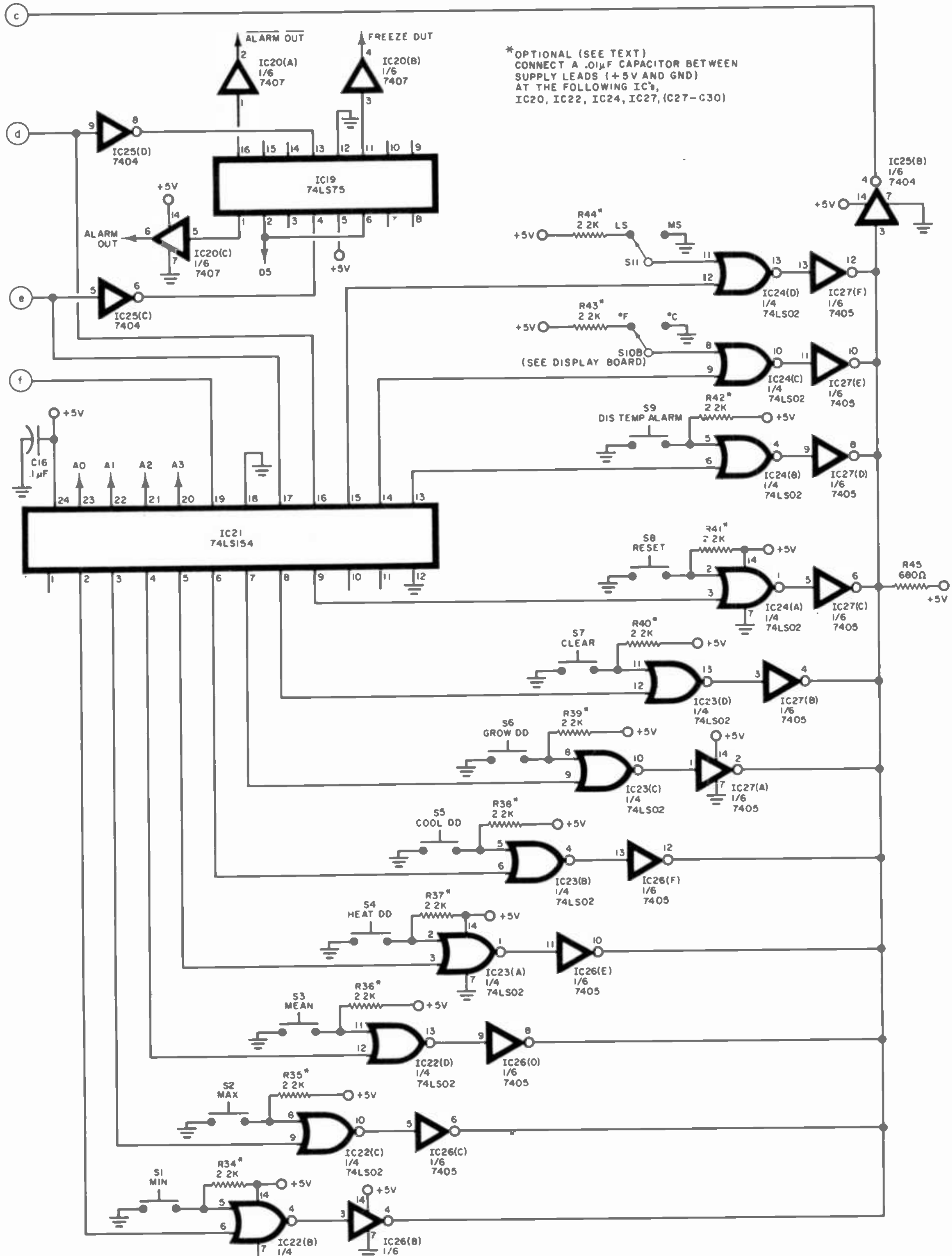


Fig. 3B. EPROM and logic circuits.



(C)

Fig. 3C. Indicating and output circuits.

temperatures between −56°F and +199°F.

The temperature-adjust control, *R26*, in this circuit provides the means for calibration. Theoretically, *R26* is set for a center-arm voltage of 2.2426 V. However, if you use only a digital voltmeter to adjust the circuit, you can have an error as great as 3°C (although 1°C would be typical). A better way to calibrate the thermometer is to put the probe in a mixture of ice and water so the display shows 32°F. This calibration procedure results in an accuracy of better than 1°F over the instrument's entire range.

When *R26* is set correctly, the output of *IC11A* (pin 1) is 0 volts when *D9* is at −56°F and 1.4167 V when *D9* is at 199°F. (*IC11A* subtracts *R26*'s center-arm voltage from *D9*'s output voltage.) At a temperature of 77°F, *D9*'s output is 2.9815 V. The output at *IC11A* is 2.9815-2.2426=0.7389 V. *IC11B* and its associated circuitry multiply this voltage by 3.516 which results in an output voltage of 2.598 V. Since the A/D interprets every .0195 V as one *least significant bit* (LSB), an input of 2.598 V gives an output of 10000101 (133 in decimal notation). Note that 133-56 = 77, which just happens to be the temperature!

The byte of information from the A/D (*IC9*) then goes to the PIA (*IC7*). The PIA, under CPU control, tells the A/D when to start its conversion and the A/D lets it know (via its $\overline{\text{INTR}}$ output at pin 5) that it has completed its conversion.

In Fig. 3B, *IC14A, IC14C, IC15,* and *IC17A* provide decoding for *IC21*'s enable input. This IC (Fig. 3C) provides address decoding for all switches and *IC19* (which controls the outputs). *IC21* is enabled when the CPU puts addresses 8800 to 880F on the address bus. (Not all of these addresses are used, which allows for easy expansion by the reader.)

As an example of how the CPU "knows" which switch is closed at any time, lets look at the MINIMUM switch (*S1* in Fig. 3C). When address 8801 goes out on the address bus (which happens when the CPU is testing the MINIMUM switch), *IC21*'s pin 2 drops low. If the MINIMUM switch is also closed, *IC22B*'s output goes high and *IC26B*'s output drops low. When any outputs of *IC26* drop low, the input to *IC25B* also drops low causing all inputs to the three-state octal buffer *IC10* to go high. If there is a read operation taking place and addresses 880E and 880F are not on the address bus, all the CPU's data lines will go high. Thus the CPU realizes that the MINIMUM switch was closed and proceeds according to the instruction in *IC12*, which tells it to display the contents stored in the MINIMUM memory register. The other switches perform similarly.

When the CPU calls up addresses 880E or 880F, *IC19* is enabled. This IC, along with the open-collector high-voltage buffer, *IC20*, provides the FREEZE, ALARM and $\overline{\text{ALARM}}$ outputs. For an example of how this circuit works, consider the FREEZE output. When the CPU places address 880F on the address bus *and* its data line 5 is high (this only occurs when the CPU has detected a temperature of 32°F or below), *IC19*'s latch 3 is set. This causes the $\overline{\text{Q}}$ output of latch 3 (pin 11) to go low. Buffer *IC20B*'s output (FREEZE) drops low allowing it to sink current.

The MEAN routine (which has a starting address of FD80) calculates the mean or average temperature by using temperature data taken every four minutes. To do this, the circuit must have a built-in accurate clock. The 60-Hz ac supply is used as a time base. Along with associated components, the CMOS

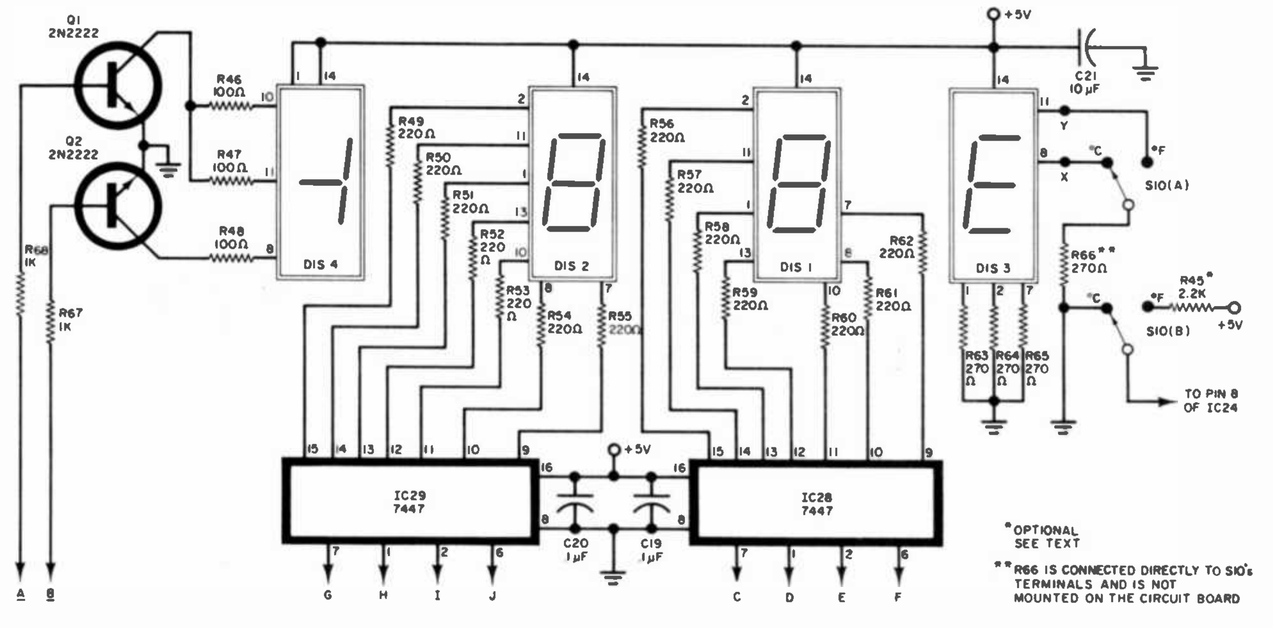
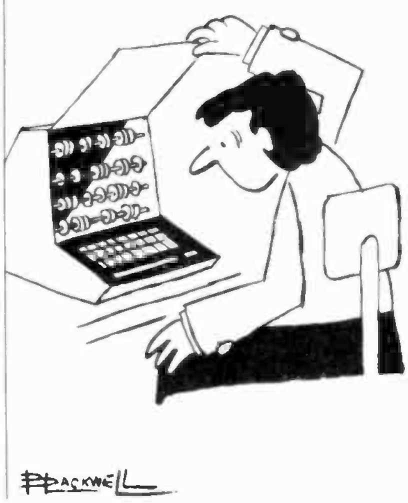


Fig. 4. Schematic of the display circuit.

Schmitt-trigger inverter, *IC2A*, shapes the 60-Hz sine wave into a CMOS compatible signal. These 60-pulses-per-second then go to the clock input of *IC1*, a 14-stage binary ripple counter. Then *IC1*, along with *IC3A*, forms a divide by 14,400 circuit, which results in one pulse every four minutes at its pin 1 output. This short pulse is inverted by *IC2B* and lengthened by *IC4*.

After leaving *IC4*, the pulse is about 50 ms long and is again inverted by *IC2C* before it is applied to the non-maskable interrupt ($\overline{NMI}$) input of the CPU (pin 6). When this pin goes from high to low, the CPU completes its present instruction and then jumps to a new set of instructions which tell it to find the present temperature and then calculate the mean temperature and degree-days.

This article will be continued next month with instructions for construction, calibration and applications. ◇



SOLID-STATE DEVELOPMENTS

Keeping Up With the New Microprocessors

By Forrest M. Mims

IN THE mid-1970's when only a few microprocessors were available, comparing the instruction sets, capabilities, and specifications of competing chips was fairly straightforward. Today, however, *dozens* of microprocessors are available. Therefore, comparing their capabilities can be difficult and time consuming, particularly since the various manufacturers follow no standardized format in their specification sheets and data manuals.

Electronics publishers were quick to recognize the need for books about microprocessors. Some of the early texts, however, were rushed into print before the rapid expansion in the number of different microprocessors. While the basic concepts presented in these books are still valid, the product descriptions are often very much out of date and incomplete.

Some of the most successful early microprocessors like Intel's 8080, Motorola's 6800, and MOS Technology's 6502 are still very popular. This is in large part due to the availability of numerous support chips, abundant software, and second-source agreements with other firms. Today, however, there's a growing trend toward CMOS microprocessors that consume far less power and require fewer support chips than their NMOS predecessors.

Consider, for example, National Semiconductor's NSC800. This CMOS chip has the processing power of Motorola's 6809 or Zilog's Z80, both of which consume 200 mA from a power supply that must have a potential within 5% of 5 V. The NSC800 can be powered by a supply providing from 3 to 12 V. At 5 V, it consumes only 10 mA and is therefore ideal for use with unregulated, battery-powered equipment.

Another important trend is the proliferation of single-chip microcomputers (microprocessors with on-chip RAM and ROM). These microcomputers are finding many applications in such dedicated consumer roles as games, toys, appliances, and automobiles. Some include on-chip analog-to-digital conversion, melody generator ROMs, real-time clocks, or other special-purpose functions.

Microcomputers with 4-, 8-, and 16-bit capacity are now available. American Microsystems manufactures the S2000 series of sophisticated 4-bit microcomputers. This family of microcomputers includes a mask-programmable ROM and is therefore intended for high-volume, dedicated applications such as controlling microwave ovens, washing machines, and toys.

Figure 1 is a generalized block diagram of the S2000 series. Versions having various memory capacities and high-voltage outputs are available. Most members of this family are NMOS, but the S2210 is a low-power CMOS version. The S2200/2400 include on-chip either an 8-bit analog-to-digital or an 8-bit digital-to-analog converter. All

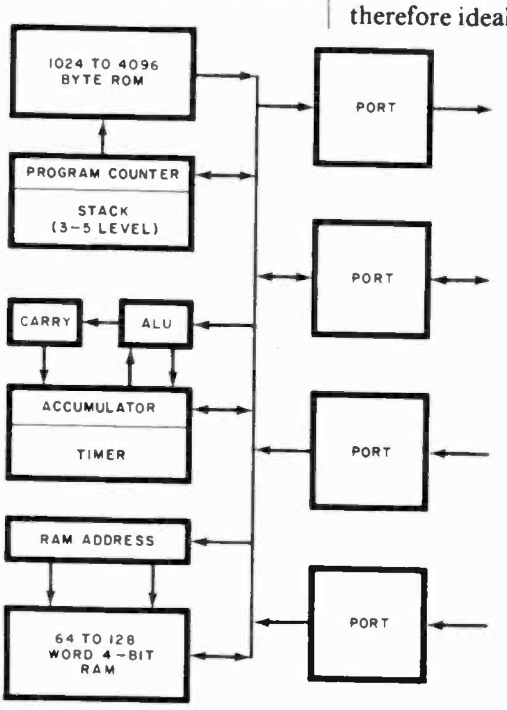


Fig. 1. Block diagram of the AMI S2000 series.

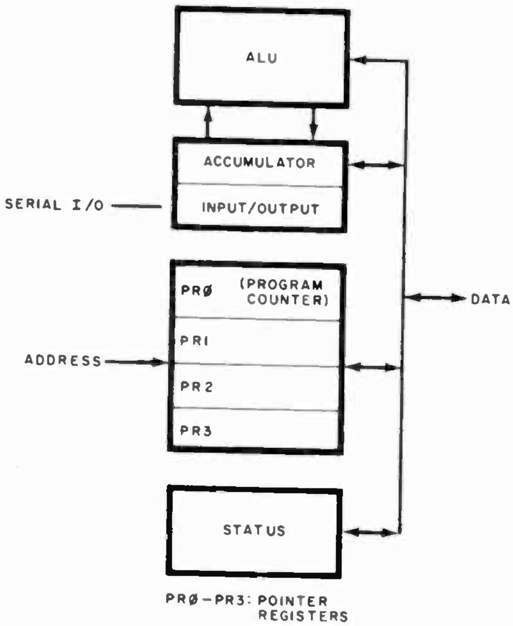


Fig. 2. Generalized block diagram of INS8075 chip.

members of the family can perform with the assistance of support chips. Depending upon the version, from 49 to 63 instructions are available.

National Semiconductor's INS8075 is a unique microcomputer that includes a BASIC interpreter programmed into its on-chip 4K ROM. Also included on-chip is a 64-byte RAM. The chip features a 16-bit address bus that is completely distinct from the data bus. It also includes logic for multiplication and division to provide faster processing than when these functions are implemented in software. An NMOS chip, the INS8075 requires 5 V and draws 100 mA. Figure 2 is a generalized block diagram of the chip.

The only 16-bit microcomputer is Texas Instrument's TMS9940. An NMOS chip, the TMS9940 includes on-chip 2048 bytes of ROM and 128 bytes of RAM. The standard TMS9940 ROM is mask programmable and is therefore intended for volume production. A version with an ultraviolet erasable EPROM is also available. It's intended for testing TMS9940 applications prior to large production runs with the standard version. It can also be used for limited production runs.

Figure 3 is a generalized block diagram of the TMS9940. The chip's instruction set is essentially identical to that of the TMS9900 16-bit microprocessor. A CMOS version of the TMS9940 microcomputer will soon be released by American Microsystems.

Collecting the literature necessary to compare the microcomputers just described, not to mention the dozens of other microprocessors and microcomputers that are available, is a time-consuming task. But this chore is not nearly as difficult as that of interpreting the literature from competing manufacturers.

Electronics trade magazines occasionally publish review articles that compare the key applications for many of the most important microprocessors and microcomputers. The limited page space in a magazine, however, does not permit the degree of coverage required by people who have to select a microprocessor for a particular design application.

Steve A. Money, a civilian computer scientist employed by the Royal Navy in England, has recently helped change this situation, for a while at least. In a large format, 264-page work entitled *Microprocessor Data Book* (McGraw-Hill, 1982), Money has summarized the key specifications of at least fifty 4-, 8-, and 16-bit microprocessors and microcomputers. He's also covered many of the memory and support chips most commonly used in conjunction with microprocessors and microcomputers. These include RAMs, ROMs, PROMs, various peripheral device controllers (e.g., display and disk-drive controllers), and numerous serial and parallel input/output devices.

The *Microprocessor Data Book* is an enormous time saver for those who wish to narrow their choice of the microprocessor and support chips best suited for a particular application. The book has a couple of drawbacks, however. First, it is expensive, selling for $38 a copy. Experimenters and hobbyists might prefer borrowing it from a library or from a friend who works for a company that provides its employees with important technical books for reference.

The second problem is unavoidable and is common to *all* books that cover a fast breaking field like solid-state electronics. How do you find out about products announced *after* the book has been published? Of course, new chips can be included in new editions. But a better solution is to collect data sheets that describe newly announced chips. They can be kept in a three-ring binder to provide, in conjunction with Money's text, a fairly complete ready reference guide to microprocessors and their support chips.

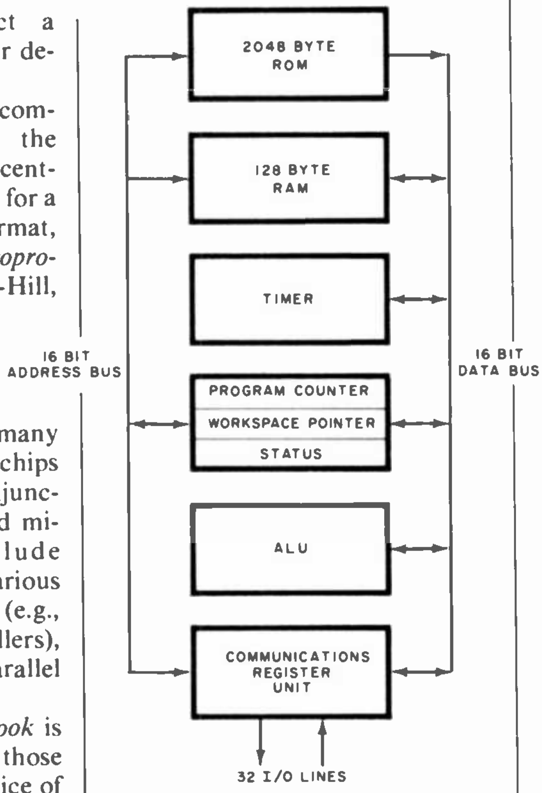


Fig. 3. Texas Instrument's TMS 9940 16-bit chip.

A New Solid-State TV Camera. General Electric's Optoelectronic Systems Operation (Electronics Park, Syracuse, NY 13221) has recently announced the availability of a new CID (Charge Injection Device) all solid-state television camera. The camera includes a built-in power supply that consumes less than two watts when powered by 12 to 35 V dc. The camera and power supply are housed in a sturdy case that measures only 3" × 3" × 2.5" and weighs less than one pound.

Two versions of the new camera are available. The TN2505 has a resolution of 244 by 388 pixels. The TN2506 has a resolution of 290 by 416 pixels. Both cameras incorporate an LSI scan generator and an LSI preamplifier. The signal-to-noise ratio of the system is an impressive 50 dB.

Though this new camera is intended primarily for security and surveillance, it may have applications in robotics as well. Another intriguing use is for pattern recognition. Until recently, the cost of the extensive memory required to implement these applications with the help of a personal computer has restricted this field to a very few affluent hobbyists and experimenters. Perhaps the cost of GE's new camera, which was not provided in its announcement, will be low enough to permit the average experimenter to explore some of these fascinating applications. ◊

COMPUTER HOTLINE

The C&E Staff Answers Your Questions About Computers

SERIAL VS. PARALLEL

Q. *What is the difference between serial and parallel computer output? Is one better than the other?—Joseph Miller, Easton, PA.*

A. Inside the CPU, data moves on a parallel data bus that is either 8, 16, or 32 bits wide. To transfer this data to an outside peripheral, we can extend the bus by means of a cable and send one complete ASCII or byte character at a time over the cable. We call this method of data transmission "bit parallel, character serial" because data bits are sent along separate parallel wires and one byte is transmitted at a time. The reason it is used is that it makes possible high-speed data transmission.

Parallel data transmission requires a cable with a wire for each data bit plus additional wires for ground and parity checking and other handshaking signals. Such a cable must be kept as short as possible to avoid electromagnetic interference problems. In most cases, parallel printer cable must be no more than 10 ft long. Another problem with parallel data transmission is that there is no standard for cables, connectors, or anything else.

The other popular method of data transmission is called serial data transmission because it sends data over the wire one bit at a time. This is very popular because it can be transmitted over longer distances and the cables require fewer wires. In addition, it can be coupled into the telephone system through peripherals called modems.

Since data is transmitted in a parallel mode inside the computer, it must be converted to an external serial transmission mode. At the destination the serial data is then converted back into parallel form for use by a printer or other device. Extra bits are added to mark the start of a data word and to provide handshaking signals to make sure that the data sent is the same as the data received. A standard for serial data transmission called RS-235 was agreed upon, and we are now using the "C" version. It specifies the type of connectors to be used, the rates of speed, timing, and identity of each wire in the cable. Without handshaking signals, a minimum of three wires must exist; additional wires up to 25 can be added for parity checking and other handshaking functions.

Neither parallel nor serial data transmission is "better" than the other. They have different uses and applications. ◊

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A Trio of Desktop BUSINESS COMPUTERS: APPLE III, NORTHSTAR ADVANTAGE, VICTOR 9000

By Stan Veit

TODAY a business person looking for a small computer often wants more than just a word processor or an accounting machine. He might be looking for the capability of doing accounting, word processing, forecasting, scheduling, inventory, materials control, and communications. These are the main applications that comprise small-business computing and these are the criteria that are applied when making a system selection.

All three of the systems examined in this article can accomplish these tasks. In addition, they can do other things—such as graphics. However, they are quite different in features, price, and level of support. The problem of evaluating these systems and deciding which is most suitable for any particular small business merely illustrates the larger problem of selection among all the computer systems on the market. We have thoroughly tested each of the machines discussed with regard to characteristics that affect their operation, software availability, maintenance support, user documentation, cost, and other factors that are not necessarily obvious to the reader.

The Victor 9000, NorthStar Advantage, and Apple III are all designed to be used on a desk like an ordinary typewriter.

Victor 9000

The Victor 9000 consists of three units. The System Unit is a rectangular chassis 16″W × 13″D × 7″H containing two 1.2M-byte minifloppy disk drives.

Design of the disk system is ingenious. The drives run at variable speeds so they can pack the diskettes with almost twice the amount of data that can be stored on the same size diskettes running at constant speed. Victor is now offering double-sided disk drives as an option. This increases the storage to 2.4M bytes. We used many types of ordinary diskettes with the Victor over the two months we had the computer. The disk system had no failures or loss of data, even with diskettes not rated for double density! This is a tribute to the design.

There are no switches on the front panel; the only indicators are the two disk-operation indicator lights on the drives. The rear panel has the power switch, reset switch, and cable connectors. There are no other controls except on the keyboard.

The system has a parallel printer connector and two RS232C serial connectors. This is very handy because it allows the user to have a serial printer and a modem connected at the same time. The serial interface can be set to operate in asynchronous mode at baud rates up to 19.2K baud. It will also operate in bisynchronous mode up to 56K baud. Furthermore, it also operates in SDLC (synchronous data link) to communicate with large main frames. The mode and baud rate are set under software control.

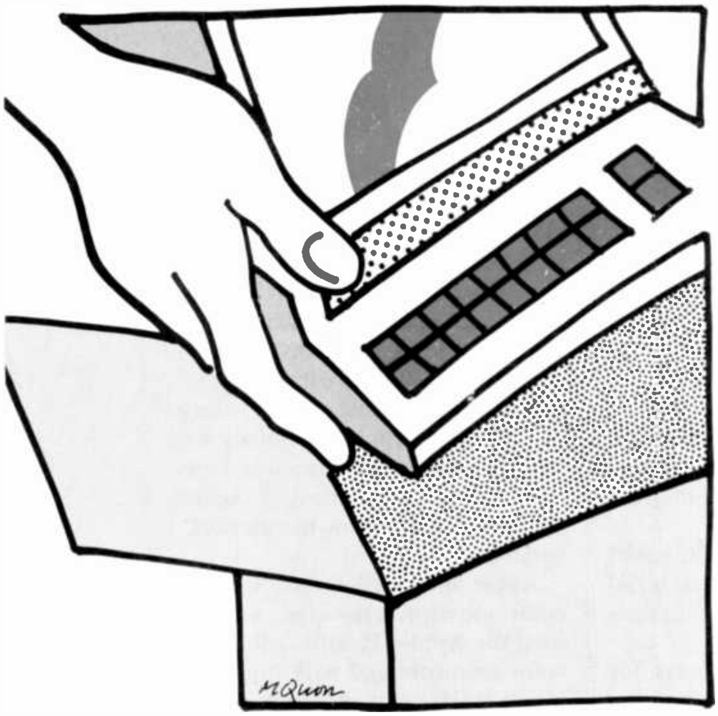
The other connectors on the rear panel are for the detached keyboard and the video display. The video monitor is a 12" diagonal green-screen CRT. CRT intensity and contrast are controlled by keys on the keyboard. This unique feature allows the operator to adjust the display during operation to meet changing light conditions without stopping the work being done. The video display is mounted on an adjustable mounting which permits the viewer to rotate the CRT in a horizontal direction about 45 degrees in either direction. the mount also tilts to raise or lower the viewing angle. This is another part of the ergonomic design by Victor Business Systems under the direction of Chuck Peddle, an outstanding computer designer and Victor's president.

Another unusual feature of the Victor 9000 is the system keyboard, which may be one of several types. In the United States, there is a U.S. Word-Processing keyboard. Victor "Standard" Keyboard, and a Victor Programming Keyboard. All of the keyboards have the same major groups such as typewriter keys, numeric entry and calculation keys, cursor control keys, and special-function keys. There are five keys on the left side for such functions as clear, home, scroll, reverse video, vertical tab, underline, and repeat. Across the top is a group of user-programmable function keys that provide application-specific functions. They are defined by the program being run.

To the right of the typewriter keys on the Word-Processing and Programming Keyboards is a second set of function keys that control intensity and contrast of the video display and loudness of sound generated by a built-in loudspeaker. In addition, these keys control cursor movement and such functions as insert, delete, and help when used with the appropriate software. Further to the right is a complete numerical calculator keypad with its own ENTER key.

Access to the interior is obtained by unscrewing the rear panel and sliding and lifting the top cover to the rear. With the cover removed, the internal construction is observed to be neatly laid out. The main board holds most of the circuitry, including the 8088 CPU, the memory, video and I/O circuits; a second board contains the disk-drive controller circuits.

The Victor comes with 128K of RAM memory, which can be expanded to 896K. Since the 8088 CPU can directly access all this memory without memory management schemes, the Victor has plenty of room to grow.



There are also five slots for plugging in boards for future growth and additional applications. Even after maximum memory is installed there are two slots left. One of them can be used for a controller for hard disks of 5 and 10M. These should be available by the time this appears.

Like many other computers, the Victor 9000 has an audio amplifier with a good speaker. However, it also includes a Coder/Decoder (CODEC) circuit that digitizes and reconstructs a human voice. Your Victor can speak to you!

This, then, is the physical design of the Victor 9000 and its CRT. It has many features that recommend it for use in an office, home, classroom, or laboratory.

Apple III Computer

The pros and cons of Apple III Computer have been discussed long and often in its brief history. Apple has spent a lot of time and money upgrading and advancing the capabilities of this top-of-the-line desktop computer.

The problems that plagued the Apple III in its introductory phase seemed to be the result of having too small a memory for the new operating system it used. People were used to simple things from Apple. Applesoft and Apple DOS are easy to learn and to use. The wonderful things it did were a function of the intelligent design of the Apple II. Then the Apple III came along with an operating system so sophisticated that Apple named it Sophisticated Operating System (SOS). To accompany this new system, the company introduced Business Basic and expanded graphics and color capabilities.

It was all very nice, except that it was not expected from Apple. Perhaps it was a case of too much too soon. When we closely examined the Apple III and its supporting software, we became convinced that this is an underrated machine.

The physical aspect of the Apple III is pleasing. Moreover, it is designed for easy use. It is a one-piece unit, although the keyboard looks like it is detached. Unlike the Apple II, which is housed in a plastic case, the Apple III is built into a sturdy metal chassis. A single Apple III disk drive is mounted in the front of the cabinet and there are a few connectors on the rear panel. First, there is a connector for a disk drive which enables the connection of up to three additional disk drives in a daisy chain. (The first additional drive plugs into the connector and then the second additional drive plugs into the first, etc.)

Next to the drive connector are two ports for the connection of various input/output devices such as joysticks and graphics digitizers. Each port has circuitry for X and Y directional inputs and for a switch. One of these two ports can be used for the connection of the Apple Silentype Printer. This is an electrothermal printer that is very good for graphics and program listings.

There are two video ports. One is designed for connection of a color monitor and it will support either NTSC composite video (such as you have on your TV set) or red, green, blue (RGB) color video. Signals available at this port enable the user to connect any color or black-and-white monitor, a studio RGB video monitor, a video tape recorder, or any other video device.

The B/W video port carries only the black-and-white video signals, and is to be connected to a monochrome monitor.

There is an audio port that enables any sound generated by the Apple III to be sent to an external speaker or any other audio device. When a plug is inserted into this jack, it turns off the internal speaker.

Lastly there is an RS232C serial port that can be used by a serial printer, a modem, or any other serial device.

There are no parallel ports for printer connection on the rear panel. If one wishes to use a parallel printer such as an Epson MX80, for example, a special interface card must be added to the Apple III by plugging it into one of the peripheral slots in the computer. The connector for this card projects through a slot in the rear of the chassis. Before any peripheral can be used with the Apple III, it must be integrated into the software operating system. The cassette port, a fixture on the Apple II, has been eliminated on the Apple III.

The keyboard on this computer is one of its nicest features. It is designed like an electric typewriter keyboard with a few additions for computer operation. It is a sculptured design, with keys set at a comfortable angle for the operator.

Almost any high-grade video monitor can be used with the Apple III. However, Apple Computer has introduced a monochrome video monitor that is styled to complement the Apple III and which bears the Apple logo. This was an unfortunate choice because it seems to be an inferior monitor. The Sanyo monitor that Apple previously sold with the Apple III was a much better monitor (as are most of the medium-priced units on the market, I believe).

Apple does not have an "official" color monitor. However, we have used the Apple III with both NTSC color monitors and with high-resolution RGB color monitors such as the Sanyo and Electrohome, and the color video appears to my eyes to be as good or better than anything else in the personal computer field.

There is a Winchester-type hard disk called the Profile designed to work with the Apple III. It fits on top of the Apple III, under the video monitor.

The Profile has a capacity of 5 megabytes and is a very useful peripheral because the Apple's floppy-disk storage capacity is not too generous. The single floppy in the front panel holds only 140K bytes and the system can support up to 3 additional drives, also 140K each. By today's standards, this is not much disk storage.

On this page is the NorthStar Advantage. Opposite above is the Victor 9000; and below that, the Apple III.

Access to the inside of the Apple III is achieved by removing the heavy metal cover held by captive screws on the bottom. Inside are slots for four plug-in boards. Card guides are built into the chassis and openings in the rear panel allow access for cables going to the connectors mounted on the plug-in cards. When no card is installed in a slot, the opening in the rear panel is covered by a "dummy card" plugged into the slot.

There has been some criticism leveled at the design for only providing four slots, though direct connections are provided on the rear panel for the disk drives, serial ports, video ports, and miscellaneous peripherals. While valid, this is the price one pays to get compact desktop design.

The power supply is contained in a sealed cabinet beside the card slot area. There is no fan in the Apple III, a practice carried over from the Apple II. The massive metal cabinet and the air spaces are designed to cool by transmission and convection. This does not always work when using the computer is a closed warm area. A fan would have been appreciated.

Memory expansion is also done by adding chips to the main board through a plug-in board. The standard Apple III comes with 128K bytes, with 256K bytes optional. It turned out that one of the slots was usually filled by a parallel interface board to operate a printer like an Epson, IDS, C. Itoh, Star Micronics, or Centronics. Another slot may be used for a Micro Modem (physically modified to fit) and that only leaves two slots for expansion. One of them is used if you add the Profile hard disk, leaving you with one slot!

Again, all of the desktop designs share this slot shortcoming.

North Star Advantage

One of the first things you notice about the NorthStar Advantage is its compact design. It is a self-contained, desktop, general-purpose computer designed to be used in an office environment and to appear as a nonthreatening office machine to those who will use it. It succeeds in this very well. It is not much bigger than an office electric typewriter, although it packs a lot of computing power into a small space.

The Advantage keyboard has a Selectric typewriter arrangement with a 14-key numeric keypad and an ENTER key. Across the top of the keyboard there are 14 special function keys. These are labled F1 through F15. In addition, there are character delete (X), Cursor Lock, ESC (escape), CONTROL, and CMD (command) keys. All of the functions are defined by program control. On the rear panel there are the ON/OFF switch, RESET pushbutton, and a brightness control for the CRT.

The 12" diagonal, P31-phosphor, nonglare video display, is protected by a safety shield. It produces a 1920-character display (24 lines by 80 characters).

The characters are 5 × 7 dots in an 8 × 10 matrix, a very readable configuration. In the graphics mode, the screen is set up as 240 pixels high by 640 pixels wide, permitting high-resolution graphics.

There are two 5¼" floppy disk drives mounted in the front of the cabinet. They are double-sided, double-density units with 360K bytes capacity each. The diskettes used are hard-sectored (10-hole), formatted with 512 bytes/sector, 10 sectors/track, 35 tracks per side, 2 sides/per diskette.

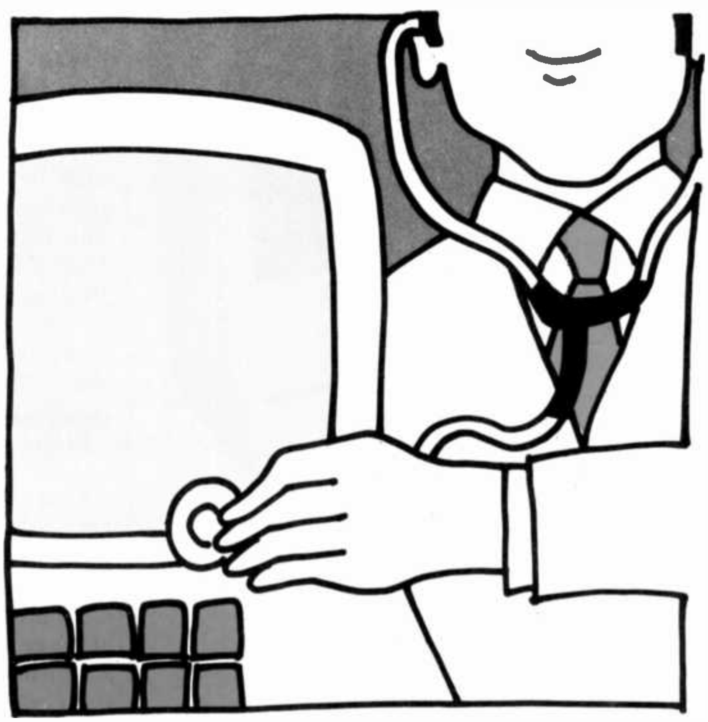
An alternate configuration has one floppy disk and a Winchester hard disk with either 5M or 15M bytes capacity. Prior to 1983, it was not possible to upgrade to the hard-disk configuration once a floppy-disk version had been purchased. Since the introduction of the 15M byte drive, a retrofit kit has been made available.

Another recent enhancement is the Advantage 8/16 CPU board, which upgrades the computer to run 16-bit or 8-bit software. It adds the MSDOS software to the already impressive list of operating systems.

The top cover of the Advantage is taken off by removing the screws on the bottom of the cabinet and carefully lifting the cover. Inside the cabinet, there is the main board assembly, the disk-drive assembly holding the drives, the power-supply transformer, and the keyboard. The CRT and the fan remain in the top-coverd assembly. There are six slots to plug in I/O and other boards. Normally the computer comes with a serial board installed. To add a parallel printer, a parallel interface board (PIO) must be installed and the operating system must be modified and patched. The hard-disk controller also plugs into one of the slots.

The Advantage has a Z80A CPU to run the computer and a separate 8035 auxiliary microprocessor to operate the keyboard and disk.

The main RAM memory is 64K bytes and there is an additional 20K bytes for the video display. There is also a 2K boot PROM. It is not possible to add additional memory to the Z80 configuration. However, the Advantage 8/16 Board, which adds the 16-bit 8088, comes with 64K of additional RAM. Up to 256K of RAM can be added with piggy-back boards that plug into the expansion board.



Operating Systems and Systems Software

The Victor 9000 has been supplied with a choice of the major 16-bit operating systems being used. Most of the application software offered for this computer runs under the Digital Research Inc., CP/M-86 operating system, although Microsoft's MSDOS is also provided. This gives the Victor the widest selection of languages and application software of any of the machines tested. Although the Victor 9000 uses a unique disk format, it is possible to read diskettes from the IBM-PC by downloading, using a communications program called Move-It from Woolf Software (23842 Archwood St., Canoga Park, CA 91307).

In addition to the 16-bit software, the Victor 9000 can use CP/M-80 software when a Victor 80 board is installed. This CP/M-80 board for the Victor 9000 is manufactured by Small Systems Inc. (1056 Elwell Ct., Palo Alto, CA 94303 Tel. 415-964-8201).

The board comes in two versions. The Victor 80A has a 4-MHz Z80 and costs $595, while the Victor 80B uses a 6-Mhz Z80 and costs $650. There is a bonus when you buy these boards since they have their own 64K of RAM on board. They also directly interface to the Corvus hard-disk drives.

The Apple III operating system, SOS, (pronounced "sauce") is the underlying structure for all programs running on the Apple III. Only advanced programmers who work in machine language will directly use the system, Apple III users must be aware of it. SOS must be included on every boot diskette used to start up the Apple III, for example. The system is resident on diskette so that newer versions can be added by updating the system on the boot diskettes. The system communicates with the outside world through "devices" that may be part of the Apple III, or a piece of peripheral equipment that transfers information into or out of the Apple III. Typical devices include the keyboard, screen, disk drives and printers.

Special programs called "device drivers" operate the foregoing devices. In order for the Apple III to recognize that a device exists, it must be configured into the operating system. If this is not done, SOS does not recognize its use even though it may be physically connected to the system. Every time a device is changed, a revised version of SOS must be placed on every boot diskette used with the computer.

SOS works on files and there is a hierarchy of files and directories (tree structure) that permit the user to access information at various levels of the tree by specifying pathways and directories. This is a very powerful feature for locating data and building programs into software systems.

The main language of the Apple III is Business BASIC, a very powerful version of the language that has many more features than Applesoft BASIC. An updated version of Pascal can also be run on the Apple III. When using it, a completely different operating system is in effect. This is an update of the UCSD Pascal used in the Apple II.

One of the features incorporated in the Apple III to make up for the initial lag in the development of application software for a new computer was the Apple II Emulation mode. This enables users to run Apple II software on the Apple III. It does not extend the power of this software so that it can use the Apple III features, such as eighty columns with Apple II word processors. However, except for one Apple II feature, you are able to use the huge collection of software written for the Apple II.

The one exception is software that uses both Applesoft and Integer Basic and moves back and forth between them. In the Emulation mode you have to select either Applesoft or Integer BASIC. Unfortunately, many graphic programs use this technique.

The Apple II Emulation is a useful feature; but as more software is developed for Apple III, it has become much less important.

SOS is indeed a sophisticated operating system, but it is not easy to learn or easy for a beginner to use. For that reason the Apple III has not become the same kind of a popular software development tool that

the Apple II is. Most of the users of Apple III turn out to be business organizations that have programmers who develop their software or who use packaged software.

Programmers who use SOS like it and find that, used with Business Basic, it is effective for business and graphics programming. But it is not the same kind of a "user friendly" operating system that Apple II DOS is.

In all of the Apple III operating systems and languages there are provisions to include color. These color commands add the ability to use color display screens to illustrate programs. This capability is not available in the other desktop computers tested.

There is now a Z80 CPU card called Apple Softcard III for $450. It includes a SOS/Utilities disk, the CP/M master disk including Microsoft BASIC, and extensive documentation and manuals. This enables the Apple III user to run CP/M. The user memory area for CP/M applications is 51K. The Apple III with Softcard III will run CP/M application software that will operate within these memory limitations and that has been configured for the Apple Softcard III. This will open up a large library of software for the Apple III, but first a lot of work has to be done to reconfigure CP/M software for the Apple III.

The NorthStar Advantage comes equipped with a broad range of operating software for graphics, language support, and application software support.

The Graphics Disk Operating System, (GDOS) was designed specially for the Advantage to allow the user to run a number of utilities and to create, run and debug programs written in Graphics BASIC or other compatible languages. It also supports application programs designed for use with GDOS. This system can be used either with floppy or hard disks.

NorthStar has also provided a special version of the CP/M system called Graphics CP/M. This system supports languages and application programs that are written to run under CP/M. It is designed to use all of the graphics features of the Advantage.

Graphics CP/M (R) will operate with either the floppy or the hard-disk models of the Advantage. NorthStar has developed an extensive package of business applications specially for the Advantage. To support them on the hard-disk version, a separate operating system called HDOS-ADV is supplied.

Language and Applications Support

Victor 9000. No new microcomputer has ever had such initial support as the Victor 9000. Victor Business Products is a division of Kiddie Inc., a huge diversified industrial corporation. It is experienced in the business-machine industry and has spared no effort to launch the Victor with a solid base of computer languages and applications software. In addition, there is a network of Victor Business Machines offices staffed with maintenance people who support both the dealers and the end users.

The Victor 9000 supports Microsoft's GW-BASIC, BASIC-86, CBASIC, MS-PASCAL, MS-FORTRAN, MS-COBOL, and CIS COBOL. Victor has provided three word processors including WordStar, Select and Victor Writer (which includes a mail merging program). In the electronic spreadsheet department, there is SuperCalc, VictorCalc, and Multiplan. At this time, dBase II is available as a data base, although Victor plans to offer users a choice in the category as well.

Since the Victor 9000 runs on both CP/M-86 and MSDOS, hundreds of programs running under these operating systems can be used. Lifeboat Associates and Westico Software will both support the Victor format and adapt their 16-bit software for it. With the addition of the Z80 Card, thousands of 8-bit CP/M-80 programs can be made available.

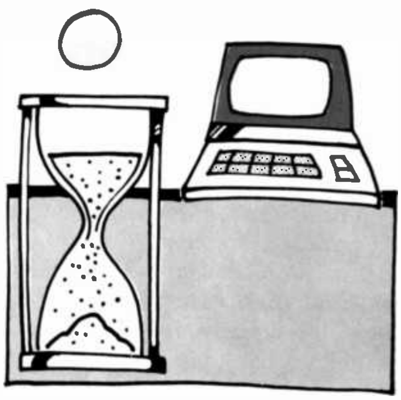
Apple III. Although the Apple III has been on the market longest of the three programs tested, it has less applications software than any of the three. Because it has a unique operating system and there were not too many computers of this type in the field, software developers have been slow to write software for the Apple III. The situation is now much better since Apple Computer has released many application programs.

VisiCalc III is the most important of these. Indeed many Apple III computers were sold just to run the improved version of VisiCalc that operates on it. There are several word processors running on the Apple III, but Apple Writer III from Apple seems to be the best of these. When using Pascal, the Script III programs format text written using the Pascal Editor. Mail List Manager is another popular application package. In the data-base category, the PFS system is available under SOS.

The Peachtree Business software now runs on the Apple III, too, fulfilling its promise as a real business computer. These programs include the Peachpak 8 Accounting Series, General Ledger, Accounts Receivable, Accounts Payable, Sales-Invoicing, Inventory Control, and Peachpak payroll. There is also the PeachText word processor, PeachCalc, electronic spreadsheet, and a Spelling Proofreader, Mailing List Manager and Telecommunications.

With the addition of the CP/M card the whole world of CP/M software will open to Apple III users. Many programs developed for the Apple II CP/M will run on the Apple III under CP/M with slight modification. The library of CP/M-80 programs will shortly be available for the Apple III.

Last but by no means least is the graphics support for the Apple III. Apple has released the Business Graphics software for Apple III, and many other software houses have graphic software for it. Apple III graphics, both in full color and monochrome, are unique among desktop computers as far as their availability and support are concerned.



NorthStar has provided a broad range of applications software under its own operating system, including NorthWord, a word processor ($399); and InfoManager, a data base program ($199). There also is the ACCPAC group of business application programs, at $499 each. These include General Ledger, Accounts Receivable, Accounts Payable, Inventory Control, Order Entry, and Invoicing. Professional Client Accounting & Billing (ProPac, $1499) system has been designed for professional practices.

Since the Advantage also runs under CP/M, there is a large population of software available under that operating system. WordStar ($500), SpellStar ($250), MailMerge ($150), MicroPlan ($399), and dBase II ($700) are only the best-known of the CP/M software for the Advantage.

The version of CP/M supplied for the Advantage is called Graphics CP/M owing to the built-in graphics capabilities. This is important because one of the features of this computer is the ability to compose and display graphic images.

Conclusions

The three computers we tested here are typical of the offerings to business people with modest computing requirements. They all have excellent support with regard to software, and they come from manufacturers with good track records in the microcomputer industry.

The Victor 9000 is one of the new generation of 16-bit computers using the latest in operating software and technology. It performs like one and it is a pleasure to operate. I used the Victor video display all day and had no eye strain or tiredness. The NorthStar display is almost as good. In contrast, the Apple III monitor was terrible. After a short time my eyes exhibited strain from viewing it. However, I have used the Apple III with a high-quality monochrome video monitor such as the Sanyo, BMC, or Electrohome, as well as with a high resolution color monitor. Not having this complaint with these, I know it is not the fault of the computer.

The keyboards on all three computers were superior to those found on most personal computers. Of the three, the Apple III had the best feel, with the NorthStar a close second.

The Victor keyboard does not live up to the quality of the rest of the machine, unfortunately. Its design is excellent and very easy to use, but it is mechanically inferior to either the Apple III, or the NorthStar Advantage. The BACKSPACE key became stuck after a short time; the other keys seemed "loose" when typing with them. Most of all, I did not like the location of the ESCAPE key. It is a shift on the OFF/ON RVS key, which is seldom used. Why couldn't the ESCAPE have been the prime function?

Service and company support are very important to business users because a computer that is not working is more than a mere annoyance. It represents lost money. In this respect all three companies have maintenance provisions expected by business people. Victor has offices throughout the United States fully staffed with personnel for both software and hardware support. Their dealers are fully trained to provided the same level of service.

NorthStar has maintenance through Sorbus, the nationwide computer maintenance service; or the dealers provide service in conjunction with the factory. Apple III is serviced by its dealers, and every authorized Apple dealer includes a service facility with factory-trained people and back-up. A user can buy an extended warranty for the system.

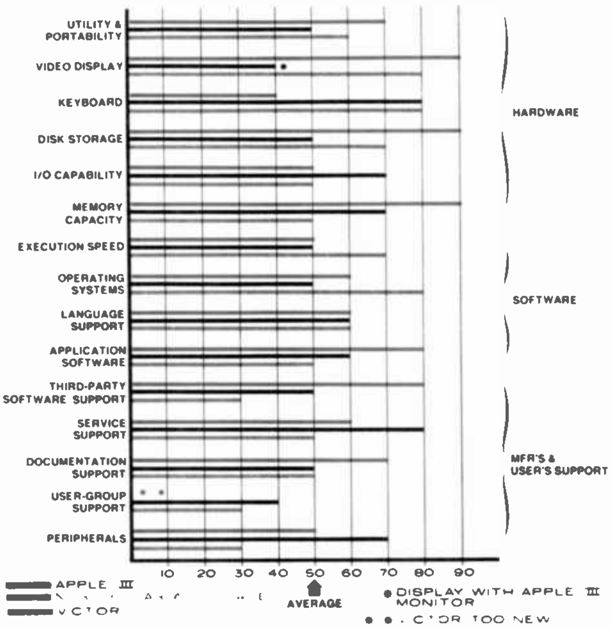
The overriding criterion in buying a computer often is the price/value ratio. This gets to be a harder and harder way to determine which is the best machine for your applications. Among the machines discussed in this article, Victor 9000, including 128K of RAM, two single-sided disk drives (612K each), keyboard, monitor, CP/M-86, and MSDOS, is priced at $4495. The same system with double-sided drivesd is $5950. Memory boards are $800 for a 128K board, or $2500 for a 384K board. The Winchester hard disk is $4995.

The Apple III system is priced at a suggested $3495 for a 128K system with one disk drive; extra drives are $495 each. The Profile Winchester disk is $2995. An extra $945 expands the computer to 256K of RAM plus $45 installation if this option is not ordered from the factory. The CP/M card is $450 and includes CP/M software.

When you add the extras to bring the Apple III up to the capabilities of the Victor, it costs about the same price. You do get the color graphics with the Apple III; and if this is important to your application, Apple is the only way to go. The Victor offers 16-bit performance, which is slightly faster than the 8-bit machines, and has the potential to perform much faster in the near future if the 8087 chip is installed. You have to weigh the various features of these two machines and cancel out the ones you want or don't need in order to come to a judicious decision.

The NorthStar Advantage is priced about $3599, with CP/M software adding an extra $150. Thus, it is the least expensive of the three systems examined here. It has the potential to become a powerful multi-user system with hard-disk support, and it now can be upgraded to 16-bit operation with the potential to run CP/M-86 and MSDOS. In its new 16-bit configuration it will retain all of the graphic capabilities. The Advantage then can be considered a worthy competitor to the more expensive Apple III and the Victor. For those who do not need all the computing power at once, at lowest money outlay, it deserves serious consideration.

We have never believed that speed benchmarks were a valid measure of the worth of a small business computer. This is a carryover from the world of mainframe computers. However, we have run benchmark tests on the computers in this article and the results are shown in the box. The features chart may be more helpful than measurements of speed. ◊



Comparative analysis of the three computers.

BENCHMARK TESTS

This benchmark program is based on the Sieve of Eratosthenes, modified by Jim Gilbreath of the Naval Ocean Systems Center, and adapted for the various operating systems and BASIC versions used by the computers tested. The benchmark program generates the prime numbers from 0 to 8190 and finds 1899 prime numbers. The times required for the three computers were:

Victor 9000 using MBASIC under MSDOS: 266 seconds.
Apple III using Business BASIC under SOS: 284 seconds.
NorthStar Advantage using NorthStar BASIC under GDOS: 235 seconds.

The results are interesting because the Victor 9000 uses the 8088 16/8-bit microprocessor, whereas the others use an 8-bit CPU. Apple III uses the 6502B microprocessor running at 2 MHz peak, 1.4 MHz average. The NorthStar Advantage uses the Z80A microprocessor running at 4 MHz, and an 8035 microprocessor is used as an auxiliary to operate the keyboard and disk. (There was no disk access during the test.) ◊

...ROBOTMATE (from page 47)

and pick up small objects. And it's pretty light on its wheels, too, turning in a one-foot radius, which makes it a perfect companion for those evenings at the roller disco. HERO knows how to conserve as well as expend energy by utilizing a "sleep" mode that's reported to have been developed by a group of Tibetan EE's.

We found HERO's sultry speech patterns reassuringly familiar in a delightfully robotic way. The phoneme-based speech synthesizer uses Votrax's familiar SC-01 chip, permitting generation of 64 phonemes to simulate human speech or sound effects. Reference pitch is hardware selectable and variable over four inflection levels with software control. Some prompts and canned phrases are inbred, such as "Ready" when it is switched on. HERO also tells you if logic or drive batteries are low.

When complimented on its speech facility, our RobotMate exhibited a flash of insecurity. "I know that anyone who meets me is impressed by my speech," HERO said, "but, frankly, I wish I had a National Semi instead of a Federal Screw vocal box. Why, it sounds so, uh...you know...robot-like!"

Hmm...seems that the circuits are always greener....

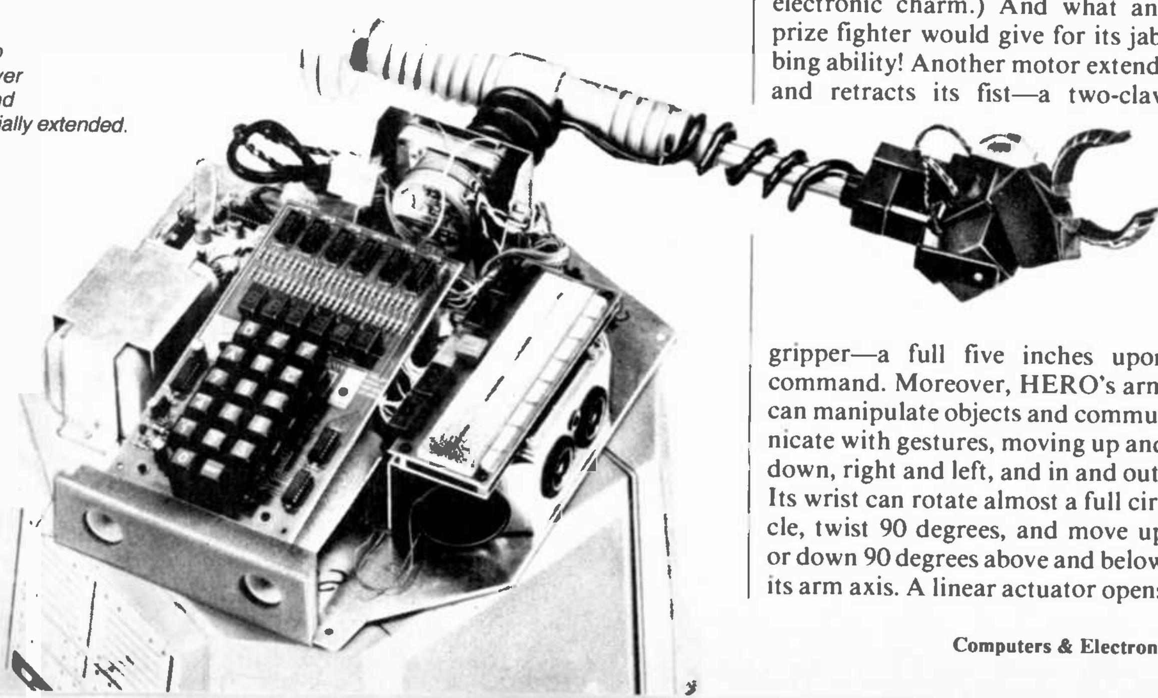
HERO's "head" is also remarkable. In a rather fetching display of modesty it initially declined to expose it during our early bare photography session. "A little mystery makes me more desirable," HERO coyly insisted. But after some gentle coaxing, it graciously revealed it later, as a picture here shows. A stepper motor rotates the head 350 degrees, enhancing the built-in senses, which include ultrasonic ranging and motion, light, and sound detection. Here's where a breadboard area is mounted, too, so that Robot Masters can develop and connect circuit cards. (Its amoebic parent, Heath Company, says that a bus system soon will be available for experimenters.) The intravenous-like system provides direct access to a user I/O port, a user-defined interrupt, the CPU control lines, and both +12- and +5-volt supplies.

When we voiced our admiration for its pulsed ultrasonic ranging system, which has a maximum range of 8 ft and a resolution of 0.42 in., with 30-degree horizontal and vertical beam width, HERO surprisingly dismissed this attribute. "My echo system, which operates at 35 kHz, is OK, I guess. But RB5X has a Polaroid option that goes out to 35 ft!" it replied petulantly. We gallantly observed that HERO was talking about a system that became available too late in its design cycle, but the inconsolable HERO kept mumbling about an electronic Right-to-Life designer who wouldn't abort.

HERO hears sound omnidirectionally over a frequency range of 200 to 5000 Hz, converting it into 8-bit digital words. Though it will never appreciate the value of a hi-fi speaker's tweeter, it does capture audio where most of the energy rests, with a resolution of 1 part in 256.

This robot uses two senses to see, so you can't escape its attention (not that any of our red-blooded readers would want to). In pitch-black darkness, a motion detector that uses continuous-wave ultrasonics will spot an adult walking toward it at a distance up to 15 ft, with omnidirectional sensing if looking toward a wall. A light detector responds to the presence (or absence) of ambient light levels over the visible spectrum, with a sensor-beam angle of about 30 degrees. HERO can be programmed to make decisions based on anything these senses detect, giving the security industry and the watchdog society cause to worry.

The most prominent feature of HERO's movable turret is its single, long robotic arm. Connected to a mounting point on its head, this arm can rotate horizontally with the turret. With a shoulder motor able to raise and lower the arm 150 degrees in a vertical plane, HERO is likely adept at frontal deltoid raises. (We hasten to add that this in no way detracts from its robotically electronic charm.) And what any prize fighter would give for its jabbing ability! Another motor extends and retracts its fist—a two-claw gripper—a full five inches upon command. Moreover, HERO's arm can manipulate objects and communicate with gestures, moving up and down, right and left, and in and out. Its wrist can rotate almost a full circle, twist 90 degrees, and move up or down 90 degrees above and below its arm axis. A linear actuator opens



HERO's top with the cover removed and the arm partially extended.

and closes the gripper, which has protective cushioning.

Shaking hands with HERO is a strange but memorable experience. It pinched me uncomfortably, using the full closing force of 5 ounces at its fingertips. With its two fingers being able to touch and having a full opening capacity of 6 in., HERO is obviously dexterous, though delicate operations such as mixing and pouring a martini are best left to a humanoid companion.

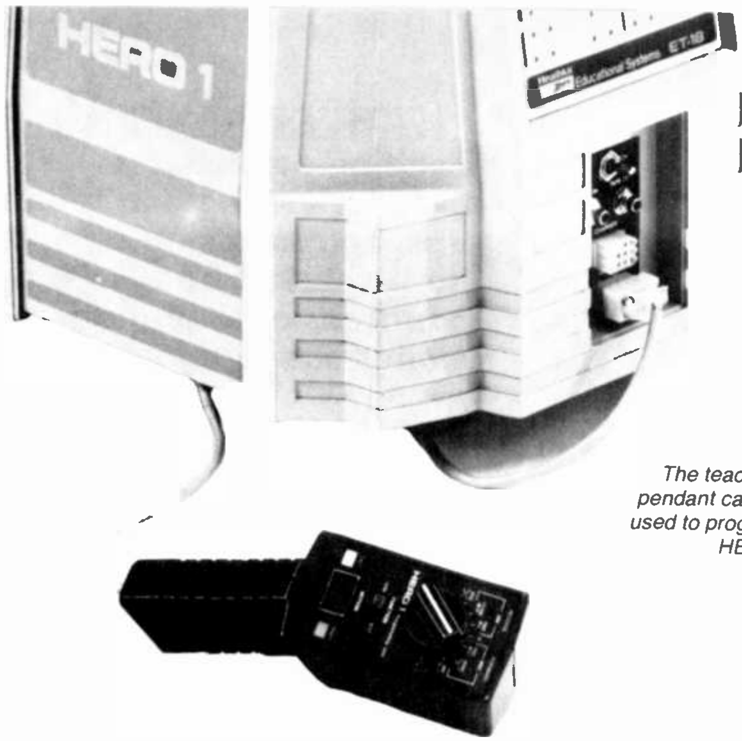
Like its industrial counterpart, HERO can be programmed relatively quickly and easily by using the teaching pendant that is part of its uniform. Connected through a 6-ft line, the pendant runs through action routines with the arm and body, which the robot memorizes in system RAM and can repeat over and over again. Arm payload is only 16 oz when fully retracted and 8 oz fully extended, but it doesn't have much to worry about in its 39-lb weightlifting division.

The robot's head also contains a programming keyboard, LED display, and one of its four batteries. Its 17-key hexidecimal keypad with multi-function keys gives one access to its onboard processor in machine language so that HERO can make decisions from its sensing inputs, arm and drive-wheel position, voice, and so on. Dumping data to a cassette tape, HERO can exchange programs with friends.

You can read HERO's mind, too, by looking at data displayed on six 7-segment LEDs on top of its head. Also, a four-year calendar clock keeps track of date and time with an accuracy of ±120 second/year, even with power shut off. So HERO will never miss performing a task at a given date and precise time for years ahead.

HERO's microprocessor has a host of operating modes. One is for utility functions such as arm homing; another is for repeating a stored program; and so on. Perhaps the most interesting one is the "sleep" mode mentioned earlier.

In this mode, HERO is shut down to conserve power and awakened only by the electronic kiss of a



The teaching pendant can be used to program HERO.

preset timer. When this happens, the robot wakes up and performs whatever programmed task it was assigned. For instance, HERO's motion detector can be programmed to turn on for 10 seconds, sleep for the next 10 seconds, and repeat this sequence over and over. When motion is detected, the robot could scream, "Halt, who goes there!" If silence follows, HERO could bellow, "Thief! Thief!" and wheel toward the closest person with its arm extended as a lance. (Imagine returning home to find a thief on the floor who died of fright.) Should there be an audio response, such as "Friend!" HERO would shut off to save power.

HERO has seven stepper motors directly driven by its internal computer through optical interfaces that are used to prevent back-EMF spikes produced by motor windings from damaging the semiconductor system. Seven input and nine output ports, all 8-bit parallel, interface the computer to motors, sensors, and control lines.

The energy-conscious robot uses a power-management scheme to conserve its electrons. Each output line is connected to a parallel switching circuit so that current is used only when that particular function is operating. As an example, when the "sleep" line goes high, a 10-second hardware timer starts, and power to all circuits except the timer and RAM is turned off. When the timer times out, normal power is restored to all systems and the next program instruction is executed.

HERO's interpreter in the ROM is essentially a high-level language that minimizes the number of commands needed to achieve an end result. For example, with step-by-step programming, it may take about 30 bytes of code to move a stepper motor a certain distance. With the interpreter, however, it takes just three bytes. Clearly, this is an efficient robot.

When questioned about its hopes for the future, HERO replied that it would like to emulate "Midnight Flash," winner of the IEEE *Spectrum*'s first "Amazing Micro-Mouse" maze-running contest, and be first among learning/personal robots, rather than miss out by 10 seconds like "Harvey Wallbanger" did in the robot-mice race. Shades of Claude Shannon!

Among its favorite activities is wheeling into a Robot Master's bedroom each morning to tell him to get up, announcing such important events as an anniversary or a business appointment, and even singing "Happy Birthday."

As the interview drew to a close, I reluctantly prepared to take my leave, but posed one final question to our January RobotMate.

"Do you think humans should get you in assembled or kit form?"

"A kit would be desirable."

I asked why and could swear I detected the glistening of moisture in HERO's "eyes" as it replied, "Dr. Frankenstein would have wanted it that way." ◇

JVC HR-C3U
Portable VHS Video Cassette Recorder

IN LAST year's January issue, I praised Technicolor's Model 212 portable VCR for its light weight—only 7 lb with battery. This model used ¼" tape in a package the size of an audio tape cassette and held up to 30 minutes of video information. It was not compatible with other video cassette formats, though. Here I am one year later reporting on another portable VCR, this time a 5.3-lb battery-equipped machine that uses conventional ½" tape in a compact VHS videocassette (TC-20), records for 20 minutes (SP speed), and is fully compatible with standard VHS machines using an adapter.

The JVC Model HR-C3U machine is smaller, too, measuring only 7½"W × 3"H × 8½"D. Only ½" is added to the depth when used with the snap-on battery pack. Unlike the Technicolor VCR, the HR-C3U can be powered from a standard ac outlet, too. Removing the battery pack reduces weight to only 4.4 lb. The unit comes with a regular (0.7 AH) battery pack, a battery charger, wired remote control, carrying case, and shoulder strap. Options include a high-capacity (1.2 AH) battery pack and car-battery adapter. $850.

General Description. JVC's compact VCR contains all of the essential features of a standard VCR. This means that the $^1/_2$" tape-recording standards are identical, using the same rotary, slant azimuth, two-head helical-scan system. It also means that video bandwidth, luminance, and color performance are inherently the same as for a full-size VCR. In theory, the only difference between the performance of a full-size and a compact VCR should be the length of the recording.

All of the controls are located on the front panel. The key operating controls—PLAY, RECORD, STOP, PAUSE, REWIND, FAST FORWARD, and AUDIO DUB—are all of the feather-touch, pushbutton type, with LED indicators next to them. These controls are recessed and can be covered by a sliding panel for carrying protection or when the remote control is used. LED indicators alert a user to excessive moisture (DEW) and low battery. An LCD tape counter display indicates how much tape is used and, pressing a miniature button, how much tape record time is left in minutes and seconds. There are two other miniature buttons controlling the counter's function. One is a memory set button to allow the user to stop at specific parts of a recording during rewind. The other resets the counter. The RECORD-LOCK button permits the tape to remain loaded when power is off and to start recording instantly when the record button is pressed after a pause.

Video and audio input as well as control signals are brought in through the standard camera cable connector, and there are three output connectors at the side of the case. Two are RCA-type phono jacks, for video and audio signals, respectively. The third is a standard coax antenna connector for the r-f signal on channel 3 or 4, depending on the setting of a screwdriver-operated switch at the bottom of the case.

Miniature phone jacks are available on the front panel for a microphone input and for earphones. A third phone jack accepts the thin cable for the remote control unit, which contains the same seven key operating controls as the front panel, plus the power switch. An EJECT lever is moved upward so that the cassette tray rises to accept a compact cassette.

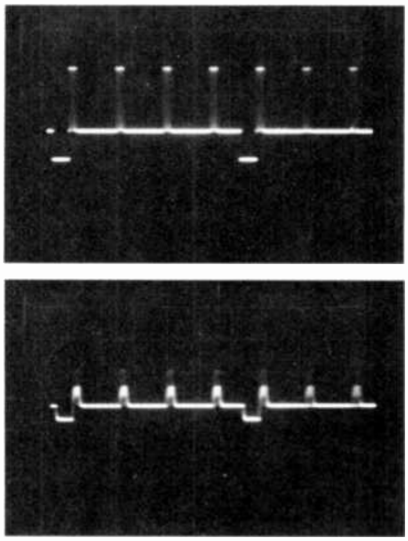


Fig. 1. Color-bar signal: input (top) and output (bottom).

The JVC HR-C3U can operate either from rechargeable batteries, from a car battery, or from the ac line through the charger, which also serves as power supply. The NiCd battery supplied with the unit is reported to be able to provide 40 minutes of continuous recording and be recharged in just 60 minutes. JVC also offers a special 60-minute battery, which, of course, requires a longer recharge time. Nominal power consumption is 5.2 watts, and to keep battery drain to a minimum, the VCR will shut itself off automatically when it is in the PAUSE or STOP mode for more than five minutes. With the use of the RECORD-LOCK switch, any delay of more than five minutes in camera adjustment, scene changes, etc., will automatically shut the recorder power off; but when the camera RECORD control goes on, the VCR starts again automatically. The memory of the LCD tape counter remains on for at least one hour.

When recording is stopped, an automatic backspace feature rolls the tape back 30 frames so that the next segment is synchronized. To confirm recording of the previous scene, the automatic quick review feature presents the last second of the recording to a separate camera's viewfinder.

The REWIND and FAST-FORWARD controls can be used in JVC's "shuttle search" mode to watch the recorded picture at three times normal speed in either direction.

JVC offers a set of adapter cables that permit the HR-C3U to record from a TV monitor, tuner, another VCR, or any other source of video and audio.

Laboratory Measurements. Our tests included use of the VCR with a studio-quality camera and monitor, as well as the recording of standard test signals such as staircase, window, color bar, and high-frequency step. As expected, the overall performance was essentially that of any standard VCR in the VHS format. Color fidelity was excellent on the video monitor, but a slight degradation was discernable when we used the r-f output and viewed the recorded test picture on a good color TV receiver. The picture appeared to have lost some fine detail in passing through the r-f modulator. As indicated in the table of test results, the resolution from a wedge test pattern was about 220 lines on the monitor and about 210 on the color TV set. (We used another brand of VCR to verify that the TV receiver was capable of showing more than 220 lines on channel 3.)

Comparing the input of the color-bar test signal and the output at the video terminal, as in Fig. 1, shows relatively good reproduction, which was further confirmed by viewing the color-bar pattern on a monitor. When viewed on a color TV set, there seemed to be again a slight degradation, especially at the vertical color-bar edges. The video bandwidth of 2.7 MHz was measured at the video output terminal and corresponds approximately to the observed resolution of 220 lines. These values are typical of moderate-priced full-size VCRs and result in very satisfactory images.

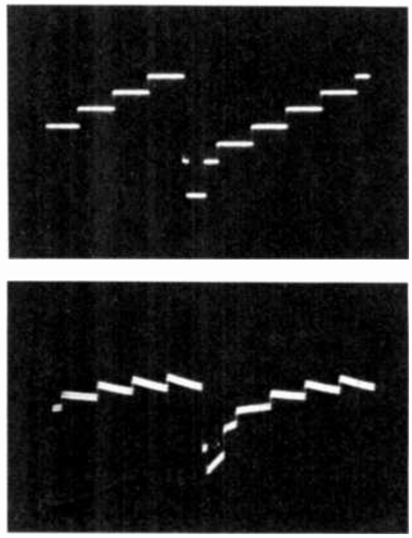


Fig. 2. Staircase signal: input (top) and output (bottom).

The grey-scale input and video-output signals are shown in Fig. 2. Though there is some differentiation at the output, no grey-scale distortion could be observed on the monitor. We carefully checked the recorded signal for noise, cross modulation, or interference; but on repeated playbacks, we observed none. Several observers viewed images of these test patterns, plus actual studio scenes, on both a monitor

LABORATORY MEASUREMENTS JVC MODEL HR-C3U VCR

Parameter	Measurement
Video bandwith:	2.7 MHz at −6 dB
Resolution:	220 lines at video
	210 lines ar r-f (Ch. 3)
Video input:	2.0 V p-p at 75 ohms
Video output:	1.0 V p-p at 75 ohms
Video S/N:	45 dB (No discernable noise)

and a color TV set. All agreed that the pictures showed good color fidelity and resolution, and appeared free from interference, noise, and instability. The signal-to-noise ratio was measured at 45 dB, a typical value for full-size VCRs and very satisfactory. The audio-frequency bandwidth ranged from about 150 Hz to 10 kHz, again a typical VCR test result.

User Comment. Housed in its carrying case, we found the JVC HR-C3U a very handy recorder when used with a handheld or shoulder-mounted video camera. It was impossible, however, to change cassettes or battery packs in this position. To change the battery pack, the entire bottom of the carrying case has to be zipped off, parts of the plastic case have to be pushed away, and the battery pack carefully lined up with an arrow and then snapped into place. When done at home, none of these tasks is a problem, but in the field, without a table or shelf handy, replacing a cassette or battery pack can be a struggle.

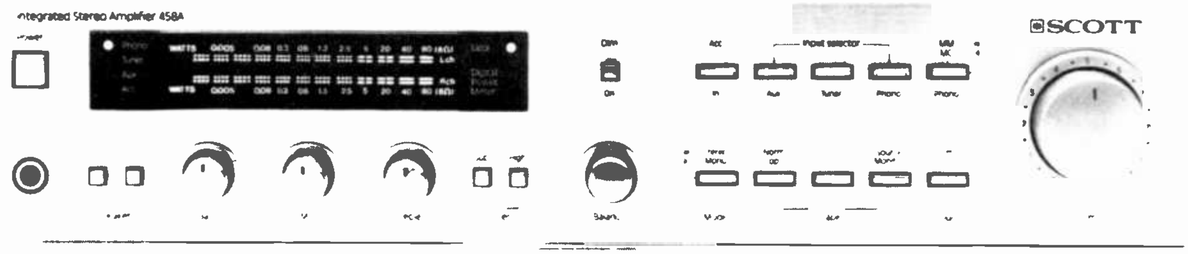
Another problem is that the camera cable connector is the only point of video input. It would have taken just one more RCA-type phone jack to be able to connect the output of a tuner, monitor, or a second VCR. With the present scheme, you need a special cable connector adapter.

Aside from these relatively minor complaints, we found the HR-C3U easy to use and versatile. Above all, it produces a good color picture. We were impressed with the smooth operation of the shuttle-search feature, and the fact that, unlike many other VCRs, this unit does not have a noisy solenoid action. While the ability to play the 20-minute compact cassette on a regular VCR through an adapter shell is appealing in and of itself, a further advantage is the possiblity of re-recording a number of 20-minute cassettes onto a longer-playing tape. In this way, you can collect live-action scenes, edit and mix them, and then re-use the 20-minute cassette.

—Walter Buchsbaum

CIRCLE NO. 102 ON FREE INFORMATION CARD

Scott Model 458A Integrated Stereo Amplifier



THE 458A, currently heading Scott's line of integrated stereo amplifiers, is rated to deliver 65 watts per channel to 8-ohm loads, between 20 and 20,000 Hz, with no more than 0.03% total harmonic distortion. The 458A has phono preamplification for both moving magnet (MM) and moving coil (MC) cartridges, dual autoranging fluorescent power meters with peak-hold, and pushbutton mode and program selection.

The amplifier, whose metal panel and covers are finished in satin silver, with matching knobs, measures about 17"W × 12¾"D × 3½"H, and weighs 18¼ lb. Its suggested retail price is $350.

General Description. The input program is selected by pressing one of a group of narrow buttons on the panel. They are mechanically interlocked, and operate with a soft, yet positive action. The available sources are AUX, TUNER, and PHONO (another button selects the input termination and preamplifier gain for either a MM or MC cartridge). On the same row of buttons is a stereo/mono selector.

Operating modes are chosen by a second row of controls parallel to the input selectors. These include the tape monitoring and dubbing facilities for 2 tape decks, an ACCESSORY button that inserts the input from a signal processor, and a LOUDNESS button. The large VOLUME knob is to the right of the button groups.

To the left is a dark window behind which are a number of luminous displays that show the operating status of the amplifier. They include LEDs for the selected input source and the status of the amplifier's "Safety" system (whose relay disconnects the speaker outputs in the event of improper operation and during the stabilizing period after the amplifier is first turned on).

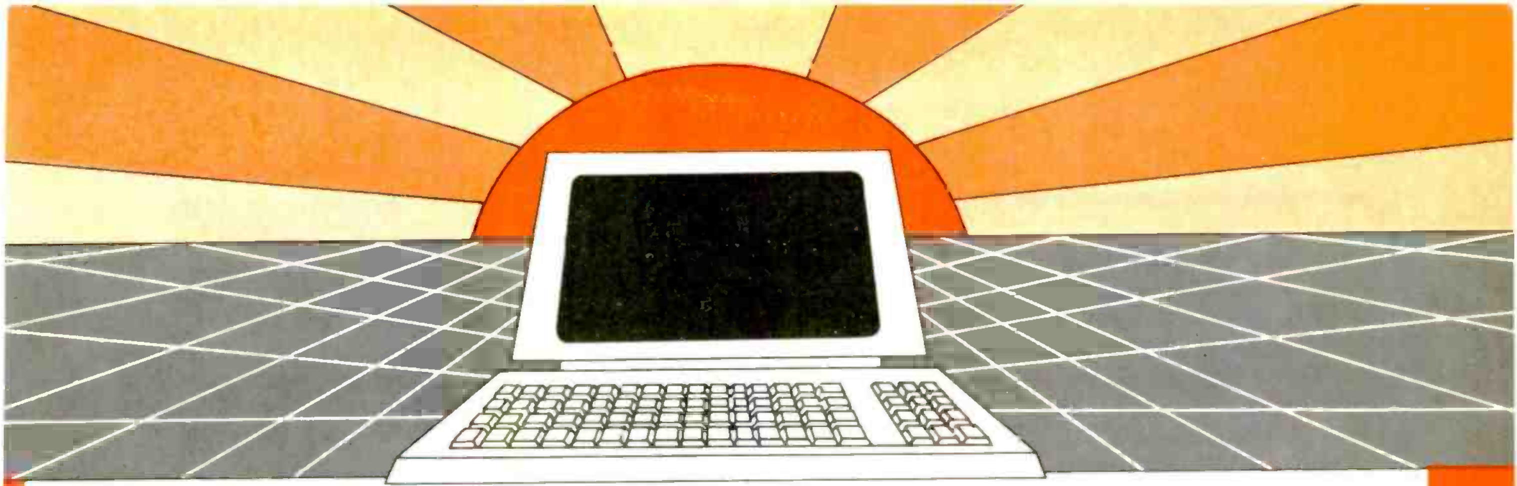
The most prominent part of the display consists of two horizontal rows of blue-white fluorescent lights that show the instantaneous output of each channel. The highest reading attained by each row is held for a couple of seconds after the level drops. When the amplifier is first turned on, the calibrated light segments cover the range from 0.0015 watts to 1 watt. If the output exceeds 1 watt, the display range automatically scales upward by a factor of 100, so that the readings cover 0.15 to 100 watts.

The POWER button is to the left of the display window, and below it is an array consisting of the phone jack, small buttons that independently connect the two sets of speaker outputs, the low- and high-cut filter buttons, and three tone controls (for BASS, MID, and TREBLE ranges). The balance knob to the right of the array completes the front panel control lineup. The tone and balance controls have light center detents, but otherwise all the knobs operate smoothly and continuously.

On the rear apron of the 458A are input jacks for all program sources, plus outputs for the two tape decks and an input/output pair for the accessory connection. The two sets of speaker outputs have insulated spring connectors that accept the stripped end of an insulated lead, gripping it firmly when the connector is released. There are also two switched ac convenience outlets and one unswitched outlet.

We were not provided with a schematic or other specific circuit information for the unit. We can tell you, however, that its power amplifier is direct-coupled internally and to the speakers.

Laboratory Measurements. The standard FTC (Federal Trade Commission) preconditioning left the top of the amplifier quite hot, and it became even hotter during our subsequent high power testing. The internal protective system operated effectively to prevent damage to the amplifier, especially when we drove low-impedance loads. (The outputs



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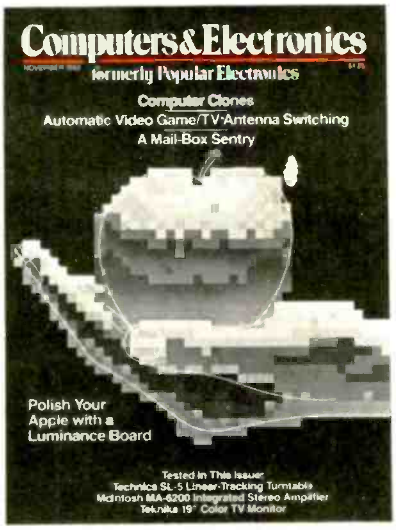

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were disconnected by the relay before the output waveform was clipped by 2-ohm loads.) After a couple of hours of testing, an internal power supply fuse (8-A, slow-blow) opened up, although we believe this to be the result of a long period of abnormal operation at high power with low impedance, rather than to any output condition. Replacing the soldered-in fuse would normally take a serviceman.

The outputs clipped at 73 watts per channel into 8 ohms, and 80 watts into 4 ohms, corresponding to an 8-ohm clipping headroom of 0.52 dB. With 2-ohm loads (for which the amplifier is not rated) the outputs were disconnected by the protective relay at about 85 watts, with both channels driven, and at about 128 watts with only one channel driven. In neither case was any waveform clipping visible before the relay operated.

With the pulsed 20-millisecond signal of the dynamic headroom test, the output clipped at 156 watts into 8 ohms, corresponding to a very high dynamic headroom rating of 3.8 dB. With 4- and 2-ohm loads, the protective relay was triggered before waveform clipping was seen, at respective outputs of about 148 and 118 watts per channel.

With both channels driving 8-ohm loads at 1000 Hz, the distortion was unmeasurable below 10 watts (being masked by system noise). It was between 0.002 and 0.005% from 10 to 70 watts, just below the clipping point. Driving 4-ohm loads, the distortion readings were only slightly higher, from 0.004% at 10 watts to 0.013% at 70 watts. As usually happens, the distortion was even higher with 2 ohms, rising from 0.011% at 1 watt to 0.11% at 40 watts and 0.22% at 90 watts.

With 8-ohm loads, the distortion at the rated 65 watts varied from 0.01% at 20 Hz, to less than 0.003% in the midrange, and a maximum of 0.021% at 20,000 Hz. It was very similar at lower power outputs. The IHF-IM distortion was measured with equal amplitudes of 18 and 19 kHz, whose peak value was equal to that of a 65-watt sine wave. The third-order distortion at 17 kHz was −72 dB (relative to 65 watts) and absolutely no second-order distortion (at 1000 Hz) could be detected down to our measurement floor of −100 dB.

At maximum gain, the 458A required an input of 18.5 millivolts (AUX) for a reference output of 1 watt. The A-weighted S/N was 76.4 dB. The PHONO sensitivity was 0.29 millivolts (MM) or 30 microvolts (MC), and the S/N for the MM input was a very good 77.7 dB. The S/N could not be measured for the MC, but in listening tests it was audibly poorer than for the MM input. The MM input overloaded at inputs between 136 and 160 millivolts, depending on frequency. The phono MM input impedance was 49 kilohms in parallel with a relatively high capacitance of 270 pF. The MC phono input resistance was 370 ohms.

The amplifier was stable with a variety of reactive loads, simulating loudspeaker operation. Its Slew Factor was greater than our measurement limit of 25. The power output indications were all somewhat higher than the actual output (by about 40 to 50%).

The RIAA phono equalization of the preamplifier section was accurate within +1 dB from 20 to 20,000 Hz. With the tone controls centered, and the volume set to the reference gain (1 watt output for 0.5 volt input) the frequency response was within ±0.5 dB from 20 to 13,000 Hz, falling to −1.5 dB at 20,000 Hz. The bass tone control turnover frequency varied from under 100 Hz to about 500 Hz as the

CONTROLS AND INDICATORS

FRONT PANEL

Pushbuttons:
STEREO/MONO MODE; INPUT SELECTORS (AUX, TUNER, PHONO); PHONO SELECTOR (MM/MC).
ACC (OUT/IN): Permits connection of signal processing accessory through rear jacks.
TAPE: SOURCE/MONITOR; recorder selector (1, 2); dubbing selector (NORM/COPY).
LOUD: Connects loudness compensation to volume control circuit.
POWER: Turns power to amplifier ON/OFF.
SPEAKERS: Two buttons, (A,B).
FILTER: Two buttons (SUB, HIGH).

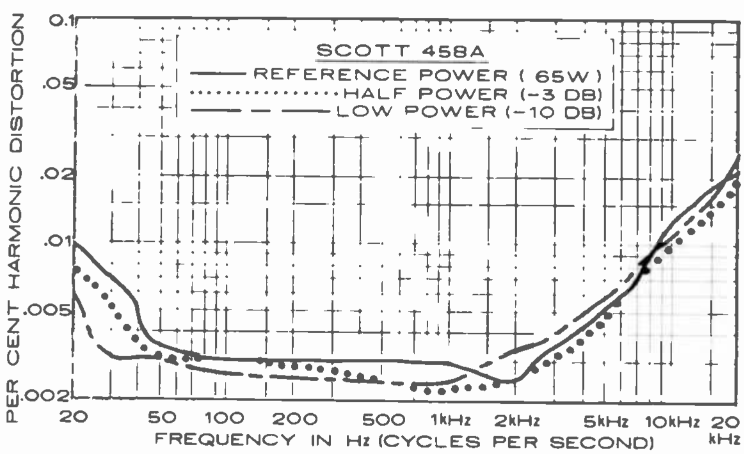
Knobs:
Tone Controls (BASS, MID, TREBLE): Center detented.
BALANCE: Center detented.
VOLUME.

Jack: PHONES.

Indicators:
INPUT: Red LEDs for AUX, TUNER, PHONO, TAPE.
SAFETY: Red LED flashes while amplifier protective system is operating.
Power Output: Two parallel horizontal rows of fluorescent light segments. Readings from 0.0015 to 1.00 W and 0.15 to 100 W (autoranging). Peak hold for about 2 seconds.

REAR APRON

Phono jacks: L and R pairs for PHONO, TUNER, AUX input, TAPE 1 REC and PLAY, TAPE 2 REC and PLAY, ACCESSORY IN and OUT.
Speakers: Insulated output connectors for two sets of speakers (A, B).
AC Outlets: Three (two switched).



Total harmonic distortion with both channels driven into 8 ohms.

control was varied, and the treble curves were hinged at about 2000 Hz. The midrange control affected much of the audio bandwidth, from about 300 to 10,000 Hz, with the maximum in the 1000 to 2000 Hz range. Its maximum boost of about 7 dB however, prevented it from having an excessive effect on the sound balance.

At maximum volume, the high frequencies rolled off above 5000 Hz, to −5 dB at 20,000 Hz. The SUB filter reduced the response by about 3 dB in the 70-to-100-Hz range, and the HIGH filter response was down 3 dB at 2500 Hz. Both had gradual slopes of 6 dB per octave beyond their cutoff frequencies. The loudness compensation boosted both low and high frequencies at low volume settings. (The high-frequency boost was much less than that for the low frequencies.)

User Comment. The measurements show, and our ears confirm, that the Scott 458A is a top-quality amplifier. Although its power rating is modest by contemporary standards, the rating itself is conservative. In fact, it has an exceptional short-term power capability (particularly when driving very low impedance loads) and a very high dynamic headroom with 8-ohm loads. In other words, it is a lot more amplifier than its ratings suggest!

Operation of the controls adds to a feeling of precision that one gets when using this amplifier. Everything works smoothly and silently, and we had the distinct impression that when an input selector was pressed, the change of program took place smoothly over a short time period (a fraction of a second) instead of in the usual abrupt manner.

The instruction booklet is generally adequate, but I felt that some of the amplifier's features were not explained sufficiently. For example, there is no elaboration of the possible role of the accessory signal connector. I wondered if it might be used in lieu of separate preamplifier outputs and power amplifier inputs (perhaps the only worthwhile feature Scott has omitted). Accordingly, it was necessary to experiment to discover what a simple block diagram would have told us—that this circuit follows the tape monitoring circuits, but it comes before the volume control, and therefore cannot be used to separate the preamp from the power amp.

All in all, we had strongly positive feelings about the Scott 458A. Even a blown fuse did not dampen our enthusiasm, since we doubt that it could ever blow in a normal home music system. (Ordinarily, we take a dim view of internal fuses, especially soldered-in fuses, because of the hassle involved when a consumer tries to replace them.) In hours of normal operation, however, the top of the 458A became only slightly warm in contrast to the almost sizzling temperatures during some of our tough tests. —*Julian Hirsch*

CIRCLE NO. 101 ON FREE INFORMATION CARD

reason, I've modified an Aero Sport transmitter by disconnecting the red battery connector lead from the unit's on-off slide switch and connecting a normally open pushbutton between the lead and the switch. The transmitter is readied for use by closing the slide switch. The pushbutton is pressed to actuate the camera.

The Aero Sport Two system operates in the 72-MHz RC band. The receiver, which is enclosed in a plastic housing, weighs about two ounces and measures $1\frac{9}{16}'' \times 1\frac{23}{32}'' \times \frac{3}{4}''$. A complete system is available for \$69.99 plus \$4 for postage and handling from Hobby Shack (18480 Bandilier Circle, Fountain Valley, CA 92708). The system includes the transmitter, receiver, two servos and a plastic battery box for four AA cells.

Selecting an RC System. If your budget is severely limited, you will want to give strong consideration to salvaging your RC equipment from a toy RC car. If you

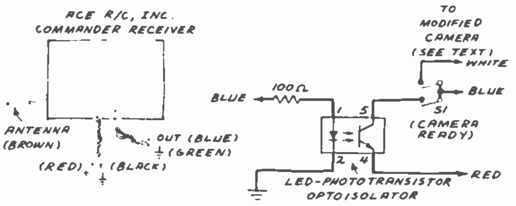


Fig. 1. Connecting RC receiver to camera.

can afford better equipment, the Ace R/C Special Applications System is inexpensive, simple to use, and compact in size. If you want to use your RC system in other projects (e.g. robotics), a digital-proportional system like the Aero Sport Two is the best choice.

You can find considerable information about various RC systems by referring to books on the subject and model airplane magazines. Some hobby dealers, incidentally, sell used but perfectly functioning RC equipment at bargain prices.

Applications for a Radio Controlled Camera. Photographers have long used radio controlled cameras to photograph wildlife, hazardous events, and otherwise inaccessible locations. All these and many other applications can be accomplished with a radio-controlled disc camera.

One of the more frustrating aspects of RC photography is not knowing if the camera is responding to your signals when it's too far away to hear. One solution is to add a light or tone generator to the camera.

When the lighting is low, the disc camera winks back with a brilliant flash each time an exposure is made, a particularly reassuring sight when the camera is tied to a kite flying high above the ground. This brings us to the most interesting application for a radio-controlled disc camera, aerial photography.

Aerial Photography. For several months I have spent much of my spare time flying a radio-controlled disc camera from various kinds of kites and helium-filled balloons. My original goal was to develop a low-cost method of obtaining aerial photographs of my house and garden. However, the experience of making aerial photos in this fashion is so interesting and entertaining that I've flown my camera from many different sites and assembled an album of hundreds of photos, a few of which accompany this article.

To fly your radio-controlled disc camera from a kite or balloon you must first install the apparatus in a suitable package. Plastic refrigerator boxes such as the Superseal line made by Eagle Affiliates make ideal en-

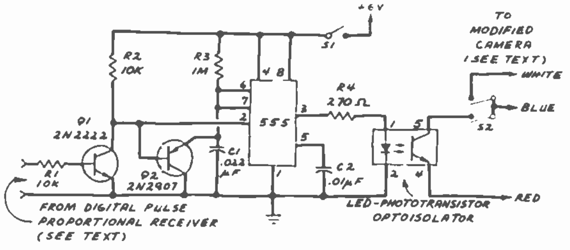


Fig. 2. Pulse-proportional RC decoder.

closures for airborne camera packages. The plastic is resilient and does not shatter or break. Openings for lenses and switches can be easily formed with a sharp knife and a drill.

Figure 3 is a bottom view of the second of two airborne disc camera packages I've assembled and flown from kites and balloons. The system employs an Aero Sport receiver connected to the decoder circuit shown in Fig. 2. It's installed in a Superseal No. 3427 sandwich box.

Note the use of foam insulation tape to provide vibration protection for the camera. A single 2-56 screw and nut secures the decoder board to the box. The camera and receiver are held in place by strips of foam plastic inserted between them. It is essential that the top of the plastic enclosure be held securely in place to prevent the camera and receiver from being dislodged should the package strike the ground. I use a heavy rubber band for this purpose.

I powered the receiver and decoder in the original version of this package with a miniature 6-V lithium battery (Duracell™ PX28L). Later, to save weight, I removed the battery and its holder and connected the receiver and decoder to the 6-V lithium battery in the

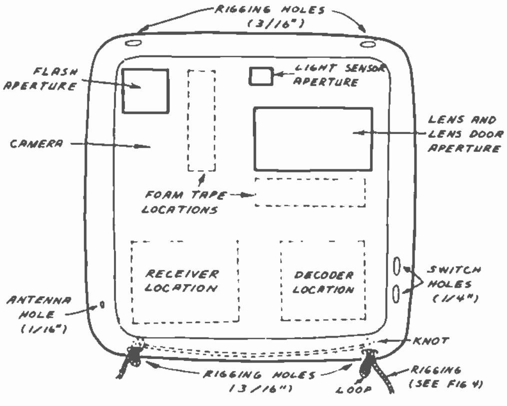


Fig. 3. Bottom view of camera package.

camera. Since the combined current consumption of the receiver and decoder is only 13 mA and the camera's batteries are rated at 1200 maH, the additional load is not significant so long as the power is switched off between flights.

Together with four nylon suspension lines and some snap swivels, the package in Fig. 3 weighs 12 oz. The first system I assembled, which used an RC system salvaged from a toy car, required a 9-V battery and weighed a full pound.

Ace R/C's special applications receiver weighs less than the Aero Sport receiver and can trigger a disc camera *without* a decoder circuit. It requires a 3-V (or 2.4-V) supply, however, and cannot be directly powered by the camera's 6-V supply.

Borrowing Power from the Camera. There are two ways to connect leads to the 6-V lithium battery in the disc camera. One is to carefully solder wrapping wire to the exposed portions of the wires to which the two series connected lithium cells are terminated. Solder the leads to the bare wire in the small gap between the insulated portion and the terminal.

A better method, the one I've used, is to solder wrapping wire to the termination points of the battery leads on the back side of the circuit board. The points can be located visually and confirmed with a voltmeter.

Caution: Should you choose to power your system by borrowing current from the camera, it is *absolutely essential* that you follow *all* the procedures and safety precautions given in Part 1 of this series (November 1982). (If you've misplaced Part 1, you can find a copy of it at most libraries.) You must also abide by the precautions printed on the lithium batteries: "CAUTION! May explode, leak, and/or flame if crushed, cut, soldered, short circuited, connected backwards, recharged, heated, or disposed of in fire."

Rigging the Airborne Package. After experimenting with various rigging arrangements, I've settled upon the straightforward approach shown in Fig. 4.

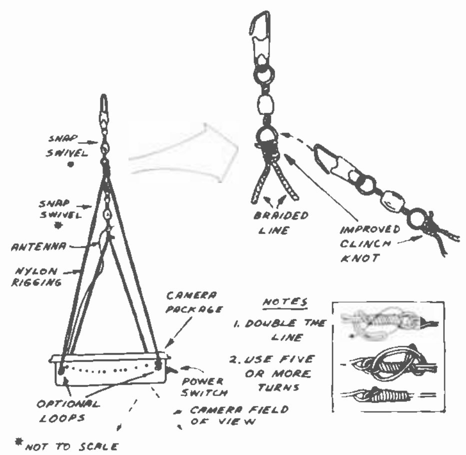


Fig. 4. Rigging the airborne camera package.

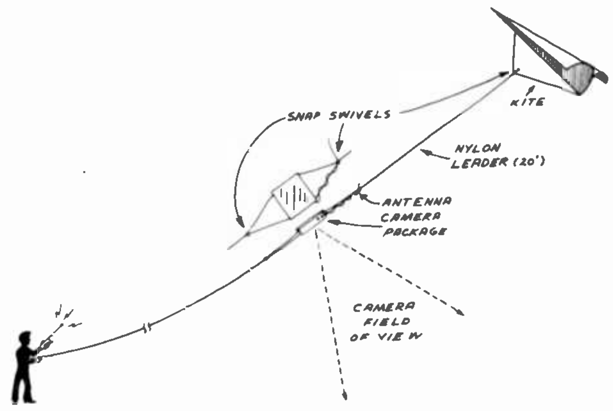


Fig. 5. Taking an oblique-away photo from kite.

Variations of this four-line rigging can be attached to a kite line to provide vertical and two kinds of oblique photos. It's also well suited for use with balloons.

Referring to Fig. 4, form each pair of rigging lines from a single high-strength, braided-nylon line several feet long. Tie two knots, each with an extension loop, about 5" apart and equidistant from the ends of each line. Pass the ends of the lines through the inside of adjacent holes in the box. The knots will secure the lines in place. Later, when the camera is flown from a kite, the loops can be pulled through the holes to provide tie down points for additional rigging that permits oblique photography toward the kite flier.

Flying the Camera from a Kite. The thrill of flying a camera from a kite hundreds of feet in the air or the total helplessness of watching it suddenly dive to within inches of hard rocks or deep water before zooming back to its former altitude is indescribable. Best of all is the ability, when the wind is right, to maneuver the camera directly over a sailboat mast, palm trees, tall signs, and even flying birds!

You'll need a sturdy, reliable kite to accomplish these aerial feats. Many different homemade kites can be fashioned from readily available materials, and you can find excellent books on their design and construction at a library. An early (1929) book reissued by Dover Publications is Leslie L. Hunt's "25 Kites That Fly." Mr. Hunt was formerly a kite maker for the U.S. Weather Bureau.

I have used with excellent results a 3' x 6' nylon Spinnaker™ delta kite manufactured by Spectra Star Kites. The kite is available in six color patterns and retails for $22.00. When properly rigged, these kites will lift a full pound in a 15-mph wind.

There are several ways to attach the disc camera package to a kite line. Figure 5, for example, shows how the camera package is rigged to provide oblique photos in the direction *away* from the kite flier. This simple rigging arrangement resists camera swing and is easy to fly. The rigging holes must be near the top of the camera package to prevent the package from flipping over high in the air.

The attachment in Fig. 5 is ideal for aerial views of the horizon. Many of the photos I've made resemble those taken from the window of an aircraft. The major drawback is the guesswork required to "aim" the camera.

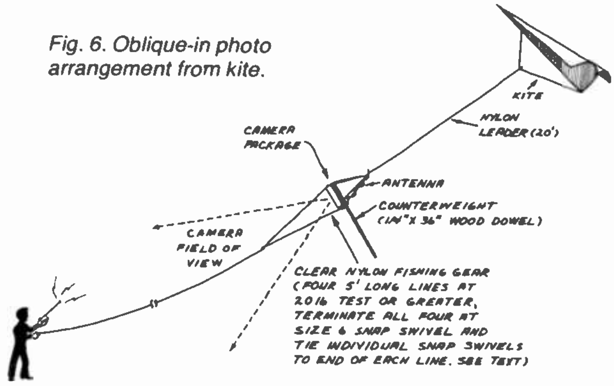


Fig. 6. Oblique-in photo arrangement from kite.

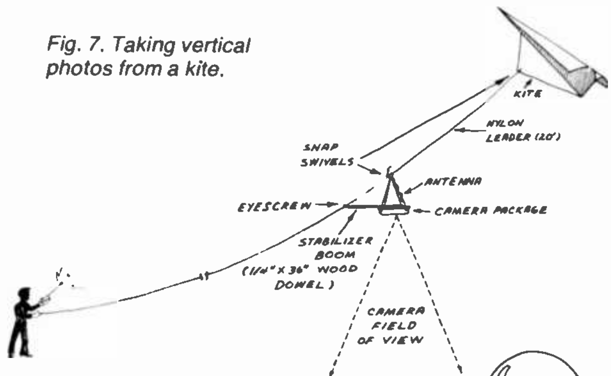


Fig. 7. Taking vertical photos from a kite.

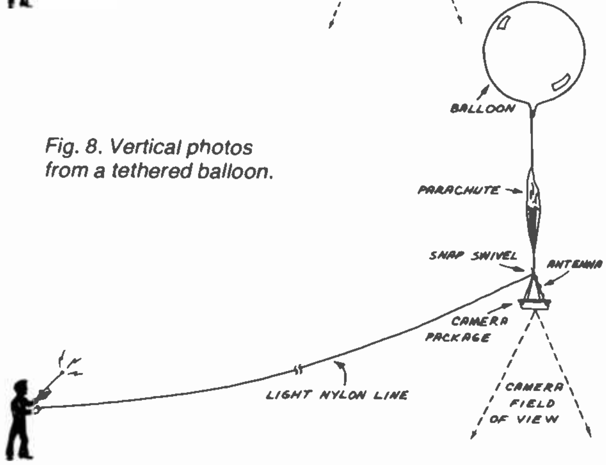


Fig. 8. Vertical photos from a tethered balloon.

Figure 6 shows how the camera is rigged to provide oblique photos in the direction *toward* the kite flier. The camera package's four nylon lines are connected together and to the kite's leader. A halter made from four clear fishing leaders having a test strength of at least 20 lb. each is attached via snap swivels to the loops on the camera package rigging (Fig. 4). All four leaders are terminated at a single size-6 (or larger) snap swivel which is then connected to the main kite line.

To prevent the camera package from rotating or taking tilted photos, it may be necessary to use a counterweight. I slipped a 1/4" x 36" wood dowel under the heavy-duty rubber band that secures the camera package's cover. A length of brightly colored plastic streamer was slipped through a small eyescrew in the end of the dowel to provide a convenient visual reference of the camera's orientation when it is high in the air.

I've used the rigging in Fig. 6 to photograph my family feeding seagulls from the vantage point of the gulls. I've also used it to photograph the stern of a tour boat from the stern of the same boat, and my car from an altitude of 545'. Surprisingly, the barely visible halter through which the photos are taken does not detract from their appearance.

Figure 7 shows how the camera is rigged for vertical photographs. The stabilizer boom prevents camera rotation. It does not, however, eliminate camera swing. To avoid blur, trigger the camera only when it is not swinging.

Kite Flying Tips. I've flown my RC cameras from kites as high as 550' over both land and water and have obtained hundreds of aerial photos. Here are some kite flying tips I've learned:

1. Flying a camera kite can be both tricky and busy at times. It helps to have someone to hold the RC transmitter and to stay with the equipment while you rescue a downed kite or walk one down.
2. Unless you design a kite to which the camera package is directly attached, insert a 20' leader between the camera and the kite. This will allow the kite to gain altitude and stability before it's required to lift any weight.
3. Always use quality nylon line. Braided line is best. I always use at least 50-lb test line with a Spectra Star delta.
4. Flying a payload from a kite requires a stiff breeze. I've found that the camera package will swing wildly and strike the ground if the wind is under 12-15 mph.
5. Avoid flying downwind from hills, buildings, bridges, signs, and other obstacles that cause turbulence.
6. If the wind is strong, be sure to protect your hands from the possibility of painful burns by wearing gloves.
7. Practice flying with a dummy payload before flying the real thing. Flying a working kite is a unique experience, and you'll learn valuable skills that may later save your camera package from a possible crash.
8. Observe appropriate safety precautions such as not flying your camera kite near airports, power lines, buildings, highways, and other potentially hazardous locations.
9. Finally, never fly your camera kite when it is raining or with a wire tether or a two-conductor remote switch attachment. Researchers have measured potentials as high as 50,000-V on the lines of wire-tethered kites flown on perfectly clear days!

Flying the Camera from a Balloon. I've found a balloon to be the best lifting device for pinpoint aerial photography. Unlike a kite, a balloon can be easily guided directly over an area of interest without guesswork or the help of an assistant to tell you where the camera is pointing. Unfortunately, balloon flying is riskier and requires almost perfectly calm air. Furthermore, preparing for a flight entails considerably more expense and time than does a kite launch.

First, a source of helium must be found. Welding and party shops sell the gas and, depending upon the volume of the cylinder, you can expect to pay 23¢ or more per cu. ft. plus a deposit for the cylinder and regulator.

Good balloons are more difficult to find than helium. I've spent $18 each for heavy-duty 4′ diameter rubber balloons.

To fly a camera balloon in a breeze requires an aerodynamically shaped balloon. The minimum cost for such balloons, which require a hundred or more cu. ft. of gas, is several hundreds of dollars.

Helium lifts about 1.1 oz. per cu. ft. Allowing a 15% excess lift margin and assuming a *total* airborne package weight of 16 oz. (camera system, balloon, parachute and tether), you'll need about 17 cu. ft. of gas. This implies a spherical balloon having a diameter of about 3.2′.

While this seems like an ideal arrangement for a 3′ diameter balloon, I've learned the hard way *never* to fill a balloon to its rated capacity. You can avoid the unpleasant experience of having an expensive balloon full of equally expensive helium burst in your face by filling your balloons to only half to two-thirds their rated capacity. This implies using a 4′ or 5′ diameter balloon or two or more smaller balloons.

The advantage of using two or more balloons is that, should one burst, the camera package will descend to earth relatively slowly rather than crashing outright. I discovered this firsthand when one of two balloons popped a hundred feet over my house.

The advantage of a single, large balloon is simplicity. In case of catastrophe, however, you will need to include a lightweight parachute between the balloon and camera to protect the camera and any people below it (see Fig. 8).

Balloon Flying Tips. My balloon flying experiences have brought home some important lessons about flying a camera from a tethered balloon. Here are some key pointers:

1. Fly only when the air is *perfectly* calm. Otherwise, the balloon will drift with the breeze and begin to descend and vibrate when it reaches the end of its tether.
2. Check the atmospheric conditions with a small pilot balloon before inflating and launching the camera rig. Keep the small balloon tied nearby to a 20′ tether. If the breeze blows it down, do not fly your camera rig.
3. Use only helium to inflate your balloons. Hydrogen and other ligher-than-air gases are highly flammable.
4. Tie the tether between the parachute and the camera package. Be sure to tie the free end of the tether to a heavy object. If you need to run toward the balloon, you can drop the tether without fear of losing the balloon.
5. Avoid jerking the tether when the balloon is flying low over trees. You may pull the tether and the balloon down into the branches.
6. If you use multiple balloons, rig them so the suspension lines do not rub against any balloon. Otherwise, the balloon may burst.
7. Never use a metallic tether or a two-conductor remote switch arrangement.
8. Avoid flying a balloon near airports, power lines, and high buildings. ◊

STATEMENT OF OWNERSHIP, MANAGEMENT AND CIRCULATION
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A	Total no copies printed (net press run)	573,177	539,763
B	Paid circulation		
	1 Sales through dealers and carriers, street vendors and counter sales	98,835	92,400
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C	Total Paid Circulation (sum of 10B1 and 10B2)	410,453	395,429
D	Free distribution by mail, carrier or other means, samples, complimentary, and other free copies	81,227	55,705
E	Total distribution (sum of C and D)	491,680	451,134
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	1 Office use, left over, unaccounted, spoiled after printing	2,163	1,529
	2 Returns from news agents	79,334	87,100
G	Total (sum of E, F1, and 2 —should equal net press run shown in A)	573,177	539,763

11 I certify that the statements made by me above are correct and complete

WILLIAM L PHILLIPS,
Assistant Treasurer

ENGLISH BROADCASTS Audible in No. AMERICA

By Glenn Hauser

TIME[1] EST	TIME UTC/GMT	STATION	QUAL.[2]	FREQUENCIES, kHz[3]
4:00-4:15 a.m.	0900-0915	BBC	A	15070, 11955, 11750, 9640, 9510, 6195
4:00-4:30 a.m.	0900-0930	R. Japan[4]	B	15195, 9505
4:00-5:30 p.m.	0900-1030	R. Australia	B	15115
4:00-5:00 a.m.	0900-1000	AFRTS, Los Angeles	A	9590, 9530, 6030
4:00-6:00 a.m.	0900-1100	FR3, New Caledonia	C	11710, 7170
4:15-6:00 a.m.	0915-1100	BBC	C	17790, 15070, (21660 Sat. & Sun. and daily from 1030), 11750, 9740
4:30-5:00 a.m.	0930-1000	AWR, Portugal	C	9670 (Sun. only)
4:30-5:20 a.m.	0930-1020	V. of Germany	C	17800, 17780, 15275
5:00-5:30 a.m.	1000-1030	V. of Vietnam	C	12036, 10080
5:00-6:00 a.m.	1000-1100	R. Japan	C	15235, 11875
5:00-6:00 a.m.	1000-1100	R. Korea	B	9570
5:00-6:00 a.m.	1000-1100	All India Radio	C	17875
5:00-6:00 a.m.	1000-1100	AFRTS, Los Angeles	A	11805, 9700, 9590, 9530, 6030
5:00-fade out	1000-	R. Australia	B	6045, 5995
5:00-8:00 a.m.	1000-1300	R. Moscow (via Cuba)	B	9600
5:00-11:02 a.m.	1000-1602	ABC, Perth	B	9610, 6140
5:10-12:00 a.m.	1010-1700	V. of Nigeria	C	15120
5:15-5:45 a.m.	1015-1045	UN Radio	B	15250, 13860-SSB, 9565 (Sat.)
5:30-6:30 a.m.	1030-1130	Sri Lanka Br. Corp.	C	17850, 15120, 11835 (not all Eng.)
6:00-6:30 a.m.	1100-1130	R. Japan	B	9505
6:00-6:30 a.m.	1100-1130	V. of Vietnam	C	12036, 10080
6:00-6:30 a.m.	1100-1130	R. Mogadishu	D	9585
6:00-6:56 a.m.	1100-1156	R. RSA	C	25790, 21535, 15220
6:00-7:00 a.m.	1100-1200	V. of Asia, Taiwan	C	5980 (Sun. 1030-1040)
6:00-7:00 a.m.	1100-1200	AFRTS, Los Angeles	A	6030
6:00-7:50 a.m.	1100-1250	R. Pyongyang	C	9977, 9740
6:00-8:00 a.m.	1100-1300	VOA	B	21840, 11715, 9760, 9565, 6110
6:00-8:00 a.m.	1100-1300	TWR-Bonaire	A	11815 (Sat. & Sun. 1100-1330)
6:00-8:00 a.m.	1100-1300	R. Australia	A	9580
6:00-8:30 a.m.	1100-1330	BBC	A-B	25650, 21710, ,21660, 21550, 21470, 11775, 11750, 9740, 9510, 6195
6:00-9:00 a.m.	1100-1400	4VEH, Haiti	C	11835, 9770
6:00-12:00 a.m.	1100-1700	AFRTS, Los Angeles	A	15430, 15330, 11805, 9700
6:15-6:30 a.m.	1115-1130	Vatican R.	C	21485, 17840, (not Sun.)
6:30-6:55 a.m.	1130-1155	R. Nacional, Angola	D	11955, 9535 (Mon.-Fri.)(irreg).
6:30-7:10 a.m.	1130-1210	R. Polonia	D	17865, 11840, 9675, 9525
6:30-7:30 a.m.	1130-1230	R. Thailand	C	11905, 9655
6:45-7:15 a.m.	1145-1215	R. Malaysia Sabah	C	5980, 4970
6:58-9:00 a.m.	1158-1400	CBC Northern Service	B-C	9625, 6065 (not all Eng.)
7:00-7:15 a.m.	1200-1215	V. Of Kampuchean People	C	11938, 9694 (vary)
7:00-7:20 a.m.	1200-1220	Vatican R.	B	21485, 17840 (not Sun.)
7:00-7:25 a.m.	1200-1225	R. Finland	B	15400, 21475 (not Sun.)
7:00-7:30 a.m.	1200-1230	Kol Israel	C	25640, 21625, 21495, 17630, 15605, 15585
7:00-7:30 a.m.	1200-1230	R. Tashkent	C	11785, 9540, 6025, 5945
7:00-7:30 a.m.	1200-1230	HCJB, Ecuador	A	26020, 15115, 11740
7:30-7:55 a.m.	1200-1255	R. Peking	B	9820
7:00-9:00 a.m.	1200-1400	WRNO, New Orleans	A	9715 (Sun.) (not all Eng.)
7:00-9:00 a.m.	1200-1400	R. Moscow World Service	B	15150, 15135, 12030, 11720, 9750, 9580
7:00-9:00 a.m.	1200-1400	WYFR, Family R.	A	21545, 17785, 11830
7:00 a.m.-1:00 p.m.	1200-1800	R. Peking	C	11600
7:00-7:35 a.m.	1200-1235	R. Ulan Bator, Mongolia	C	12070, 6383 (not Sun.)
7:30-7:55 a.m.	1230-1255	R. Tirana	D	11960, 9515
7:30-7:57 a.m.	1230-1257	Austrian R.	B	21615
7:30-8:00 a.m.	1230-1300	R. Bangladesh	D	15282, 17743 (variable)
7:30-8:15 a.m.	1230-1315	V. of Germany	B	21600
7:30-9:30 a.m.	1230-1430	SLBC, Sri Lanka	C	15425, 9720
7:30-9:30 a.m.	1230-1430	HCJB, Ecuador	A	26020, 17885, 15115, 11740
7:35-7:45 a.m.	1235-1245	V. of Greece	C	17560, 15050, 11645 (Mon.-Sat.)
8:00-8:25 a.m.	1300-1325	R. Canada International	A	17860,15440, 11955, 11855, 9575 (Mon.-Fri.)
8:00-8:25 a.m.	1300-1325	R. Finland	B	21475, 15400 (Mon-Sat.)
8:00-8:30 a.m.	1300-1330	R. Bucharest	A	17850, 15250, 11940
8:00-8:45 a.m.	1300-1345	R. Japan	B	9505
8:00-9:00 a.m.	1300-1400	VOA	A	21840, 15205, 11715, 9760, 9565
8:00-9:00 a.m.	1300-1400	R. Australia	C	9770
8:00-10:57 a.m.	1300-1557	R. RSA	B	25790, 21535, 15220
8:15-8:45 a.m.	1315-1345	Swiss R. International	B	25780, 21570, 21520, 17830, 15305
8:30-9:15 a.m.	1330-1415	R. Berlin International	C	21465
8:30-9:20 a.m.	1330-1420	R. Nederland	C	17605, 11930
8:30-9:30 a.m.	1330-1430	R. Korea	C	9750
8:30-9:30 a.m.	1330-1430	V. of Turkey	C	15125
8:30-9:30 a.m.	1330-1430	V. of Vietnam	C	15010, 10040
8:30-10:00 a.m.	1330-1500	All India R.	C	15335, 11810

8:30-10:25 a.m	1330-1525	R. Finland	B	21475, 15400 (Sun.)
8:30-11:00 a.m.	1330-1600	BBC	B-C	25650, 21710, 21660, 21550, 21470, 15400 (from 1430), 15070, 11750
8:30-11:00 a.m.	1330-1600	R. Malaysia Sabah	C	5980, 4970
8:30 a.m -fade	1330-	R. Australia	B	6060
8:30 a.m.-5:00 p.m.	1330-2200	R. Moscow World Service (via Cuba)	B	11840
8:57-11:55 a.m.	1357-1655	V. of Philippines	D	9578 (Sun.-1556) (not all Eng.)
9:00-9 25 a.m.	1400-1425	R. Finland	C	25950, 15400 (Mon.-Sat.)
9:00-9.30 a.m.	1400-1430	KTWR, Guam	C	9505
9:00-9.30 a.m.	1400-1430	R. Norway	B	26030, 25730, 21730, 21700, 17830 (Sun.)
9:00-9:30 a.m.	1400-1430	R. Sweden	B	21615
9:00-9:30 a.m.	1400-1430	V. Rev. Party, N. Korea	D	4557, 4109
9:00-9:30 a.m.	1400-1430	R. Tashkent	C	11785, 9600, 9540, 6025, 5945
9:00-9.35 a.m.	1400-1435	R. Ulan Bator	C	12070, 9575 (not Sun.)
9:00-9:45 a.m.	1400-1445	BRT, Belgium	B	21810, 17915 (Mon.-Fri.)
9:00-10:00 a.m.	1400-1500	WYFR, Family Radio	A	15215, 17785, 21545
9:00-10:00 a.m.	1400-1500	R. Moscow World Service	A	30300, 15150, 15135, 12030, 11900, 11720, 9750, 9580
9:00-10:00 a.m.	1400-1500	R. Malaysia Sarawak	C	7160, 4950
9:00-10:00 a.m.	1400-1500	V. of Indonesia	C	15200 or 15150, 11789
9:00-10:00 a.m.	1400-1500	VOA	A	26040, 21840, 15205, 11715, 9760, 9565, 6110
9:00-11:00 a.m.	1400-1600	WRNO, New Orleans	A	11940 (Sun.) (not all Eng.)
9:00-12:00 a.m.	1400-1700	CBC Southern Service	A	17820, 11955 (Sun.)
9:00-12:30 a.m.	1400-1730	R. Australia	C	17795, 9770, 9710
9:00 a.m.-6:30 p.m.	1400-2330	CBC Northern Service	C	11720, 9625 (not all Eng.)
9:30-10:25 a.m.	1430-1525	N. Nederland	B	21480, 17605, 11740
9:30-10:30 a.m.	1430-1530	HCJB, Ecuador	A	26020, 17885, 15115 (Sat. & Sun. 1430-1600)
9:30-11:00 a.m.	1430-1600	Burma Br. Ser.	D	5985, 5040
9:30 a.m.-5:00 p.m.	1430-2200	UN Radio	A	21670, 21625, 15410, 15120 (when in session)
9:35-10:20 a.m.	1435-1520	R. Nepal	D	3425, 7105 or 9589
9:45-10:20 a.m.	1445-1520	R. Ulan Bator	C	12070, 9575 (not Sun.)
10:00-10:30 a.m.	1500-1530	V. of Asia, Taiwan	D	5980 (not Sun.)
10:00-10:50 a.m.	1500-1550	V. of Germany	C	21600
10:00-11:00 a.m.	1500-1600	VOA	A	26040, 21840, 15205, 9760, 9565, 6110
10:00-11:00 a.m.	1500-1600	V. of Rev. Ethiopia	D	9560
10:00-11:00 a.m.	1500-1600	FEBA, Seychelles	C	11895, 15320†
10:00-11:00 a.m.	1500-1600	V. of Nigeria	C	11770 (varies)
10:00-11:00 a.m.	1500-1600	KTWR, Guam	C	9505
10:00-11:00 a m.	1500-1600	BBC	B	17830, 15260 (Sat., Sun.)
10:00-11:00 a.m.	1500-1600	R. Moscow World Service	C	30300, 15150, 12050, 12010, 11900, 11720, 9580
10:00-11:00 a.m.	1500-1600	WYFR, Family Radio	A	15365, 15215, 17785, 21545
10:00-12:30 a.m.	1500-1730	BSHKJ, Jordan	D	9560
10:30-11:00 a.m.	1530-1600	R. Yugoslavia	C	15415
10:30-11:00 a.m.	1530-1600	Swiss R. International	B	21570, 17830
10:30-11:30 a.m.	1530-1630	V. of Vietnam	C	17560, 15010
10:35-10:45 a.m.	1535-1545	V. of Greece	C	17555, 15050, 11645 (Mon.-Sat.)
10:37-10:45 a.m.	1537-1545	R. Canada International	A	21695, (17820 Mon.-Sat.), 15325
11:00-11:15 a.m.	1600-1615	Vatican R.	C	17730
11:00-11:15 a.m.	1600-1615	R. Pakistan	C	21486, 17660, 17640, 15565, 15530 21685 (not Sun.)
11:00-11:30 a.m.	1600-1630	R. Portugal	C	
11:00-11:30 a.m.	1600-1630	R. Norway	B	25730, 25615, 21725, 17875 (Sun.)
11:00-12:00 a.m.	1600-1700	VOA	A	26040, 21840, 15430, 15205, 9760, 6110
11:00-12:00 a.m.	1600-1700	R. Korea	C	11830, 9720
11:00-12:00 a.m.	1600-1700	WYFR	A	15365, 15215
11:00-12:00 a.m.	1600-1700	R. Moscow World Service	B	24020, 15240, 15150, 12050, 12030, 11900, 11720
11:00-12:00 a.m.	1600-1700	R. France Int'l	B	21620, 21580, 21525, 17850, 17795, 17620, 15315, 15300
11:00 a.m.-12:30 p.m.	1600-1730	VOA to Africa	A	26040, 26000, 21485, 19480-LSB, 17870, 15600, 15410
11:00 a.m.-12:45 p.m.	1600-1745	BBC	B	21710, 17830, 15260
11:00 a.m.-1:00 p.m.	1600-1800	WRNO New Orleans	A	15140 (Sun.) (not all Eng.)
-11:30 a.m.	-1630	R. Singapore	C	11940, 5052, 5010 (fade-in-time varies)
11:15-12:00 a.m.	1615-1700	UAE Radio, Dubai	B	21655, 17775, 15320
11:45-12:00 a.m.	1645-1700	R. Canada International	A	21695, (17820 Mon.-Sat.) 15325
11:45-12:45 p.m.	1645-1745	R. Pakistan	C	15545, 11672
12:00-12:30 p.m.	1700-1730	R. Japan	C	9505
12:00-12:45 p.m.	1700-1745	BBC	C	17695, 21470
12:00-1:00 p.m.	1700-1800	R. Moscow World Service	A	15455, 15425, 15240, 15150, 12050, 12030, 11960, 11900
12:00-1:00 p.m.	1700-1800	WYFR, Family Radio	A	21615, 15440, 15365, 15215
12:00-1:30 p.m.	1700-1830	AFRTS, Los Angeles	A	15430, 15345, 15330, 11805, 9700
12:00-3:00 p.m.	1700-2000	4VEH, Haiti	C	11835, 9770 (Sun.)
12:00-4:00 p.m.	1700-2100	BSK Saudi Arabia	C	11850 (varies)
12:00-2:00 p.m.	1700-1900	VOA	B	21840, 17785, 15580, 15430, 15205, 11760
12:30-1:00 p.m.	1730-1800	HCJB, Ecuador	B	26020, 21477.5, 17825†
12:30-1:00 p.m.	1730-1800	VOA to Africa	A	26040, 26000, 21485, 19840-LSB, 17870, 15877.5-LSB, 15600, 15410
12:45-3:00 p.m.	1745-2000	BBC	C	15400, 15070, 12095
12:45-5:30 p.m.	1745-2230	All India R.	C	11620
1:00-3:00 p.m.	1800-1830	R. Canada International	A	17820, 15260 (Sat. & Sun. 1800-1900)
1:00-1:30 p.m.	1800-1830	V. of Vietnam	C	15010, 10040
1:00-2:00 p.m.	1800-1900	R. Moscow World Service	A	17700, 15455, 15425, 15240, 15150, 12050, 11960, 11900, 11700
1:00-2:00 p.m.	1800-1900	WYFR, Family Radio	A	21615, 15440, 15365
1:00-2:00 p.m.	1800-1900	V. of Nigeria	C	15120, 17800
1:00-3:00 p.m.	1800-2000	WRNO, New Orleans	A	17895 (not all Eng.)
1:00-4:00 p.m.	1800-2100	R. Kuwait	B	11675
1:00-4:00 p.m.	1800-2100	AFRTS, Los Angeles	A	17765, 15430, 15345, 15330, 11805
1:00-5:00 p.m.	1800-2200	VOA to Africa	A	26040, 26000, 21660, 21485, 19840-LSB, 17870, 15877.5-LSB, 15600, 15410
1:15-2:15 p.m.	1815-1915	R. Bangladesh	D	15285, 11765 (both vary)*
1:30-1:40 p.m.	1830-1840	UN Radio	A	21710, 20060-SSB, 18782.5-SSB, 15360, 15120 (Fri.)
1:30-1:57 p.m.	1830-1857	Austrian Radio	C	15560, 11860 (Sun. from 1805)
1:30-2:00 p.m.	1830-1900	V. of Revolution, Guinea	C	15309 (varies) 9650 (Mon., Wed. and Fri.)(irregular)
2:00-2:30 p.m.	1900-1930	V. of Vietnam	C	15010, 10040
2:00-2:30 p.m.	1900-1930	R. Canada International	A	17875, 15325, 11905 (Sat. & Sun. 1900-2000)

2:00-2:30 p.m.	1900-1930	R. Afghanistan	C	15077 (varies), 9665, 11960
2:00-2:45 p.m.	1900-1945	R. Japan	B	17755
2:00-3:00 p.m.	1900-2000	HCJB, Ecuador	C	26020, 2177.5, 17825†
2:00-3:00 p.m.	1900-2000	WYFR, Family Radio	A	15440, 15365, 15215, 11925
2:00-3:00 p.m.	1900-2000	R. Moscow World Service	A	17700, 15455, 15150, 12050, 11960
2:00-5:00 p.m.	1900-2200	VOA	A	21840, 17785, 15580, 15430, 15205, 11760
2:15-3:00 p.m.	1915-2000	BRT Belgium	B	15590, 7335
2:20-2:30 p.m.	1920-1930	V. of Greece	B	15050, 9865, 9420
2:30-3:00 p.m.	1930-2000	UN Radio	A	21710, 20060-SSB, 18782.5-SSB, 15360, 15120 (Fri.)
2:30-3:30 p.m.	1930-2030	V. of Iran	C	9022, 9765
2:45-4:15 p.m.	1945-2115	R. Free Grenada	C	15104 (time varies and irregular)
3:00-3:30 p.m.	2000-2030	R. Algiers	C	Some of 25700, 21725, 21635, 17745, 15370, 15307, 15215, 15160, 11810, 9760, 9610, 9510 (may be one hour later)
3:00-3:30 p.m.	2000-2030	R. Norway	C	17875, 15225, 15175, 11850 (Sun.)
3:00-3:30 p.m.	2000-2030	R. Canada International	A	17875, 17820, 15325, 11905 (Mon.-Fri.)
3:00-3:30 p.m.	2000-2030	Kol Israel	C	13745, 11637, 9815, 9420
3:00-4:00 p.m.	2000-2100	R. Moscow World Service	A	17700, 15425, 15150, 15100, 12050, 11960, 7390
3:00-4:00 p.m.	2000-2100	Spanish Foreign Radio	C	15375
3:00-4:15 p.m.	2000-2115	BBC	B	15260, 15070, 11750, 12095, 9410
3:00-5:00 p.m.	2000-2200	WRNO, New Orleans	A	15355 (not all Eng.)
3:00-5:00 p.m.	2000-2200	WYFR, Family R.	A	17845, 15440, 15365, 15215, 11925
3:10-4:40 p.m.	2010-2140	R. Habana Cuba	A	15365†
3:15 p.m.-2:15 a.m.	2015-0715	R. New Zealand	C	15485, 17705
3:30-3:45 p.m.	2030-2045	Vatican R.	C	9645, 7250, 6190
3:30-4:20 p.m.	2030-2120	R. Nederland	B	21685, 17695, 17605, 15220, 9715
3:30-4:30 p.m.	2030-2100	V. of Vietnam	C	15010, 10040
3:30-4:30 p.m.	2030-2130	V. Turkey	C	9625
3:45-4:00 p.m.	2045-2100	Vatican R.	C	15120, 11700, 9625
3:50-4:40 p.m.	2050-2140	R. Habana Cuba	C	17750, 11725
4:00-4:15 p.m.	2100-2115	R. TV Benin	C	4870
4:00-4:30 p.m.	2100-2130	R. Japan	B	17755
4:00-4:30 p.m.	2100-2130	UN Radio	A	17730, 15120
4:00-4:50 p.m.	2100-2150	R. RSA	B	17745, 15155, 11900
4:00-5:00 p.m.	2100-2200	V. of Nigeria	C	15120, 17800
4:00-5:00 p.m.	2100-2200	AFRTS, Los Angeles	A	21570, 15430, 15345, 15330
4:00-5:00 p.m.	2100-2200	R. Moscow World Service	C	17700, 15425, 15240, 15100, 12050, 11960, 11750, 11700, 9700
4:15-4:30 p.m.	2115-2130	Vatican R.	C	15120, 11700, 9645
4:15-5:00 p.m.	2115-2200	BBC	A	15260, 15070, 11750, 6175
4:15-5:00 p.m.	2115-2200	BBC to Falklands	B	15390, 12040, 11820, 9915 (Tue., Thur., Sun.)
4:15-7:30 p.m.	2115-2430	R. Free Grenada	B	15045 (time varies)(irregular)
4:30-5:00 p.m.	2130-2200	R. Canada International	A	17820, 15150, 11945, 17875, 15325
4:30-5:00 p.m.	2130-2200	HCJB Ecuador	C	26020, 21477.5, 17825†, 15340†
4:30-5:00 p.m.	2130-2200	R. Sofia	B	7115
4:30-5:25 p.m.	2130-2225	R. Baghdad	C	9745
4:31-5:00 p.m.	2131-2200	KGEI, San Francisco	C	15280
4:40-5:40 p.m.	2140-2240	V. of Free China	C	17890, 15270 or 15210, 11825
4:45-5:00 p.m.	2145-2200	RTVC, Congo	C	15190 (irregular)
4:45-5:15 p.m.	2145-2215	Swiss R. International	C	21520, 17830, 17850, 15305
5:00-5:45 p.m.	2200-2245	BRT, Belgium	B	11975, 7335 (Mon.-Sat.)
5:00-6:00 p.m.	2200-2300	WYFR, Family Radio	A	17845, 15440, 15380, 15365, 11935
5:00-6:00 p.m.	2200-2300	R. Moscow World Service	A	21565, 17760, 17700, 15425, 12050, 11850, 11770, 11750, 11720, 11700, 9760, 9720, 9685, 9720, 9685, 9665, 9610
5:00-6:00 p.m.	2200-2300	CBC Radio	A	15325, 11925, 9760 (Mon.-Fri.)
5:00-6:00 p.m.	2200-2300	VOA to Africa	A	26040, 26000, 21660, 21485, 19480-LSB, 17870, 15600, 15415
5:00-6:00 p.m.	2200-2300	V. of Turkey	B	17760, 11900, 7215
5:00-6:00 p.m.	2200-2300	BBC	A	15260, 15070, 11750, 9915, 9410, 6175, 5975
5:00-7:00 p.m.	2200-2400	WRNO, New Orleans	A	11890† (not all Eng.)
5:00-7:00 p.m.	2200-2400	AFRTS, Los Angeles	A	21570, 17765, 15430, 15330
5:00-7:00 p.m.	2200-2400	VOA	A	26000, 21460, 17820
5:15-5:30 p.m.	2215-2230	R. Yugoslavia	C	9620
5:15-5:30 p.m.	2215-2230	R. Japan	C	17755, 15195 (via Portugal 9630†)
5:30-6:00 p.m.	2230-2300	Kol Israel	A	13745, 15585, 17630, 11655, 9815
5:30-6:00 p.m.	2230-2300	RAE, Argentina	D	11710 (Mon.-Sat.)
5:30-6:00 p.m.	2230-2300	R. Nacional, Angola	D	11955, 9535 (Mon.-Fri., irregular)
5:30-6:00 p:m.	2230-2300	R. Polonia	C	7125
5:30-6:30 p.m.	2230-2330	R. Sofia	B	15110, 9700
5:30-7:00 p.m.	2230-2400	R. Jamahiriya, Libya	B	11815
6:00-6:30 p.m.	2300-2330	R. Vilnius	B	17870, 15100, 12060,11735, 9665
6:00-6:30 p.m.	2300-2330	R. Japan	C	17755
6:00-6:30 p.m.	2300-2330	R. Sweden	C	11705, 9695
6:00-7:00 p.m.	2300-2400	4VEH, Haiti	B	11835, 9770
6:00-7:30 p.m.	2300-2430	BBC	A	15260, 15070, 9915, 9590, 9410, 7325, 6175, 6120, 5975
6:00-7:50 p.m.	2300-2450	R. Pyongyang	C	15231, 9745
6:00-8:00 p.m.	2300-0100	CBC Southern Service	A	11850, 5960, (Sat. 2300-2330, Sun. 2300-2400)
6:00-8:00 p.m.	2300-0100	R. Moscow	A	21530, 9800, 9685, 9610, 7195, 7115
6:00-8:00 p.m.	2300-0100	WYFR Family R.	A	17845, 15365
6:30-7:00 p.m.	2330-2400	V. of Vietnam	C	12036, 10080
6:00-p.m.-1:07 a.m.	2330-0607	CBC Northern Service	B-C	9625, 6195 (not all English)
6:35-6:45 p.m.	2335-2345	V. of Greece	C	12045, 9865
6:45-7:45 p.m.	2345-2445	R. Japan	C	17825, 15300
7:00-7:25 p.m.	0000-0025	R. Tirana	B	9750, 7065
7:00-7:30 p.m.	0000-0030	Kol Israel	A	11655, 9815, 7410
7:00-7:30 p.m.	0000-0030	R. Norway	C	15175, 11870, 11860, 11850, 11760 9610, 6015 (Mon.)
7:00-7:55 p.m.	0000-0055	R. Peking	B	15520, 15120, 11650
7:00-8:00 p.m.	0000-0100	VOA	A	21460, 17820, 6873-USB
7:00-8:00 p.m.	0000-0100	R. Sofia	B	15110, 9700
7:00-8:00 p.m.	0000-0100	FEBC, Philippines	C	17810
7:00-8:00 p.m.	0000-0100	AFRTS, Los Angeles	A	21570, 15430, 15330, 11790, 6030
7:00-9:00 p.m.	0000-0200	VOA to Latin America	A	17730, 17640, (15650-LSB to 0100) 15205, 11740, 9650, 6130, 5995, 1580
7:00-9:00 p.m.	0000-0200	WRNO, New Orleans	A	11965†
7:00-9:00 p.m.	0000-0200	R. Luxembourg	C	6090 (Time varies)
7:00-12:00 p.m.	0000-0500	R. Moscow (via Cuba)	A	9600
7:00 p.m.-4:00 a.m.	0000-0900	UN Radio	A	6055 (when in session)
7:05-8:55 p.m.	0005-0155	Spanish Foreign R.	B	11880, 9630
7:15-8:00 a.m.	0015-0100	R. Berlin International	C	11975, 9730
7:30-8:00 p.m.	0030-0100	R. Prague	C	6055

7:30-8:00 p.m.	0030-0100	R. Kiev	B	17900, 11870, 9530
7:30-8:00 p.m.	0030-0100	La Cruz del Sur, Bolivia	D	4875 (Mon. only)
7:30-8:15 p.m.	0030-0115	BRT Belgium	C	11695, 9870
7:30-8:30 p.m.	0030-0130	HCJB, Ecuador	A	15175†
7:30-9:00 p.m.	0030-0200	R. Mexico	C	17765, 15430, 11770, 9705, 5985 (Sat.)
7:30-9:30 p.m.	0030-0230	SLBC, Sri Lanka	C	15425
7:30-9:30 p.m.	0030-0230	BBC	A	15260, 11750, 9915, 9515, 9410, 7325, 6175, 6120, 5975
7:35-9:35 p.m.	0035-0230	HCJB, Ecuador	B	17885†, 15155, 9745
8:00-8:15 p.m.	0100-0115	Vatican R.	B	11845, 9605, 6015
8:00-8:20 p.m.	0100-0120	RAI, Italy	B	11800, 9575
8:00-8:25 p.m.	0100-0125	Kol Israel	A	11655, 9815, 7410
8:00-8:30 p.m.	0100-0130	R. Argentina	C	11710 (not Mon.)
8:00-8:30 p.m.	0100-0130	R. Japan	C	17755
8:00-8:30 p.m.	0100-0130	La Voz De la Mosquitia, Honduras	C	4910
8:00-8:30 p.m.	0100-0130	R. Canada International	A	11850, 5960
8:00-8:45 p.m.	0100-0145	R. Berlin International	C	11975, 9730
8:00-8:50 p.m.	0100-0150	V. of Germany	A	11865, 11785, 9565, 9640, 6145 6085, 6040
8:00-8:55 p.m.	0100-0155	R. Prague	B	11990, 11970, 9740, 9630 7345, 5930
8:00-8:55 p.m.	0100-0155	R. Peking	B	15520, 15120, 11650
8:00-9:00 p.m.	0100-0200	V. of Free China	C	17890, 15345, 11825
8:00-9:00 p.m.	0100-0200	R. Zinica, Nicaragua	C	6120 (variable Tue.-Sat.) (time varies)
8:00-9:00 p.m.	0100-0200	VOA	A	21460, 17735, 7205, 6873-USB
8:00-9:00 p.m.	0100-0200	AFRTS, Los Angeles	A	21570, 15430, 15330, 11790, 6030
8:00-11:00 p.m.	0100-0400	R. Australia	B	21740
8:00-11:00 p.m.	0100-0400	R. Moscow	A	21530, 17720, 9800, 9685 7195, 7115
8:00-11:00 p.m.	0100-0400	WYFR Family R.	A	9715, 6065
8:00-11:50 p.m.	0100-0450	R. Habana Cuba	B	11930, 11725
8:20 p.m.-12:10 a.m.	0120-0510	R. Belize	C	3285, 834
8:30-8:40 p.m.	0130-0140	V. of Greece	B	15050, 12045, 9865 (not Sunday)
8:30-8:57 p.m.	0130-0157	Austrian Radio	B	9770, 5945
8:30-8:55 p.m.	0130-0155	R. Tirana	B	9750, 7120
8:30-9:00 p.m.	0130-0200	R. Budapest	B	17710, 15220, 11910, 9835, 9585, 6025 (Wed. and Sat.)
8:30-9:30 p.m.	0130-0230	R. Japan	C	21640, 21610, 17825, 15195
8:45-9:15 p.m.	0145-0215	Swiss R. International	A	15305, 11715, 9725, 6135
9:00-9:25 p.m.	0200-0225	Kol Israel	A	11655, 9815, 7410
9:00-9:30 p.m.	0200-0230	R. Canada International	A	11845, 5960 (Sat. & Sun. also 11940, 9755, 9535)
9:00-9:30 p.m.	0200-0230	R. Budapest	B	17710, 15220, 11910, 9835, 9585, 6025 (not Mon.)
9:00-9:40 p.m.	0200-0240	R. Polonia	C	15120, 11815, 9525, 7270 7145, 6135, 6095 (length varies)
9:00-9:50 p.m.	0200-0250	R. RSA	B	15325,11730, 9580, 5980
9:00-9:55 p.m.	0200-0255	R. Bucharest	C	15380, 11940, 11830, 9570, 6155
9:00-9:55 p.m.	0200-0255	R. Peking	B	15120, 11650
9:00-10:00 p.m.	0200-0300	VOA	A	21460, 17735, 7205, 6873 USB
9:00-10:00 p.m.	0200-0300	R. Nacional, Brazil	A	17830, 15290
9:00-10:00 p.m.	0200-0300	V. of Free China (via WYFR)	B	11740
9:00-10:30 p.m.	0200-0330	R. Cairo	B	12000, 9475
9:00-11:00 p.m.	0200-0400	VOA to Latin America	A	17640, 15205, 9650, 6130 5995, 1580
9:00-11:30 p.m.	0200-0430	AFRTS, Los Angeles	A	11790, 6030
9:00 p.m-1:00 a.m.	0200-0500	WRNO, New Orleans	A	6155
9:00-12:00 p.m.	0200-0500	R. Australia	B	17795 (not all English)
9:15-9:30 p.m.	0215-0230	UN Radio	A	15435, 6035, 15752-SSB, 10869-SSB (Sat.)
9:30-9:45 p.m.	0230-0245	R. Pakistan	C	21725, 21595, 17840
9:30-9:55 p.m.	0230-0255	R. Tirana	B	9750, 7120
9:30-10:00 p.m.	0230-0300	RAE, Argentina	C	11710, 9690 (not Mon.)
9:30-10:00 p.m.	0230-0300	R. Sweden	B	11705, 9695, 17840-SSB
9:30-10:15 p.m.	0230-0315	R. Berlin International	C	11975, 9730
9:30-10:25 p.m.	0230-0325	R. Nederland	A	9590, 6165 (Mon. 0230-0320)
9:30-10:30 p.m.	0230-0330	R. Korea	C	15575, 11810
9:30-10:30 p.m.	0230-0330	BBC	A	11750, 9915, 9515, 9410, 7325 6175, 6120, 5975
9:30-12:00 p.m.	0230-0500	HCJB Ecuador	A	15155, 9745
10:00-10:25 p.m.	0300-0325	R. Polonia	C	15120, 11815, 9525, 7270. 7145, 6135, 6095 (length varies)
10:00-10:25 p.m.	0300-0325	R. Mexico	C	17765, 15430, 11770, 9705, 5980 (Sun.)
10:00-10:30 p.m.	0300-0330	R. Budapest	B	17710, 15220, 11910, 9835, 9585, 6025
10:00-10:30 p.m.	0300-0330	R. Japan	C	17755
10:00-10:30 p.m.	0300-0330	R. Kiev	B	17900†, 17870
10:00-10:30 p.m.	0300-0330	R. Canada International	A	11940, 11845, 9755, 9535, 5960
10:00-10:30 p.m.	0300-0330	R. Portugal	B	11925, 9520
10:00-10:30 p.m.	0300-0330	R. Australia to Antarctica	C	17750 (Fri.)
10:00-10:50 p.m.	0300-0350	V. of Free China	C	15345, 11825, 17800
10:00-10:55 p.m.	0300-0355	R. Prague	B	11990, 11970, 9630, 9540, 7345, 5930
10:00-10:55 p.m.	0300-0355	R. Peking	B	15520, 15120, 11650
10:00-11:00 p.m.	0300-0400	VOA	A	21460, 17740, 9670, 7200, 6040
10:00-11:00 p.m.	0300-0400	TIFC Costa Rica	C	5055, (Mon. 0235-0435)
10:00-11:00 p.m.	0300-0400	V. of Free China (via WYFR)	A	5985, 17800
10:00-11:00 p.m.	0300-0400	R. Baghdad	D	21585, 15400, 11935
10:00-11:00 p.m.	0300-0400	HRVC, Honduras	B	4820 (Mon.)
10:00-11:00 p.m.	0300-0400	R. Uganda	B	15325 (irregular)
10:00-11:00 p.m.	0300-0400	V. of Turkey	C	11900†
10:00-11:26 p.m.	0300-0426	R. RSA	B	9585, 7270, 5980, 4990, 3230
10:00-11:30 p.m.	0300-0430	VOA to Africa	A	15752-USB, 15240, 15185, 15175, 10880-USB, 10869-USB, 7280, 6035
10:00-12:00 p.m.	0300-0500	AWR Guatemala	C	12180, 6090, 5980
10:25 p.m.-fade	0325-	R. One, Zimbabwe	C	3396 (exc. Sun.)
10:30-10:55 p.m.	0330-0355	R. Tirana	B	7300, 6200
10:30-10:57 p.m.	0330-0357	Austrian Radio	C	9770, 5945
10:30-11:00 p.m.	0330-0400	U.A.E. Radio, Dubai	B	17775, 15300, (length varies)
10:30-11:15 p.m.	0330-0415	R. Berlin International	B	11975, 11890, 11840, 9560
10:30-11:30 p.m.	0330-0430	R. Cultural, Guatemala	B	3300 (Mon. 0030-)
10:30-11:30 p.m.	0330-0430	BBC	C	9410, 6175, 6120, 5975
10:30 p.m.-1:00 a.m.	0330-0600	R. Habana Cuba	A	11760, 11725
10:40-10:47 p.m.	0340-0347	V. of Greece	B	15050, 12045, 9865 (not Sun.)
10:50-11:10 p.m.	0350-0410	RAI, Italy	B	17795, 15330, 11905
10:51-10:58 p.m.	0351-0358	V. of Yerevan	C	17900, 17870, 15100
11:00-11:12 p.m.	0400-0412	R. Budapest	B	17710, 15220, 11910, 9835, 9585, 6025 (Wed. & Sat.)(0400-0430 Mon.)

11:00-11:30 p.m.	0400-0430	R. Bucharest	C	11940, 11830, 9570, 6155, 5990
11:00-11:30 p.m.	0400-0430	R. Canada International	A	9755, 9535, 5960
11:00-11:30 p.m.	0400-0430	R. Norway	C	9865, 9675, 9610, 9590, 6185 6030, 6015
11:00-11:55 p.m.	0400-0455	R. Peking	B	15120, 11650
11:00-12:00 p.m.	0400-0500	R. Sofia	C	7115
11:00-12:00 p.m.	0400-0500	R. Australia	B	21680, 21650, 17870, 17795, 17755, 17725, (15320 from 0430) 15240, 15160
11:00-12:00 p.m.	0400-0500	FEBA, Seychelles	C	11810, 15200 (Sat.&Sun.)
11:00-12:00 p.m.	0400-0500	R. Moscow World Service	A	9665, 9610
11:00 p.m.-1:00 a.m.	0400-0600	WYFR, Family Radio	A	6065
11:00 p.m.-1:00 a.m.	0400-0600	VOA	A	15205, 9670, 7200, 6040, 5995
11:00 p.m.-2:30 a.m.	0400-0730	TWR, Bonaire	A	9755, 800
11:00 p.m.-3:00 a.m.	0400-0800	R. Moscow	A	12050, 9580
11:30-11:57 p.m.	0430-0457	Austrian R.	B	5945
11:30-12:00 p.m.	0430-0500	VOA to Africa	A	15752-USB, 15240, 15185, 15175, 10869-USB, 7280, 6035
11:30-12:00 p.m.	0430-0500	Swiss R. International	B	11715, 9725
11:30-12:00 p.m.	0430-0500	RAE Argentina	C	11710, 9690
11:30 p.m.-12:45 a.m.	0430-0545	BBC	A	15070, 9510, 9410, 6175, 5975
11:30 p.m.-1:00 a.m.	0430-0600	AFRTS, Los Angeles	A	11790, 9755, 6030
11:30 p.m.-1:30 a.m.	0430-0630	TWR, Swaziland	C	5055
11:55 p.m.-3:00 a.m.	0455-0800	V. of Nigeria	B	15185 or 15120
12:00-12:15 a.m.	0500-0515	Kol Israel	B	11655, 11637, 9815, 9420
12:00-12:30 a.m.	0500-0530	R. Japan	C	15325
12:00-12:50 a.m.	0500-0550	V. of Germany	A	11905, 9690, 9545, 5960
12:00-1:00 a.m.	0500-0600	R. Australia	C	21680, 17870, 17725, 15240, 15160
12:00-1:00 a.m.	0500-0600	R. Moscow World Service	C	17880, 12010, 11735, 9530
12:00-1:00 a.m.	0500-0600	VOA	A	15752-USB, 15345, 15185, 10869-USB, 7280, 6035
12:00-2:00 a.m.	0500-0700	HCJB Ecuador	B	11910, 9745, 6095
12:00-3:00 a.m.	0500-0800	R. Kuwait	C	15345
12:00-3:00 a.m.	0500-0800	R. Nigeria, Kaduna	B	4770 (not all Eng.)
12:00-3:00 a.m.	0500-0800	WRNO, New Orleans	A	6155 (Sun) (not all Eng.)
12:30-12:40 p.m.	0530-0540	R. Garoua, Cameroon	C	5010
12:30-1:00 a.m.	0530-0600	R. Portugal	A	9520, 6075
12:30-fade	0530-	R. Ghana	C	3366, 4915
12:30-1:25 a.m.	0530-0625	R. Nederland	A	9715, 6155 (Mon. 0530-0620)
12:30-1:30 a.m.	0503-0630	Spanish Foreign R.	B	11880, 9630
12:35-1:30 a.m.	0530-0630	R. Korea	C	15575, 11810
12:45-1:00 a.m.	0545-0600	Vatican Radio	C	9645, 6210 or 6190
12:45-1:00 a.m.	0545-0600	UN Radio	B	15105, 11740 (Sat.)
12:45-2:30 a.m.	0545-0730	BBC	B	15070, 11955, 9640, 9510, 9410, 7150, 6175, 5975
12:55-3:25 a.m.	0555-0825	V. of Malaysia	C	15295, 12350, 9750
1:00-1:30 a.m.	0600-0630	V. of Germany	C	17875, 15275, 11905, 11765, 9700
1:00-1:30 a.m.	0600-0630	R. Australia	C	21680, 17870, 17795, 17755, 17725, 15395, 15240, 15160
1:00-2:00 a.m.	0600-0700	AFRTS, Los Angeles	B	11790, 9755, 6030
1:00-2:00 a.m.	0600-0700	VOA	A	15205, 9670, 7325, 7200, 6060, 6040, 5995
1:00-2:30 a.m.	0600-0730	R. Kiribati	C	16433-SSB (not all English)
1:00-2:30 a.m.	0600-0730	VOA to Africa	A	15752-USB, 15345, 15330, 11915, 10869-USB, 9530, 7280, 6125, 6080, 6035
1:00-4:00 a.m.	0600-0900	R. Cook Islands	D	11760, or 9695 or 5045
1:10-2:10 a.m.	0610-0710	V. of Free China	A	5985, via WYFR (not all English)
1:15-1:30 a.m.	0615-0630	R. Canada International	B	11960, 11825, 11775, 9760, 6140, 6045 (Mon-Fri)
1:30-1:45 a.m.	0630-0645	RTVC, Congo	C	9715 (Mon.-Fri.)
1:30-2:00 a.m.	0630-0700	R. Australia	B	21680, 17870, 17725, 15240, 15160, 15115
1:30-2:00 a.m.	0630-0700	Radio Polonia	B	9675, 7270
1:30-2:30 a.m.	0630-0730	R. RSA	C	17780, 15220, 11900
1:30-2:00 a.m.	0630-0800	R. Habana Cuba	A	9525
1:45-2:00 a.m.	0645-0700	R. Canada International	B	11960, 11825, 11775, 9760, 6140, 6045 (Mon.-Fri.)
1:57-4:55 a.m.	0657-0955	V. of Philippines	C	9578 (not all English)
2:00-2:15 a.m.	0700-0715	R. Japan	C	15325, (15190 or 15270† via Portugal)
2:00-2:20 a.m.	0700-0720	R. Nederland	C	21480, 15560, 11720, 9895
2:00-2:30 a.m.	0700-0730	Swiss Radio International	C	15305, 9625, 9560, 9535, 6165, 3985
2:00-3:00 a.m.	0700-0800	ELWA, Liberia	C	11830
2:00-3:00 a.m.	0700-0800	V. of Vietnam	C	9840
2:00-3:30 a.m.	0700-0830	HCJB, Ecuador	C	11810, 9760
2:00-4:00 a.m.	0700-0900	R. Australia	B	21680, 17725, 15115, 12290-SSB, 9570
2:00-6:00 a.m.	0700-1100	HCJB, Ecuador	C	11925, 6130, (9745, 0700-1030)
2:10-2:15 a.m.	0710-0715	UN Radio	A	17815, 15195, 15120, 11740 (Sat.)
2:25-4:40 a.m.	0725-0940	TWR, Monte Carlo	B	9495 (Sun. to 1100)
2:30-3:25 a.m.	0730-0825	R. Nederland	B	9770, 9715
2:30-4:00 a.m.	0730-0900	BBC	B	15070, 11955, 9640, 9510, 7150, 9410
2:30-6:15 a.m.	0730-1115	R. New Zealand	C	11960, 15485
2:30-6:30 a.m.	0730-1130	Solomon Isl. Broadcasting	C	9545 or 5020 (not all Eng.)
2:30-9:00 a.m.	0730-1402	ABC Melbourne	C	9680
2:30 a.m.-fade	0730-	Action Radio, Guyana	C	5950
2:45-4:30 a.m.	0745-0930	KTWR, Guam	B	11840
3:00-3:15 a.m.	0800-0815	UN Radio	A	17860, 15235, 15120, 11740 (Sat.)
3:00-7:00 a.m.	0800-1200	WRNO, New Orleans	A	6145 (not all Eng.)
3:15-3:30 a.m.	0815-0830	R. Vanuatu	D	7260, 3945
3:30-4:25 a.m.	0830-0925	R. Nederland	B	9715
3:30-5:00 a.m.	0830-1000	FEBC, Philippines	C	11890
24 Hours	24 Hours	CFRX, Toronto	C	6070

ExplanatoryNotes.

1. Times in first column are EST. For AST add 1 hour; CST subtract 1 hour; MST subtract 2 hours; PST, subtract 3 hours. Days of week are in GMT.
2. Quality. A—Strong signal and very reliable reception. B—regular reception. C—occasional reception under favorable conditions. D—rarely audible. These ratings are for locations in the central USA. European and African stations are in general, more reliably received in eastern North America. Asian and Pacific stations are more reliably received in western North America. North American stations are received well except in areas too close to the transmittersite.
3. The information in the listing is correct to press time. However, frequencies and schedules are constantly changing. Listen to "SWL Digest" on R. Canada International for late changes, Saturday at 2135; Sunday at 1930; GMT Mondays at 0106 and 0406.
4. R.—Radio; V.—Voice
† = frequent changes

PROJECT OF THE MONTH

A Multifunction VMOS Oscillator

By Forrest M. Mims

IN THIS era of increasingly complex integrated circuits, it's easy to overlook the versatility offered by some very simple transistor circuits. Figure 1, for example, shows a multivibrator made with a pair of VMOS MOSFETs. This circuit has many useful applications.

To understand how the multivibrator operates, assume that initially *C1* is discharged and *C2* is charging to V_{DD}. Therefore, *Q2* is off and *Q1* is on. Components *C2* and *R3* form a differentiator that delivers to the gate of *Q1* a voltage that decreases in time. Eventually, the voltage falls to a point at which *Q1* is switched off. Then *C1* in the differentiator formed by *C1* and *R4* immediately begins charging and turns on *Q2*. The charge-discharge cycle then repeats, and the two transistors are alternately switched on and off.

The basic circuit has an oscillation frequency of approximately the reciprocal of 3.6 multiplied by R times C where R = *R3* = *R4* and C = *C1* = *C2*. Under these conditions, the on and off times for *Q1* and *Q2* are equal. It's easy to produce nonsymmetrical operation where one transistor is on or off longer than the other simply by altering the RC time constant of one or both halves of the circuit.

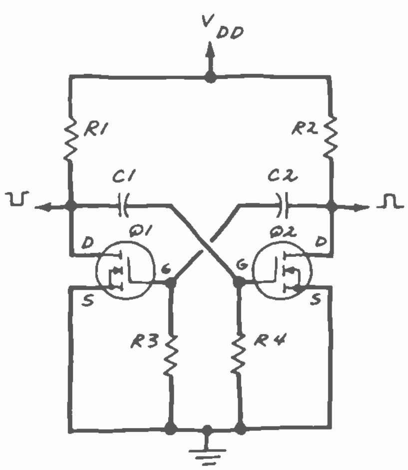

Fig. 1. Multivibrator made with a pair of VMOS MOSFETs.

Practical Applications. The circuit in Fig.1 has two important advantages over similar types that use bipolar transistors. First, the VMOS power MOSFET transistors are capable of driving directly such current-demanding loads as incandescent lamps. Second, the almost infinite gate resistance of VMOS MOSFETs makes it possible to have cycle times much longer than those obtained when bipolar transistors are used.

Figure 2 shows the most obvious application for a VMOS multivibrator, a dual LED flasher. Here *R1* and *R2* limit current through the LEDs to a safe level. Note the inclusion of *Q3* to provide an enable input that can be controlled by a TTL or CMOS signal. When *Q3*'s gate is high, the oscillator operates. Otherwise the oscillator is disabled. If an enable input is not needed, *Q3* can be omitted or replaced by an spst on-off switch.

Another interesting addition to the circuit is potentiometer *R5*. Reducing its resistance *increases* the circuit's flash rate. If the resistance of *R5* is reduced below about 1 kilohm, the circuit will cease oscillation. Therefore you may wish to insert a 1.5-kilohm fixed resistor in series with *R5*. Should the circuit cease to oscillate and then fail to restart when power is interrupted, it can be restarted by momentarily shorting one or both timing capacitors.

The circuit in Fig. 2 can be easily modified for different flash rates and nonsymmetrical operation by changing the values of the RC components. A particularly interesting application is to replace *R3* and *R4* with thermistors or cadmium-sulfide photocells. The circuit can then be used to visually monitor temperature or light level differences in two locations.

For example, say you wish to match the temperatures of two solutions of darkroom chemicals but you have misplaced your thermometer. First immerse the thermistors in each of the two solutions. If the temperatures are identical, the LEDs will flash on and off at equal time intervals. If, however, the temperatures are different, the flash rate will be uneven. Simply add ice to the warmer solution until the flash rate is even.

For this application to be successful, you should use glass-bead thermistors. They are fragile, but they can be immersed. You will also have to devise some flexible leads to connect the thermistors to the circuit. Be sure to completely insulate the connection between the thermistors and the leads as moisture may cause erroneous results.

The circuit in Fig. 2 can also be used as a tone generator. Piezoelectric speakers can be connected directly across the LEDs, or standard 8-ohm miniature speakers can be substituted for the LEDs. You will need to reduce the resistances of *R1* and *R2* to about 100 ohms. One or two speakers can be used, depending upon your application.

If the device(s) you wish to drive adversely affects the operation of the circuit, you can always use additional VMOS transistors as buffers. Simply connect their gate leads to the drain connection of *Q1* or both *Q1* and *Q2*.

Finally, to provide one cycle of operation, insert a capacitor between *R4* and ground. Add a normally open pushbutton switch and 1.5-kilohm resistor in series across the capacitor. When the switch is closed, the circuit will operate. Release the switch, and it will cease operation after one cycle. Use any capacitance from 0.01 to 0.1 μF for the capacitor. ◇

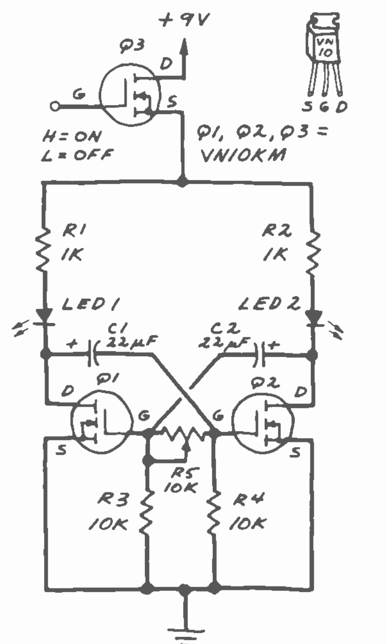

Fig. 2. Adjustable rate dual LED flasher with enable input.

OPERATION ASSIST

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RCA Model WT115A color picture tube tester. Need manual and schematic. Gordon S. Johnson, 1570 Diana Blvd., Merritt Island, FL 32952.

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A.B. Dumont AN/USM-32 oscilloscope. Need probes. Sean Powell, 8509 Rawls Ave., Pensacola, FL 32504.

Precision Model ES-500A oscillograph. Need schematic and service manual. Jon Andreasen, 70 West End Ave., #5-6B, Newton, NJ 07860.

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Jackson Model CRO-2 oscilloscope. Need operator's manual, wiring diagrams or schematics. Paul Fleming, Box A, Fort Washington, PA 19034.

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Tektronix Type 31 scope. Need service manual. Robert Sorenson, 2411 Middlefield #15, Redwood City, CA 94063.

American Bosch Magneto Corp., Model 28 receiver. Need schematic. Henry M. Cantor, 21 Friendly Court, Babylon, NY 11702.

Triplet Serial #40122 RX microtabulometer. Need schematic diagram. Bill Gilbert, WDX24VW, 26 Terrill Lane, Kings Park, NY 11754.

Gonset Model 3442 GA38A communicator. Need manuals and schematic or any technical data. Jack D. Brainard, 514 Mark Dr., Westminster, MD 21157.

EMC Model 801 capacitor/resistor tester and **Solar** Model CB-1 60 capacitor analyzer. Need schematics, manuals and parts lists. J. R. Hetherington, 2820 So. Main St., Soquel, CA 95073.

Nikoltronix Model GN1375B CB analyzer. Need operating instructions and schematics. T. G. Stikeleather, 39 Hibiscus Ave., FPO, San Francisco, CA 96630.

Collins R-388/URR receiver. Need manual and schematic. Larry Gotts, Box 44, Pleasant Mount, PA 18453.

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74LS05	.25	74LS95	.75	74LS181	2.15	74LS364	1.95
74LS08	.28	74LS96	.89	74LS189	8.95	74LS365	.49
74LS09	.29	74LS107	.39	74LS190	.89	74LS366	.49
74LS10	.25	74LS109	.39	74LS191	.89	74LS367	.45
74LS11	.35	74LS112	.39	74LS192	.79	74LS368	.45
74LS12	.35	74LS113	.39	74LS193	.79	74LS373	.99
74LS13	.45	74LS114	.39	74LS194	.69	74LS374	.99
74LS14	.59	74LS122	.45	74LS195	.69	74LS377	1.39
74LS15	.35	74LS123	.79	74LS196	.79	74LS378	1.18
74LS20	.25	74LS124	2.90	74LS197	.79	74LS379	1.35
74LS21	.29	74LS125	.49	74LS221	.89	74LS385	1.90
74LS22	.25	74LS126	.49	74LS240	.95	74LS386	.45
74LS26	.29	74LS132	.59	74LS241	.99	74LS390	1.19
74LS27	.29	74LS133	.59	74LS242	.99	74LS393	1.19
74LS28	.35	74LS136	.39	74LS243	.99	74LS395	1.19
74LS30	.25	74LS137	.99	74LS244	.99	74LS399	1.49
74LS32	.29	74LS138	.55	74LS245	1.49	74LS424	2.95
74LS33	.55	74LS139	.55	74LS247	.75	74LS447	.37
74LS37	.35	74LS145	1.20	74LS248	.99	74LS490	1.95
74LS38	.35	74LS147	2.49	74LS249	.99	74LS624	3.99
74LS40	.25	74LS148	1.35	74LS251	.59	74LS668	1.69
74LS42	.49	74LS151	.55	74LS253	.59	74LS669	1.89
74LS47	.75	74LS153	.55	74LS257	.59	74LS670	1.49
74LS48	.75	74LS154	1.90	74LS258	.59	74LS674	9.65
74LS49	.75	74LS155	.69	74LS259	2.75	74LS682	3.20
74LS51	.25	74LS156	.69	74LS260	.59	74LS683	3.20
74LS54	.29	74LS157	.65	74LS266	.55	74LS684	3.20
74LS55	.29	74LS158	.59	74LS273	1.49	74LS685	3.20
74LS63	1.25	74LS160	.69	74LS275	3.35	74LS688	2.40
74LS73	.39	74LS161	.65	74LS279	.49	74LS689	3.20
74LS74	.35	74LS162	.69	74LS280	1.98	74LS783	24.95
74LS75	.39	74LS163	.65	74LS283	.69	81LS95	1.49
74LS76	.39	74LS164	.69	74LS290	.89	81LS96	1.49
74LS78	.49	74LS165	.95	74LS293	.89	81LS97	1.49
74LS83	.60	74LS166	1.95	74LS295	.99	81LS98	1.49
74LS85	.69	74LS168	1.75	74LS298	.89	25LS2521	2.80
						25LS2569	4.25

IC SOCKETS

	1-99	100
8 pin ST	.13	.11
14 pin ST	.15	.12
16 pin ST	.17	.13
18 pin ST	.20	.18
20 pin ST	.29	.27
22 pin ST	.30	.27
24 pin ST	.30	.27
28 pin ST	.40	.32
40 pin ST	.49	.39
ST SOLDERTAIL		
8 pin WW	.59	.49
14 pin WW	.69	.52
16 pin WW	.69	.58
18 pin WW	.99	.90
20 pin WW	1.09	.98
22 pin WW	1.39	1.28
24 pin WW	1.49	1.35
28 pin WW	1.69	1.49
40 pin WW	1.99	1.80
WW WIREWRAP		
16 pin ZIF	6.75	call
24 pin ZIF	9.95	call
ZIF TEXTOOL (Zero Insertion Force)		

CONNECTORS

RS232 MALE	2.95
RS232 FEMALE	3.50
RS232 FEMALE RIGHT ANGLE	5.25
RS232 HOOD	1.25
S-100 ST	3.95
S-100 WW	4.95

DIP SWITCHES

4 POSITION	.85
5 POSITION	.90
6 POSITION	.90
7 POSITION	.95
8 POSITION	.95

7400

7400	.19	74132	.45
7401	.19	74136	.50
7402	.19	74141	.65
7403	.19	74142	2.95
7404	.19	74143	2.95
7405	.25	74145	.60
7406	.29	74147	1.75
7407	.29	74148	1.20
7408	.24	74150	1.35
7409	.19	74151	.55
7410	.19	74152	.65
7411	.25	74153	.55
7412	.30	74154	1.25
7413	.35	74155	.75
7414	.49	74156	.65
7416	.25	74157	.55
7417	.25	74159	1.65
7420	.19	74160	.85
7421	.35	74161	.69
7422	.35	74162	.85
7423	.29	74163	.69
7425	.29	74164	.85
7426	.29	74165	.85
7427	.29	74166	1.00
7428	.45	74167	2.95
7430	.19	74170	1.65
7432	.29	74172	5.95
7433	.45	74173	.75
7437	.29	74174	.89
7438	.29	74175	.89
7440	.19	74176	.89
7442	.49	74177	.75
7443	.65	74178	1.15
7444	.69	74179	1.75
7445	.69	74180	.75
7446	.69	74181	2.25
7447	.69	74182	.75
7448	.69	74184	2.00
7450	.19	74185	2.00
7451	.23	74186	18.50
7453	.23	74190	1.15
7454	.23	74191	1.15
7460	.23	74192	.79
7470	.35	74193	.79
7472	.29	74194	.85
7473	.34	74195	.85
7474	.33	74196	.79
7475	.45	74197	.75
7476	.35	74198	1.35
7480	.59	74199	1.35
7481	1.10	74221	1.35
7482	.95	74246	1.35
7483	.50	74247	1.25
7485	.59	74248	1.85
7486	.35	74249	1.95
7489	2.15	74251	.75
7490	.35	74259	2.25
7491	.40	74265	1.35
7492	.50	74273	1.95
7493	.35	74276	1.25
7494	.65	74279	.75
7495	.55	74283	2.00
7496	.70	74284	3.75
7497	2.75	74285	3.75
74100	1.75	74290	.95
74107	.30	74293	.75
74109	.45	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	4528	1.19
4001	.25	4531	.95
4002	.25	4532	1.95
4006	.89	4538	1.95
4007	.29	4539	1.95
4008	.95	4543	1.19
4009	.39	4555	.95
4010	.45	4556	.95
4011	.25	4581	1.95
4012	.25	4582	1.95
4013	.38	4584	.75
4014	.79	4585	.75
4015	.39	4702	12.95
4016	.39	74C00	.35
4017	.69	74C02	.35
4018	.79	74C04	.35
4019	.39	74C08	.35
4020	.75	74C10	.35
4021	.79	74C14	.59
4022	.79	74C20	.35
4023	.29	74C30	.35
4024	.65	74C32	.39
4025	.29	74C42	1.29
4026	1.65	74C48	1.99
4027	.45	74C73	.65
4028	.69	74C74	.65
4029	.79	74C76	.80
4030	.39	74C83	1.95
4034	1.95	74C85	1.95
4035	.85	74C86	.39
4040	.75	74C89	4.50
4041	.75	74C90	1.19
4042	.69	74C93	1.75
4043	.85	74C95	.99
4044	.79	74C107	.89
4046	.85	74C150	5.75
4047	.95	74C151	2.25
4049	.35	74C154	3.25
4050	.35	74C157	1.75
4051	.79	74C160	1.19
4053	.79	74C161	1.19
4060	.89	74C162	1.19
4066	.39	74C163	1.19
4068	.39	74C164	1.39
4069	.29	74C165	2.00
4070	.35	74C173	.79
4071	.29	74C174	1.19
4072	.29	74C175	1.19
4073	.29	74C192	1.49
4075	.29	74C193	1.49
4076	.79	74C195	1.39
4078	.29	74C200	5.75
4081	.29	74C221	1.75
4082	.29	74C373	2.45
4085	.95	74C374	2.45
4086	.95	74C901	.39
4093	.49	74C902	.85
4098	2.49	74C903	.85
4099	1.95	74C905	10.95
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14410	12.95	74C907	1.00
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14419	7.95	74C910	9.95
4502	.95	74C911	8.95
4503	.65	74C912	8.95
4508	1.95	74C914	1.95
4510	.85	74C915	1.19
4511	.85	74C918	2.75
4512	.85	74C920	17.95
4514	1.25	74C921	15.95
4515	1.79	74C922	4.49
4516	1.55	74C923	4.95
4518	.89	74C925	5.95
4519	.39	74C926	7.95
4520	.79	74C927	7.95
4522	1.25	74C928	7.95
4526	1.25	74C929	19.95
4527	1.95	74C930	19.95

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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
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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
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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

LINEAR

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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
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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
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LM337T	1.95	LM710	.75	LM3905	1.25
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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	78H05K	9.95	7924K	1.49
7824T	.89	78H12K	9.95	79L05	.79
7805K	1.39	7905T	.99	79L12	.79
7812K	1.39	7908T	.99	79L15	.79
7815K	1.39	7912T	.99	LM323K	4.95
7824K	1.39	7915T	.99	UA78S40	1.95
		7924T	.99		

T = TO-220 K = TO-3 L = TO-92

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

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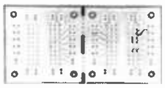
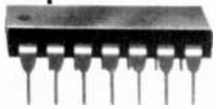


Accepts two 6 to 20-pin DIP ICs. Four contact points for each IC pin. **276-159 . . . . . . 1.49**

Computer Communicators



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14-Pin DIPs With Data

1488. RS232 Quad Line Driver. Interfaces terminal equipment with communications devices or connects different logic families. Current limited output. Split supply, 15VDC max. **276-2520 . . . . 1.79**

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2.79

40-Pin DIP With Data

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Keeps radio frequency interference from being conducted into sensitive equipment from power line or into line from equipment. 5A at 120VAC, 4A at 250VAC. **273-100 . . . . . 11.95**

MOV Spike Protector

With Data

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1.59

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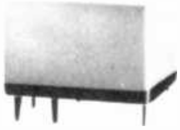


For limited-space projects that require switching up to 3 amps at 125VAC. Excellent for computer control and other digital circuits 72-ohm, 5VDC coil. **275-246 . . . . 3.49**

12VDC Coil. 400 ohms, 30 milliamps. For mobile communications and automotive switching **275-247 . . . . 3.49**

3.49 Each

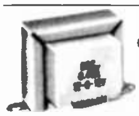
Low-Voltage Sensor

3.59

TO-72 Case

ICM7201. Lights LED (not incl.) when voltage falls below preset 2.9V level. Add voltage divider for low-battery warning—ideal for nickel-cadmium packs! **276-2333 . . . . 3.59**

Shielded Power Xformers

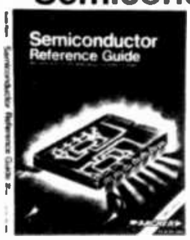


*Has Center Tap

■ *120VAC Primaries*
■ *Miniature Size* ■ *U.L. Listed*

Secondary VAC	Cat No	Each
6 3 at 450 mA	273-1364	2 99
12 0* at 450 mA	273-1365	3 59
24 0* at 450 mA	273-1366	3 99

Semiconductor Guide



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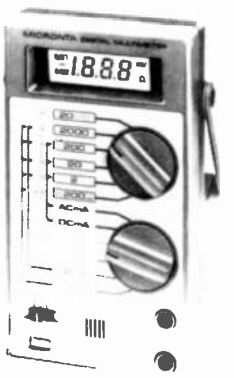

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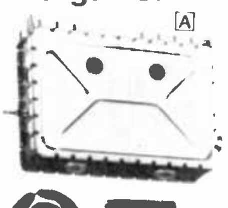

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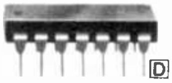

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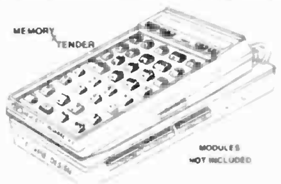

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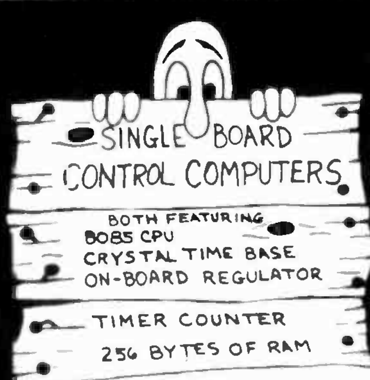

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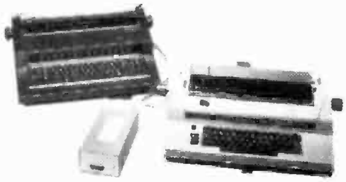

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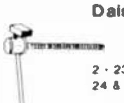

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Classified Adv. contd. on pg. 126

WHEN WE ANNOUNCED THE COMMODORE 64 FOR $595, OUR COMPETITORS SAID WE COULDN'T DO IT.

THAT'S BECAUSE THEY COULDN'T DO IT.

The reason is that, unlike our competitors, we make our own IC chips. *Plus* all the parts of the computer they go into.

So Commodore can get more advanced computers to market sooner than anybody else. And we can get them there for a lot less money.

WHAT PRICE POWER?

For your $595,* the Commodore 64™ gives you a built-in user memory of 64K. This is hundreds of dollars less than computers of comparable power.

Lest you think that the Commodore 64 is some stripped-down loss leader, a look at its available peripherals and interfaces will quickly convince you otherwise.

SOFTWARE THAT WORKS HARD.

The supply of software for the Commodore 64 will be extensive. And with the optional plug-in Z80 microprocessor, the Commodore 64 can accommodate the enormous amount of software available in CP/M.®

Add in the number of programs available in BASIC and you'll find that there are virtually no applications, from word processing to spreadsheets, that the Commodore 64 can't handle with the greatest of ease.

PERIPHERALS WITH VISION.

The Commodore 64 interfaces with all the peripherals you could want for total personal computing: disk drives, printers and a telephone modem that's about $100, including a free hour's access to some of the more popular computer information services. Including Commodore's own Information Network for users.

RUN YOUR BUSINESS BY DAY. SAVE THE EARTH BY NIGHT.

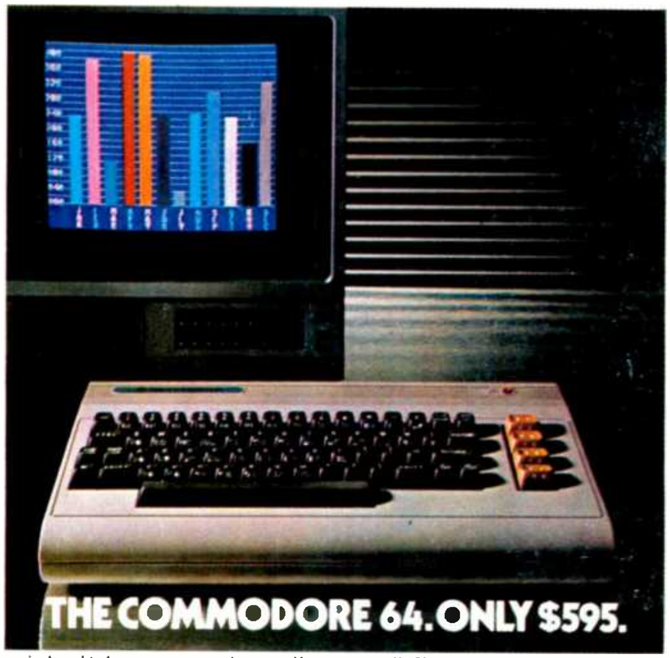
At the end of a business day, the Commodore 64 can go into your briefcase and ride home with you for an evening's fun and games.

Because of its superior video quality (320x200 pixel resolution, 16 available colors and 3D Sprite graphics), the Commodore 64 surpasses the best of the video game machines on the market. Yet, because it's such a powerful computer, it allows you to invent game programs that a game machine will never be able to play; as well as enjoy Commodore's own video game cartridges.

ATTACK, DECAY, SUSTAIN, RELEASE.

If you're a musicologist, you already know what an ADSR (attack, decay, sustain, release) envelope is. If you're not, you can learn this and much more about music with the Commodore 64's music synthesizing features.

It's a full-scale compositional tool. Besides a programmable ADSR envelope generator, it has 3 voices (each with a 9-octave range) and 4 waveforms for truly sophisticated composition and playback—through your home audio system, if you



wish. It has sound quality you'll find only on separate, music-only synthesizers. And graphics and storage ability you won't find on any separate synthesizer.

DON'T WAIT.

The predictable effect of advanced technology is that it produces less expensive, more capable products the longer you wait.

If you've been waiting for this to happen to personal computers, your wait is over.

See the Commodore 64 soon at your local Commodore Computer dealer and compare it with the best the competition has to offer.

You can bet that's what the competition will be doing.

Commodore Business Machines
Personal Systems Division
P.O. Box 500, Conshohocken, Pennsylvania 19428

Please send me more information on the Commodore 64™

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commodore COMPUTER

CE-1

**Manufacturer's Suggested Retail Price July 1, 1982. Disk drives and printers are not included in prices. The 64's price may change without notice.*

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