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MAY 1983 VOLUME 21, NUMBER 5

FEATURE ARTICLES

EQUIPMENT REVIEWS

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BASIC VS. JRT PASCAL:

A NO-HOLDS-BARRED COMPARISON.

EASE-OF-USE By dividing programs into modules, JRT Pascal makes even very complex programs—of nearly any size—a breeze to manage. Pascal code is *self-documenting;* program sections are identified by meaningful names, not line numbers. Error messages are verbal, not number codes. JRT offers *12 data types* (to Basic's 2 or 3), and it has both regular and hex numbers.

POWER For power—the ability to write better, clearer programs, faster—Pascal is the run-away winner. Example: JRT simplifies programming by accomplishing complicated operations (for Basic) with one command:

Basic	JRT Pascal
IF A$ = "V" OR A$ = "W" OR A$ = "X" OR A$ = "Y" OR A$ = "Z" THEN...	IF A IN ['V'..'Z'] THEN...

FLEXIBILITY JRT's wide variety of data types reduces programming restrictions. And the data types are not all fixed in size. There are *3 looping statements* (Basic has 1). With JRT, very large programs can be created and run, because program modu es can be spread over many diskettes. Common modules can be used for several programs. Basic generally limits strings to 255 bytes; *JRT strings go up to 64K.*

EFFICIENCY Whereas Basic relies on a static, inefficient memory map to allocate storage, JRT's *dynamic storage* fills every available main storage area; there's no waste. With Basic, sub-routine modules must be linked together; with JRT, they can be linked—but don't have to be. JRT's more powerful commands run faster; typically, you'll *write Pascal programs 3 to 10 times faster* than in Basic. *Exclusive:* JRT lets you directly access the CP/M* operating system for better total system control.

NOW! Consider our copy policy. (If you want to make copies, it's OK with us—so long as they're not for re-sale.) Check our astounding price: **$29.95!**—and *satisfaction is guaranteed—or your money back.* Basic versus JRT Pascal: which comes out on top? Right! The coupon below is for your convenience. Or call. Today.

Here's the real shocker!

Features	Basic	JRT Pascal
Structured programs	No	Yes
Separate compiled modules	"Chaining"	Structured procedures with auto-loading & purging
Arithmetic precision	Usually 6 or 7 digits	14 digits
Indexed files	No	Yes
Maximum string size	255 characters	64,000 characters
Loop statements	1	3
Data types	Usually 2 or 3	12
CASE statement	No	Yes
Introduced	1965	1980
Price	???	$29.95!

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- More than 200 verbal error messages
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EDITORIAL

Sexism and the Computer

". . . girls find the world of computers a mostly male domain," reports *Psychology Today* in a March 1983 article, "Second-Class Citizens?"

The authors, both of whom are psychologists and female, charge that game software reflects such a bias. They cite land battles, space wars, and other forms of destruction as examples of games that appeal to the boys, but not the girls. Moreover, on a visit to a computer store, the researchers examined computer software on display racks and counted 28 men and only four women illustrated on the game packages. Obviously in a gender-counting mood, the authors also visited a video arcade where they saw about 175 customers, only 30 of whom were female.

Computer stores are also an alien environment for women, contend the authors, since electronics and such are unfamiliar products to them. Furthermore, sales people in these stores were noted as being mainly young males. Thus one might assume that the cards are stacked against women in the computer field.

These are interesting views. There is no question that males are more predisposed through our culture to favor things electronic and mechanical than females are, and that computer marketers recognize that their best prospects are therefore males and, consequently, direct products to attract men.

So what's new? Our readership has always reflected this, being overwhelmingly a male audience. There are no real barriers, professional or avocational, for women in the computer field, though. More than 25% of computer specialists are, in fact, female, among them some true leaders in the industry. Merit counts more than anything else, too, as evidenced by reports of virtually equal pay for women and men in this field. I know a woman who gets $1500 per day for computer consulting work, as an example, which I think everyone will agree is more than equal.

Cultural hangups are indeed difficult to overcome. I don't underestimate the impact. Reports indicate that its effect is considerably less on females younger than 15 years of age. Combined with a fast-growing move toward achieving computer literacy in elementary schools, we should see a new generation of women that's more at ease with computers. Even liberal arts colleges are pursuing computer-familiarity courses. Two women's colleges (yes, there are still single-sex colleges), Wellesley and Mount Holyoke, both in Mass., will be embarking on courses that relate computer work to the humanities.

As more and more women enter the computer field, perhaps they will have the drive and wherewithall to initiate special physical-fitness programs to relieve the special tensions developed by men and women alike when working at terminals. A nationwide study authorized by Verbatim Corp. (323 Soquel Way, Sunnyvale, CA 94086) revealed that 63 percent of people working continually on word-processing and data-processing machines experience eyestrain, while 36% cited back strain. As a result, an exercise guide, "Tone Up At The Terminals," was devised by an exercise physiologist to combat such problems. (The guide is available free from Verbatim.)

Perhaps Jane Fonda can follow up on her exercise best seller with one for work at computer terminals for both men and women.

Art Salsberg

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Growing Demand for Computer Technicians

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.

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

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LETTERS

BBC COMPUTER EXPANSION

In the "British Are Coming" (March 1983), it was not made entirely clear that the buffered extension bus in the Model B of the BBC Computer permits connection to expansion units such as a 6502 second processor and an extra 64K of memory or a Z80 second processor with 64K of RAM. This allows the system to run CP/M 2.2 and turns the BBC machine into a business computer. *—Mike Firth, Dallas, TX.*

MISSING VIDEO CONNECTION

I find that two essential parts were missing from connection 5 in my article, "The Video Connection" (March 1983). In order to get full watch/record versatility and record scrambled channels, it is necessary to have a splitter on the cable input before the first converter-descrambler. The other connection from the splitter then should go to an A/B switch in front of the second converter-descrambler. The switch then chooses between the direct input from the splitter and the output of the VCR.*—Dave Trowbridge.*

HOBBY ROBOT IS ALIVE

I enjoyed your article "Personal Robots" in the January issue, but I was surprised to read that our company, Hobby Robot Co., was defunct. It is very much in the running! Our Tread Base Unit RBU-II is currently very successful. Our base and arm modules are the only Man Rated units we know of in the hobby and educational price ranges. We have also completed development of a new low-cost "Rabbit Robot" for the modeling and experimenting enthusiast.

On the robot industry itself, robot clubs such as those formed by John Gutman (Atlanta Robot Special Interest Group) and Ted Blank (Boston Robot Club) have made important contributions. Yours was a really significant boost to this fledgling industry!*—Bill Dodd, President, Hobby Robot Co., PO Box 997, Lilburn, GA 30247.*

ADVANTAGE HARD DISK

In a recent item in the Computer Hardware column, it was noted that NorthStar had introduced a computer system with 5M bytes of hard disk and one 360K floppy for $6599. That would be a pretty high price for a 5M-byte capacity which is priced at $4999. The reference probably got confused with our 15M-byte Advantage, which is $5999.*—Kristine M. Sokoloski, NorthStar Computers, Inc. San Leandro, CA.* ◇

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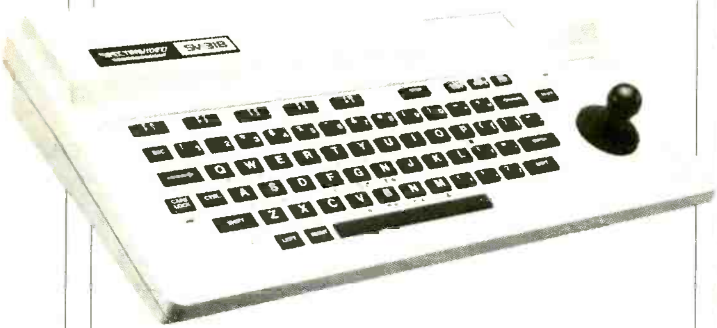

COLOR/SOUND COMPUTER

CP/M compatibility, built-in Microsoft extended BASIC, and 32K each of RAM and ROM are incorporated in Spectravideo's Model SV-318. It has 71 movable keys; 10 user define functions; memory expansion to 96K of ROM and 144K of RAM; u/lc and graphics character sets; 32 sprites; 256 × 192-pixel resolution; three 8-octave sound channels; ADSR envelope control for creating musical sounds; built-in joystick for games and cursor positioning; and 16-color palette. $299.95.

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The 8088-based Professional Computer from Texas Instruments has 64K bytes of RAM expandable to 256K, 320K disk drive, and 5-slot expansion bus. The keyboard has a 56-key typewriter layout plus an 18-key numeric pad, 5 cursor controls, and 12 special-function keys. Display can be 12" monochrome or 13" color, 25 lines of 80 columns and 710 × 300 pixels with graphics controller option. Basic system is $2595.

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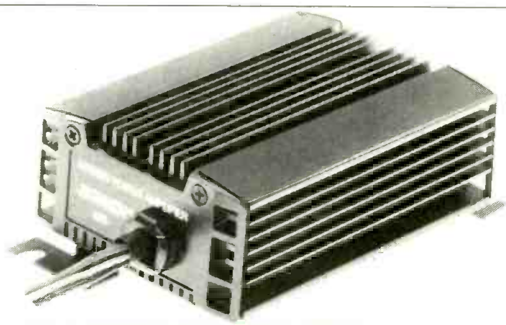

CAR BOOSTER AMPLIFIER

Jensen Car Audio's Model A35 is a car-stereo booster amplifier with electronic protection from thermal overload and reverse polarity; fused power lead; short-circuit protection; and compatibility with virtually all car receivers and tape players. Specifications: 15 W/ch into 4 ohms continuous; 0.3% THD; frequency response, 20 to 50,000 Hz ±3 dB; S/N, 80 dB; 5" × 3" × 2". $74.95.

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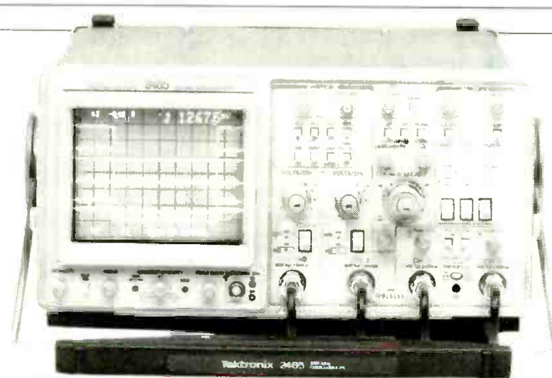
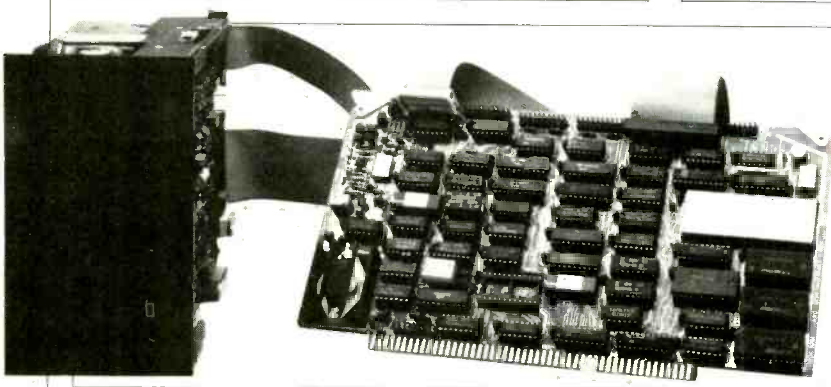


PORTABLE OSCILLOSCOPE

Tektronix Model 2465 oscilloscope features 300-MHz bandwidth, 500-ps/div sweep speed, and auto-level trigger having a bandwidth in excess of 500 MHz. Four full-bandwidth vertical channels have calibrated scale factors and positioning controls. CRT has cursors for time and voltage measurement. $4600.

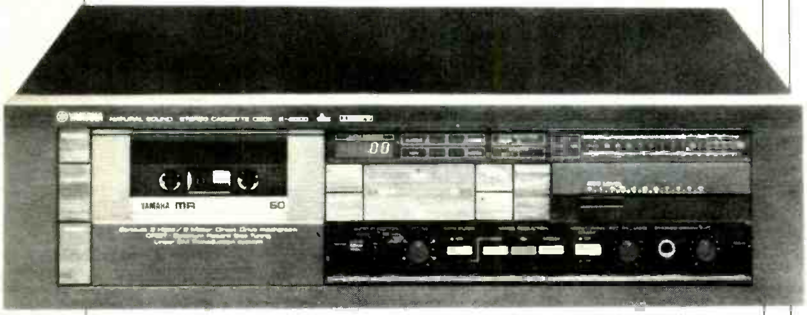
Circle No. 97 on Free Information Card



HARD-DISK SUBSYSTEM FOR S-100 COMPUTERS

Advanced Digital Corp.'s 5¼" Winchester hard-disk subsystem for S-100 microcomputers is built around the Model HDC-1001 IEEE-696 Standard error-correcting controller board. It is available in 5M-, 10M-, 20M-, and 40M-byte versions and features an on-board microprocessor for control of up to four drives and 8 R/W heads. Consists of controller board, connector cable, CP/M BIOS disk, and hard-disk drives, depending on capacity. $1800 for 5M, plus $200 for 20M.

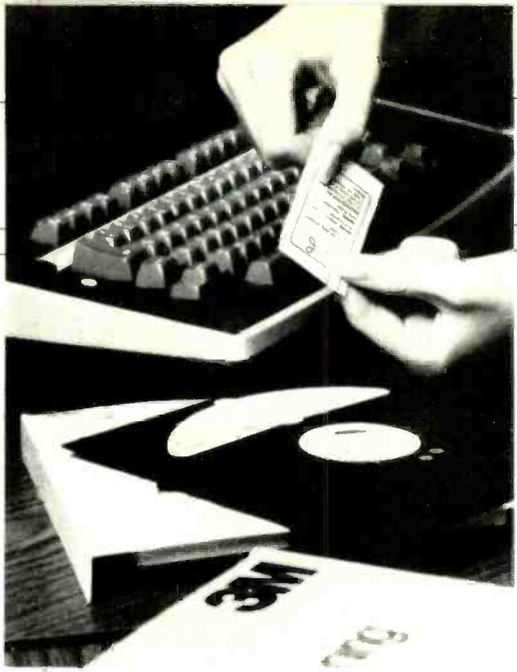
Circle No. 96 on Free Information Card



HIGH-END CASSETTE DECK

Yamaha's Model K-2000 three-head, direct-drive stereo cassette deck offers off-tape monitoring and incorporates double Dolby B and double dbx noise-reduction. Features include: 16-segment LED bargraph meter (−40 to +18 dB range); automatic Optimum Record Bias Tuning (ORBIT); metal tape capability; digital linear tape counter; touch-panel transport controls; and MPX filter. Specifications: wow and flutter, 0.02% wrms; frequency response, ±3 dB, 10-18,000 Hz normal, to 21,000 Hz chrome, to 20,000 Hz metal; harmonic distortion, 0.8%; fast-wind time, 75 s with C-60. 17⅛"W × 13⅝"D × 4¾"H. $795.

Circle No. 95 on Free Information Card



DISKETTE CLEANING

3M's new method of dispensing cleaning solution for 8" head cleaning diskettes is in the form of individual packets, each containing the amount needed for cleaning a single disk drive. The fluid is applied to the porous cleaning diskette contained in a modified envelope, and the diskette is run normally for 30 seconds. The method is nonabrasive and can be used on drives designed for either one- or two-sided diskettes. Each kit contains two diskettes and 30 packets of fluid. $30.

Circle No. 94 on Free Information Card

EXECUTIVE PORTABLE COMPUTER

Osborne Computer Corp. has a new-generation portable computer-in-a-suitcase that addresses what some people felt were shortcomings in the Osborne 1. Called the "Executive," the new computer offers 128K of bank-switched RAM, dual half-height double-density floppy disk drives, and a 7" amber CRT (a 5" CRT was used in the Osborne 1) to display an 80-character by 24-line "page" without scrolling. Extra RAM is provided for video (4K), character-font (4K), and scratchpad (2K) memory. A very attractive optional feature is an IBM-compatible coprocessor/bus. In addition to being CP/M compatible, the system can run (but not be used to write) compiled p-code programs. Other features include: 4-MHz Z80A microprocessor; serial communications controller; parallel and DMA ports; 69-key detachable keyboard with separate numeric keypad (all keys soft configurable); two 128-character sets; video brightness and contrast controls. Supplied at no additional cost are CP/M, MBASIC, C BASIC, Wordstar, and Supercalc. Options available for the Executive include a compact modem that fits into the computer's disk storage slot and a high-resolution graphics board. The keyboard assembly snaps to the front panel and becomes the bottom of the computer's case during storage and transport. Size is 20.5" × 13" × 9", and weight is 28 lb. Price is about $2495 ($3195 with IBM coprocessor/bus).

Circle No. 93 on Free Information Card

LES SOLOMON ON COMPUTER HARDWARE

Talking About Standards

IN THE beginning there was Ed Roberts, the PE-8 computer, and a company called MITS in Albuquerque, NM. The PE-8 was renamed "Altair" and the 100-pin bus structure it used became the Altair bus. An article about it was published in our January 1975 issue. Soon after, entrepeneurs jumped on the bandwagon. The Altair bus was appropriated and soon was called the "Altair/Imsai" bus. (Imsai began marketing a similar type of computer a while later.) As more manufacturers joined the parade, the bus became known as the "Altair/Imsai/Processor Technology/Whatever" bus, a name far too unwieldy to use.

It was at the first Atlantic City Computer Show in 1976 that Roger Melen of Cromemco came up with the name "the Standard-100." Some liked the name, some didn't. Some suggested as an alternative the name "Roberts Bus," after its original designer. In any case, references to the Standard-100 were shortened to S-100 and the name stuck. Thus a new add-on industry was spawned.

Soon, however, the importance of the S-100 became undermined. Not all 100 pins were used in the original bus, and some manufacturers used the extra ones for their "private" signals—ones that would work only with their computers and boards. It quickly got to the point where very few so-called "S-100" boards would work with very few so-called "S-100" computers. For a few years, intermixing S-100 boards and machines became an adventure in frustration.

In 1979, to clean up this mess, several manufacturers got together to try to develop a real S-100 standard spurred by an S-100 standards proposal by Ithaca Audio. After $4^1/_2$ years of meetings, arguments, and minor hassles, the IEEE finally gave it its blessing and the IEEE-696 (S-100) bus standard was born.

The major changes included 16-bit devices on the bus (the original S-100 was designed to accommodate the 8-bit 8080) and clearing up any ambiguities still attached to the S-100 after it was

IEEE-696 BUS LAYOUT

Pin			Pin		
1	+8 Volts (B)		51	+8 Volts (B)	
2	+16 Volts (B)		52	−16 Volts (B)	
3	XRDY (S)	H	53	0 volts	
4	VI0* (S)	L	54	SLAV CLR* (B)	L
5	VI1* (S)	L	55	TMA0* (M)	L
6	VI2* (S)	L	56	TMA1* (M)	L
7	VI3* (S)	L	57	TMA2* (M)	L
8	VI4* (S)	L	58	sXTRQ* (M)	L
9	VI5* (S)	L	59	A19	H
10	VI6* (S)	L	60	SIXTN* (S)	L
11	VI7* (S)	L	61	A20 (M)	H
12	NMI* (S)	L	62	A21 (M)	H
13	PWRFAIL* (B)	L	63	A22 (M)	H
14	TMA3* (M)	L	64	A23 (M)	H
15	A18 (M)	H	65	NDEF	
16	A16 (M)	H	66	NDEF	
17	A17 (M)	H	67	PHANTOM* (M/S)	L
18	SDSB* (M)	L	68	MWRT (B)	H
19	CDSB* (M)	L	69	RFU	
20	0 volts		70	0 volts	
21	NDEF		71	RFU	
22	ADSB* (M)	L	72	RDY (S)	H
23	DODSB* (M)	L	73	INT* (S)	L
24	ϕ (B)	H	74	HOLD* (M)	L
25	pSTVAL* (M)	L	75	RESET* (B)	L
26	pHLDA (M)	H	76	pSYNC (M)	H
27	RFU		77	pWR* (M)	L
28	RFU		78	pDBIN (M)	H
29	A5 (M)	H	79	A0 (M)	H
30	A4 (M)	H	80	A1 (M)	H
31	A3 (M)	H	81	A2 (M)	H
32	A15 (M)	H	82	A6 (M)	H
33	A12 (M)	H	83	A7 (M)	H
34	A9 (M)	H	84	A8 (M)	H
35	DO1 (M)/ED1 (M/S)	H	85	A13 (M)	H
36	DO0 (M)/ED0 (M/S)	H	86	A14 (M)	H
37	A10 (M)	H	87	A11 (M)	H
38	DO4 (M)/ED4 (M/S)	H	88	DO2 (M)/ED2 (M/S)	H
39	DO5 (M)/ED5 (M/S)	H	89	DO3 (M)/ED3 (M/S)	H
40	DO6 (M)/ED6 (M/S)	H	90	DO7 (M)/ED7 (M/S)	H
41	DI2 (S)/OD2 (M/S)	H	91	DI4 (S)/OD4 (M/S)	H
42	DI3 (S)/OD3 (M/S)	H	92	DI5 (S)/OD5 (M/S)	H
43	DI7 (S)/OD7 (M/S)	H	93	DI6 (S)/OD6 (M/S)	H
44	sM1 (M)	H	94	DI1 (S)/OD1 (M/S)	H
45	sOUT (M)	H	95	DIO (S)/OD1 (M/S)	H
46	sINP (M)	H	96	sINTA (M)	H
47	sMEMR (M)	H	97	sWO* (M)	L
48	sHLTA (M)	H	98	ERROR* (S)	L
49	CLOCK (B)		99	POC* (B)	L
50	0 volts		100	0 volts	

used as a sort of standard for the preceding years.

Although the original S-100 "standard" gave some thought to 16-bit CPUs (and, in fact, called the data lines DATA 0 -DATA 16) a problem was created because some 16-bit microprocessor manufacturers wanted to transfer the high byte on the lower half of the data bus, while others wanted to do just the opposite.

The IEEE-696 solved this by considering the data bits as two bytes—one odd and the other even. These are now called OD7-0 (OD for Odd Data) and ED7-0 (Even Data), thus replacing the older designations. The "rule" is: byte data written or read with A0 = 1 appears on the OD7-0 lines during a 16-bit transfer, while byte data written or read with A0 = 0 appears on the ED7-0 lines during a 16-bit transfer. All you have to remember is that any address where A0 = 1 is odd, and any address where A0 = 0 is even.

Generally, 16-bit processors do not produce address line A0. This is because these processors have a basic data path of two bytes. If 0 is the lowest address, then the next word address must be 2, the next 4, etc. Since only odd addresses could use A0 explicitly, it can be eliminated. The fact the address line is missing does little harm since all processors capable of byte addressing provide some means of generating a "fake" address, A0. For example, the MC68000 uses its UDS and LDS lines for this operation. Address A0 is user definable as even or odd for maximum flexibility to allow older "S-100" I/O and memory boards to work.

The PHANTOM line (pin 67) is used to remove a slave from the system address space, and is considered part of the address bus. This signal allows "shadow" ROM to exist and overlay a portion of memory. When the PHANTOM operates (strikes?) the shadow ROM "disappears" from the system. This allows a bootstrap ROM on power up to disappear when the system is running.

The IEEE-696 data bus includes the original S-100 data in/out unidirectional 8-bit data buses, but allows them to be combined into a single bidirectional 16-bit bus.

One other change was the re-naming of DMA (Direct Memory Access) to TMA (Temporary Master Access). When a temporary master is accessing the bus, it may execute either a memory or an I/O cycle. The term DMA implies a memory access only, while the term TMA does not imply any particular cycle, thus more realistically describing this signal.

Two new terms have been added to the S-100 bus. These are NDEF for "Not Defined" (the manufacturer must specify any use in detail), which appear at pins 21, 65, and 66; and RFU for "Reserved for Future Use" that appears at pins 27,28,69, and 71.

The IEEE-696 bus is organized into eight sets of signal lines, one set of power lines, and is shown in the accompanying Table.

The signal lines are formed from 16 lines that make up the data bus, 16, or 24 lines forming the address bus, eight lines in the status bus, five in the control output bus, six for the control input bus, eight for TMA, eight for vectored interrupt, 16 utility signals, and nine for the power bus.

The mnemonics for status lines are preceded by a lower-case "s," while the mnemonics for the control output lines are preceded by a lower-case "p." The suffix asterisk "*" expresses the relationship between the truth state and the electrical state. That is, the variable so indicated is true when its bus line is low. (Note that the vinculum—a bar over a name indicating active low—is not used.) The M or S refer to Master or Slave operation.

Other Standards. There are several other places where standards are needed. In a classical example of serendipity, the lack of standards in the printer industry produced the parallel printer port we call "Centronics." It looks like we lucked into a good thing here. Since it is so widely accepted, why is it not a standard?

Now let us take a look at the pin designations on a typical DB-25 connector. Why do some companies put "private" signals on this connector? Should we not conceive a DB-25 connector standard before the European community takes over with their DIN plugs? Take a close look at many new systems for the appearance of this round connector.

Let us look at floppy disks. Once you leave the security of the IBM format for 8" drives, you are in a wilderness. In the 8" disk business alone, there are five different sizes and 21 different interfaces. Some diskettes differ not only in their overall diameter, but also in the size of their center holes. The 5¼" diskette is burdened with hard and soft sectoring, with the latter offering the choice of 10 or 16 holes (even this is not true since there is an extra index hole). In fact, just buying a package of 5¼" diskettes can be exciting, especially if you have to make a long trip back to the dealer. Also, I don't think many of us really know if there is a standard for single/double/quad-density diskettes without even worrying about single- or double-sided. I am afraid to ask.

Another place where a problem has loomed is in terminals. Why is it when we change terminals from, say, a DEC or Health/Zenith to, for example, a Hazeltine-1500 (Hazeltine has announced it is going out of the terminal business by the way), the software won't work properly? Is this because the bulk of software is written not only for a particular operating system and computer, but also for a particular terminal? There is a standard for terminals (ANSI 3.64), so why do we have a battle between those using this standard and those that abide with ASCII?

Software has "standards" problems, too. For instance, how many BASICs do you know of that can actually communicate with another BASIC? How many books have been written explaining how each version of BASIC works? And why do we have to have BASIC-to-BASIC translation manuals?

Even our schematics need clarification. Back in 1973 (remember that microcomputers didn't come along until 1975), there was ANSI Standard Y32.14 that spelled out how logic symbols should be used. But, outside of HP and TI, who else uses or has even heard of this standard? If it exists, and it is a standard, then why don't we use it?

However, there are some gleams of light down the tunnel. Seagate Technology (it pioneered the 5¼" hard disk) very quickly established a de-facto standard for this storage approach. The Network Users Associaton is pushing for standards to make sure that equipment from different manufacturers interface properly over a communications link. The IEEE is currently working toward creation of guidelines for software standards, while half-inch tape systems are the bailiwick of the California Tape Standards Association.

I've posed a number of questions here. Calling several industry people looking for some answers or even good suggestions, I gleaned very little in the way of answers. Most responses were similar: "We've always done it that way with no complaints." "Our customers are happy so why should we change?" "Ask our competition why they do it their way." And so it went.

The importance of standards cannot be underestimated. They make possible easy implementation, which results in faster growth and lower costs. For its own good, therefore, the microcomputer industry should develop as many as possible with dispatch. ◇

STAN VEIT ON COMPUTER SOFTWARE

The Battle of the Disk Operating Systems

PART of the 16-bit war now raging between the Intel 8086/8088 family and the Motorola 68000 family is the Battle of The Disk Operating Systems. The principal contenders in this battle are Unix (product of AT&T) and its licensees and Digital Research Inc. (owners of CP/M.) Also in contention are such operating systems as the UCSD P-system, Oasis, TSC's Uniflex, Cromix 68000, OS-16, Alpha Micro's AMOS, ISIS-II, VersaDOS, Idris, and some others that are essentially one-computer operating systems from Apple and other manufacturers.

The order of battle shifts as companies hedge their entries and try to guess which side will win the war. At this time the lineup is as follows.

For Motorola M68000:

VersaDOS—Motorola
Unix—AT&T and its licensees
CP/M-68000—Digital Research Inc.
AMOS 68000—Alpha Micro
Chromix 68000—Cromenco
Uniflex 68—TSC
Idris—Whitesmiths
UCSD P-system—Softtech Microsystems (licensee of Regents of UCSD)
Oasis—Phase One Systems
Xenix—Microsoft

For Intel 8086/8088 iAPX-86:

MS DOS (PC-DOS)—Microsoft
CP/M-86—Digital Research Inc.
MP/M-86—Digital Research Inc.
UCSD P-system—Softech Microsystems (licensee of Regents of UCSD.)
Oasis-16—Phase One Systems

There are also operating systems for other 16-bit CPUs, such as the Z8000, the DEC LSI11, the National 16032 and the Data General MicroNova. However, these are not in universal contention for the role of leading DOS.

From time to time I'll be writing about one or the other of the operating systems and its supporting application software. This month I'm focusing on a system that has become the object of a cult among those in the know—the Alpha Micro's 68000-based AM1000.

Alpha Micro Systems developed one of the first 16-bit, multi-user, multi-tasking systems. It was the very first one to run on the S-100 bus. It used the WD 16-Chip Set from Western Digital and was known as the AM-100 Computer System. What made the AM-100 multi-user, time-sharing system such a success was the AMOS operating system and Alpha BASIC.

This system—developed in 1976 by Dick Wilcox, one of the founders of Alpha Micro—was modeled after DEC software, but ran on the S-100 bus and supported multi-users on a time-shared basis. It never became as popular as CP/M, but it did attract a large following of devoted users and the support of considerable applications software.

As single-chip 16-bit CPUs were developed such as the 8086(8088), M68000, and Z8000, the people at Alpha Micro Systems realized that the slower multi-chip WD-16 Chip Set was outmoded by the new generation of CPUs. In order to compete, they developed a new system based upon the M68000. There are two versions of this system: the AM-100L, which is a 68000-based system in the S-100 Bus, and the AM-1000, an M68000 single-board computer with 128K of RAM (expandable to 265K) and several I/O ports. This computer comes in several versions, which include a 10-megabyte (or larger) Winchester hard disk. The system has both floppy disk and video cassette back-up support.

The AMOS multi-user, multi-tasking, time-sharing system and the excellent Alpha BASIC have been adapted for the M68000. Many who have used this system say that it is superior to either Unix or Concurrent CP/M-86 for multi-user, multi-tasking 16-bit systems. Reportedly, Alpha Micro Inc. of Irvine, CA is quietly selling 300 AM-1000 Systems per month at $7800 (retail) and up.

The Alpha BASIC is included, as is View (Word Processing and Formatter), Macro Assembler and Linker, and Debug. Pascal is also available from Alpha Micro and C; Cobol and two kinds of FORTRAN can be purchased from other vendors.

Third-party application software support for the Alpha Micro AM-1000, 68000 System exceeds that for any other 68000 system. Dravac Ltd has adapted its ANDI Data Base Version #1L for the M68000 and also its TSASS (Time Shared Accounting Security System). Alpha Micro has made the famous MCBA Business Software available for its equipment, and there is also the QikCalc, QikFile and QikStat software from Pony Express Software. Softworks Inc. is providing its C language and FORTRAN for the AM-1000. As frosting on the cake, there is a very active User's Group called AMUS, which maintains an extensive public domain software library and a newsletter to keep users up to date on new software.

In all, the Alpha Micro AMOS system is the best-supported M68000 system now in use. Though it is certain that other systems will catch up and perhaps surpass it because it only operates on one computer, right now Alpha Micro is No. 1 in M68000 software.

Xenix on Mod 16. Radio Shack has implemented Xenix on the Model 16, M68000 system with 256K of memory and a hard disk. The system will support up to three users simultaneously. I saw the system running and was very impressed. It provides application support in the form of interactive accounting software and the Multiplan spreadsheet from Microsoft. The Xenix is a Unix operating system licensed from AT&T and its implementation on the Model 16 multiuser system makes Radio Shack one of the first microcomputer manufacturers to implement a full Xenix system on a micro.

In looking at the Shell (the part of the Unix system that interacts with the user), I saw that Radio Shack has taken great pains to make this new system look like the TRSDOS that is familiar to Radio Shack users. While this may not make for the most efficient Shell, it makes the system more "user friendly"and compatible with the way people have been used to seeing things. To my mind, the only way the Unix systems will appeal to most people is by using simple, clear Shells that don't require users to learn unfamiliar commands and expressions.

So far, only multiuser Xenix has been introduced. Single-user Xenix will come later as well as a Xenix development system featuring a C compiler and a version of Microsoft BASIC for the 68000 CPU. The BASIC will become the standard on the Model 16 when using the 68000 processor. ◇

SANSUI MODEL Z-5000 FM/AM Stereo 70-W/Ch RECEIVER

THE Sansui Z-5000 AM/FM stereo receiver features a digital synthesis tuner and a built-in clock that can be programmed to switch the receiver on and off up to three predetermined times during the day. Its power amplifier uses Sansui's "Super-Feedforward" circuitry, a combination of negative feedback and feedforward techniques claimed to reduce distortion without the disadvantages of large amounts of overall negative feedback. The amplifier is rated to deliver 70 watts per channel to 8-ohm loads from 20 to 20,000 Hz with no more than 0.007% total harmonic distortion.

A sealed "heat pipe" conduction/convection cooling system removes heat efficiently from the output transistors without bulky and heavy external heat sinks. This contributes to making the Z-5000 unusually compact and light for a receiver of its power ratings. The receiver, with a satin-finish, silver-colored front panel, measures 17"W × 5¼"H × 14³⁄₁₆"D. Weight is 19 lb. Suggested retail price is $500.

General Description. The dominant feature of the front panel is a system status display containing a bright blue digital frequency/time readout, a five-light LED signal strength display, tuning lock and FM stereo indicators, and a numerical readout for the preset station selector (showing which of the 8 preset channels is being received).

On each side of the status panel are three clear plastic "keys," resembling the "piano key" operating controls used on some cassette decks. They operate with a very light touch and short movement, and exercise control through relays. Five of them are input-source selectors that also switch on the receiver. A red light next to each switch shows that it has been pressed. The sixth key (Stand-By) turns off the receiver, and the digital display then becomes a 24-hour clock readout. The volume control is a vertical slider, and knobs control tone and balance. The other basic receiver functions are performed with small pushbuttons.

Other buttons recall the clock display for a few seconds without interrupting the program, and ready the memory circuits for storing a tuner frequency. A group of 10 larger square buttons at the right of the panel are used to store and recall the 8 station memories (each can serve for both an FM and an AM frequency), and for setting the clock and timer. A switch below them controls the clock/timer operation, which can be set to turn the receiver on (and off) for up to three different programs. One is a one-time setting; the others repeat automatically every day if not shut off. The programmer also selects any of the program sources, and any of the preset channels if a tuner input is used, as well as controlling the receiver's three switched ac outlets.

Laboratory Measurements. Preconditioning the Sansui Z-5000 for one hour at one-third rated power caused the top of the cabinet, over the cooling fins, to become very hot. However, it never reached the point of thermal shutdown and did not become more than comfortably warm during later listening tests.

The output waveform clipped at 80 W per channel with both channels driving 8-ohm loads at 1000 Hz. The 4-ohm output was 54 W, but the receiver's current-limiting system kept the 2-ohm output to only 26 W. Using the Dynamic Power test signal, a 20-millisecond tone burst of 1000 Hz occurring twice per second, maximum output into 2 and 4 ohms was about the same as the continuous values, but the 8-ohm Dynamic Output increased to 90.4 W. The receiver's Clipping Headroom and Dynamic Headroom measurements (8 ohms) were 0.58 and 1.29 dB, respectively.

The 1000-Hz harmonic distortion was somewhat larger than the rated value at most power outputs, reducing from about 0.05% at 1 W to 0.009% at 30 W and 0.0074% at the rated 70 W. The distortion was slightly higher with the lower load impedances (for which the receiver is not rated). With 4-ohm loads, distortion was about 0.015 to 0.05% at most usable power levels, and with 2 ohms it was in the range of 0.03 to 0.05%. Obviously, although the receiver did not fully equal its distortion ratings, its distortion is entirely negligible and inaudible.

At the rated output into 8-ohm loads, distortion was between 0.007% and 0.016% from 20 to 20,000 Hz, and only slightly higher at reduced power outputs. A spectrum analysis of the output with the two-tone (18 and 19 kHz) input signal of the IHF-IM distortion test showed third-order products at 17 and 20 kHz to be about 83 dB below rated output. The second-order (difference tone) distortion at 1000 Hz was −84 dB.

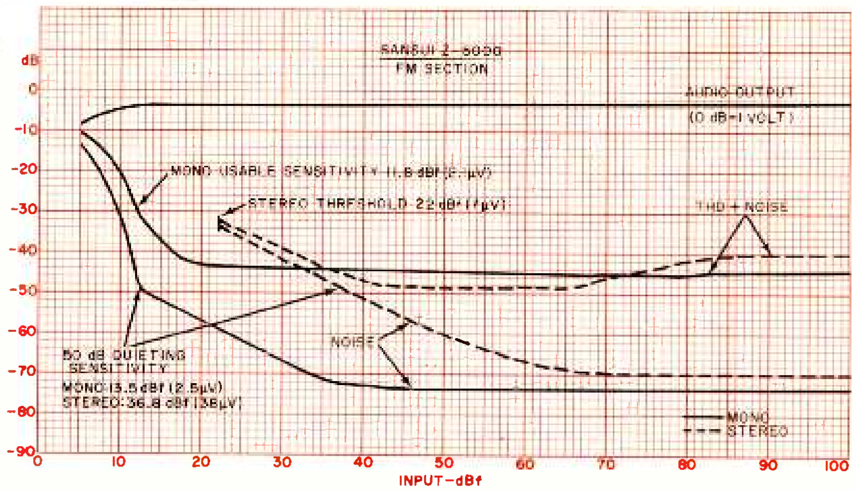
The amplifier was stable when driving reactive loads at high and low frequencies, and its Slew Factor was 11.5. (The internal protective relay disconnected outputs when we drove the Z-5000 with a full power input signal at 230 kHz.) At maximum volume setting, 17 mV at the AUX inputs drove the amplifier to a 1-W reference output, and the PHONO and MIC inputs required 0.27 mV and 20 μV, respectively. The A-weighted noise levels for these three inputs (referred to 1 W) were, respectively, −76.6 dB, −74.7 dB, and −61 dB. The phono preamplifier input overloaded at 74 to 80 mV for frequencies from 20 to 20,000 Hz.

Although these are not truly superb figures, there is little likelihood of the preamplifier being driven to distortion by any combination of record and cartridge. The phono input impedance was 50 kilohms in parallel with 225 picofarads, a moderately high capacitance that is nevertheless compatible with most cartridge requirements.

Tone controls of the Z-5000 had conventional properties, with the bass turnover frequency varying between approximately 100 and 400 Hz as the control was varied, and the family of treble curves being hinged at about 1500 Hz. The treble response was somewhat unusual in peaking at about 6000 Hz for both boost and cut, so that the effect on the response at 20,000 Hz was about the same as at 2000 Hz. The audio filters had gradual (6 dB per octave) slopes, with −3-dB frequencies of 50 and 6000 Hz. Loudness compensation was fairly typical in boosting both low and high frequencies as the volume was reduced, but departed from usual practice in having even more boost at the high end than in the bass.

The RIAA phono equalization was very accurate, within 0.5 dB overall from 20 to 20,000 Hz, and it was unaffected by cartridge inductance. We discovered a strange effect when measuring phono response (which we normally do at the tape recording outputs of an amplifier). The response was attenuated extremely sharply above 17,000 Hz, dropping at least 15 dB by 20,000 Hz. This effect did not occur at the speaker outputs, nor did it show up when any of the other program sources was measured at the tape output jacks. Nothing in the instruction manual refers to this characteristic, which will probably never be heard by most listeners because of its frequency range. The microphone input frequency response was essentially flat from 1000 to 5000 Hz, falling to −6 dB at 150 and 17,000 Hz.

The FM tuner of the Sansui Z-5000 had an IHF Usable Sensitivity (mono) of 11.8 dBf, or 2.1 µV. The muting and stereo threshold was 22 dBf (7µV), and the respective 50-dB Quieting Sensitivities for mono and stereo were 13.5 dBf (2.5 µV) and 36.8 dBf (38 µV). At 65 dBf (1000 µV) the distortion was 0.45% in mono and 0.34% in stereo, and the respective noise levels were −75 and −70.5 dB. Since the tuner of the Z-5000 is synthesized, and its LOCKED light comes on only when the signal is at the exact tuning point of the receiver, we made all our measurements with the light on. A slight detuning cut the distortion—largely second harmonic—in half, but that option is not available to the user.

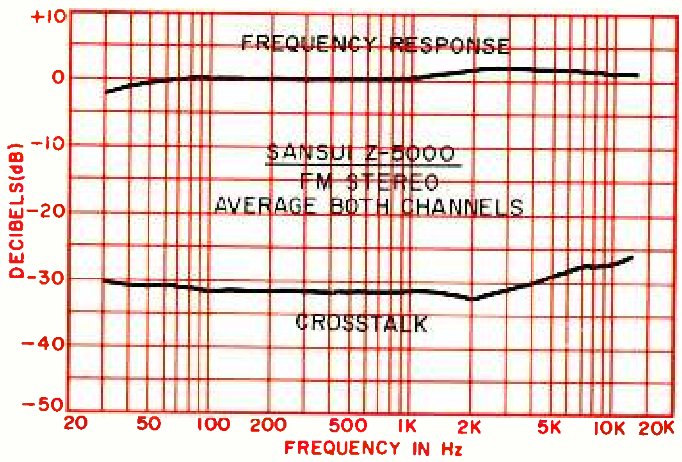


Noise and harmonic distortion for mono and stereo of FM section.

The tuner frequency response was flat within ±1.5 dB from 30 to 15,000 Hz. The FM stereo channel separation was unusually uniform, measuring 30 ±1.5 dB from 30 to 7000 Hz, and still 26 dB at 15,000 Hz. Although this is not a particularly large separation, it is at least as much as the broadcast program is likely to contain. It is arguable that an acceptable and constant channel separation across the audio range is preferable to one that is very great in a narrow range of frequencies, but deteriorates to much smaller values elsewhere.

The FM capture ratio was 1.76 dB at 45 dBf (100 µV) input, and the AM rejection was 51 dB. Image rejection was only 40 dB. This is a rather low figure, but probably adequate for anyone who does not live along a flight path to and from a major airport. Alternate channel selectivity was a good 70 dB, and adjacent channel selectivity was 7.3 dB. The 19-kHz pilot carrier leakage into the audio was −37 dB, an excessive level for cassette recording with Dolby noise reduction unless the recorder has an MPX filter in its input (most do). The tuner power-line hum was −68.5 dB. The AM tuner frequency response was down 6 dB at 30 and 2800 Hz.

The tuner signal strength indicator lights came on at such close intervals that they were completely useless for their intended function. The first light came on at 6.7 µV, and the second at 7 µV! Even the fifth (and highest) light came on at only 27 µV. In other words, every signal capable of being heard reasonably well will light all the LEDs.



Frequency response and crosstalk, average of both channels.

User Comment. The Sansui Z-5000 aroused a very mixed reaction in us. It is refreshingly different in styling from previous receivers seen, from Sansui or any other manufacturer. It is easy to use, highly functional, and sounds fine. The timer-controlled switching system was very simple to set up, and worked flawlessly. In fact, if our judgment of the receiver were tó be based only on subjective use tests, it would earn very high marks in every respect, though it failed to meet some of its detailed performance specifications. However, we cannot fault the unit for not meeting some of our own performance criteria (such as an ability to drive low load impedances to a reasonable power output) since no such claims are made for it.

In sum, the Sansui Z-5000 is a receiver that we (and most people) would likely enjoy for its many positive qualities. If our expectations had not been raised by its impressive specifications, we would have been willing to accept some shortcomings without question in this very handsome and utilitarian package. —*Julian D. Hirsch*

CIRCLE NO. 101 ON FREE INFORMATION CARD

COMPONENT COLOR TV FROM SEARS, ROEBUCK and Co.

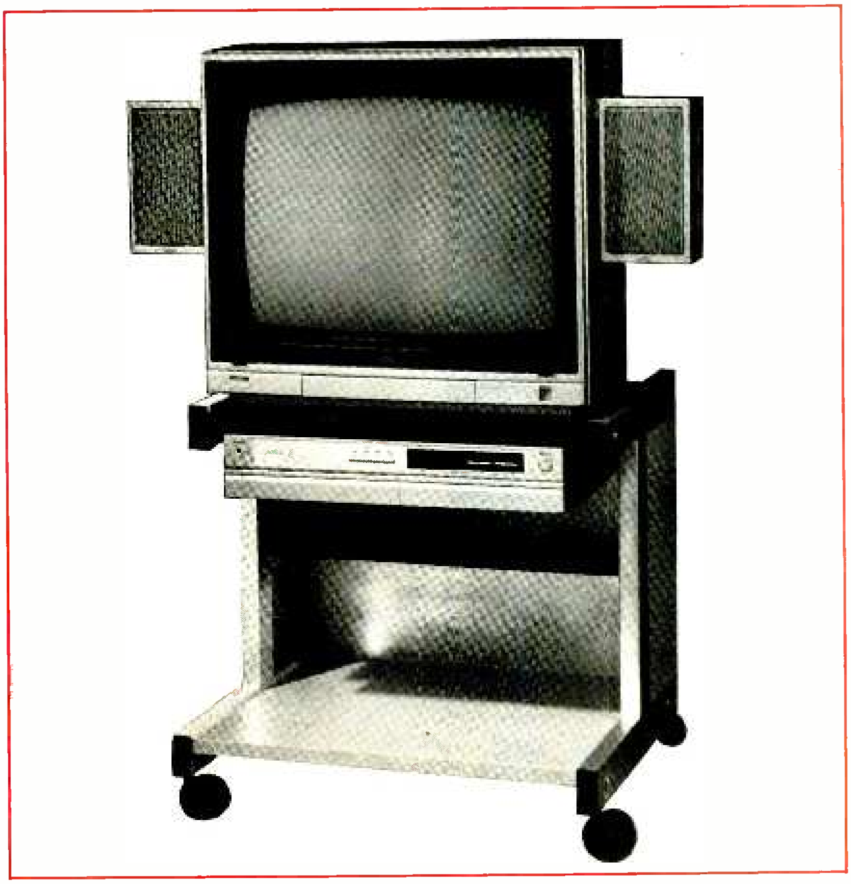
THE Sears entry into the growing list of component TV systems consists of a 19" monitor, two speakers, and a 105-channel tuner with IR remote control, called System 1. In comparing the features and performance of the Sears Model 564.42810250 monitor and Model 564.42840250 tuner with the Sony and Teknika systems evaluated in earlier issues, we found a great deal of similarity as well as a number of significant differences. Sears offers the entire system, including two speakers, for a suggested retail price of $999.95, as compared to $1450 for an equivalent Sony and $1200 for the Teknika system. The Sony and Teknika systems have a number of equipment and performance features not available in the Sears equipment; but when these features are not important, the lower price is certainly an important factor.

Sears offers its components only as a complete package. If you already own a VCR and want to use the VCR's tuner for TV reception, or if you want to add a color TV display to your home computer, you really only need a monitor. Sears, however, apparently intends its component TV system to be used only as the center of a complete entertainment system. This is confirmed by the fact that the TV monitor has only one video/audio set of input terminals and no video output. The tuner, however, contains a set of TV OUTPUT jacks for video and TV audio, a set of MONITOR OUTPUT jacks for video, two (left/right) AUDIO OUTPUTS, and three sets of AUDIO/VIDEO input jacks, each including two audio inputs. A single, 4-ft cable is provided for connecting the tuner to the monitor. These features favor an arrangement in which the tuner and the monitor are located near each other, as indicated in the photo, which also shows an optional ($69.95) stand.

General Description. The tuner front panel contains four program source selection keys, with a green LED above each, for either TV, A/V I, (Audio/Video), A/V II or A/V III, UP/DOWN channel scanning keys, volume UP/DOWN keys, and a power key. All pushbuttons or keys on the Sears system are feather-touch types. A phone jack, IR sensor, and channel number display are also on the front panel. Under a separate compartment door are keys to select mono or stereo on each of the three A/V inputs, a key to select TV or cable, two keys for fine tuning the vhf/uhf tuner (UP/DOWN), and a key to activate the Sears pseudo-stereo sound expander circuit for TV audio. In addition, there are potentiometer controls for bass, treble, balance, and headphone jack output level. At the rear of the tuner are a total of 14 RCA-type jacks for all of the video and audio inputs and outputs, the 300-ohm vhf and uhf antenna terminals, and a coaxial connector for 75-ohm input. There is also an ac outlet controlled by the tuner power switch and one that is not controlled. All of these features fit into a compact 3½"H × 17½"W × 13¾"D cabinet that weighs 12 lb.

Like most recent electronic tuning systems, the Sears tuner uses a microprocessor IC to handle remote-control commands and the frequency-synthesizer-controlled tuner. In addition to the 82 vhf/uhf channels, the tuner also covers 23 cable channels which are converted into uhf channels 14 through 36 when the TV/CABLE control on the front panel is set for CABLE giving it 105-channel capability. A dot at the upper-right corner of the channel display indicates to the viewer that he is now on cable. Sears provides a conversion table that the viewer is advised to stick to the back of the hand-held remote control.

The vhf/uhf tuner is varactor tuned and includes a uhf r-f amplifier stage for low-noise uhf reception. As in most good-quality TV systems, there is a SAW filter, followed by the i-f IC which also contains the noise limiting,

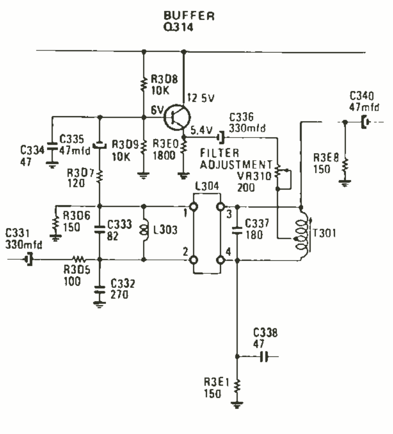


automatic gain control (agc), detection, and video preamp circuits. A video output amplifier and two buffer stages bring the video signal to the TV video terminal.

A conventional sound i-f IC amplifies and detects the TV audio and passes it on to the audio selector IC. One of the novel features of the Sears tuner is the use of analog switch ICs for both audio and video selection. Three different ICs are used in the tuner, including one that contains a 4-position, double-pole selector switch. Other manufacturers typically use transistor or IC amplifiers gated by the switching signal, but analog switches generally provide less distortion and almost no bandwidth limiting of the switched signal. Sears also includes a sound expander circuit to provide "expanded" or enhanced audio for the TV sound. This circuit uses a special "bucket brigade delay" (also known as charge-coupled device or CCD) IC which contains a 24-kHz clock. A total of four op-amp ICs, three transistors, and two RC filters complete the sound expander circuit.

Although the Sears tuner uses a power transformer that isolates the chassis and cabinet from the ac power line, the manufacturer's service notes recommend a leakage test. All initial dc voltages are well filtered and regulated.

The handheld IR remote control unit contains ten numbered keys for direct channel selection and one for the timer. In the Sears tuner, the timer function is limited to programming either a 30, 60 or 90 minute automatic turn-off time, programmed by pressing the TIMER key once, twice, or three times. When this key is activated, the time will be displayed on the channel display, with a dot in the upper-left corner indicating timing; the remaining minutes are counted down. Whenever other keys on the remote control unit are depressed, the channel number is displayed for five seconds whereupon time is shown again. The remote-control unit also contains keys for UP/DOWN channel scanning, UP/DOWN volume control, a MUTE key to cut off sound, and the power key.



Schematic of the comb filter section of the tuner.

The Sears 19" TV monitor is relatively compact at 18¾"H × 19¾"W × 19"D, and weighs only 44 lb. As on many recent TV models, the front safety glass can be removed by two thumb screws; and, except for the power switch, all other controls are located under a hinged door at the bottom of the set. Color, tint, contrast, brightness, sharpness, and volume are the conventional controls, but the vertical-hold control is not usually provided (or needed) in the most recent, high-performance TV receivers or monitors. There is a small connection panel at the rear for the video and two (left/right) audio inputs. The four speaker connections are also on this panel. At each side of the cabinet there is a recess where the speaker brackets can be attached.

While ac leakage testing is recommended, only the power input circuit is "hot" and it is insulated from the chassis. A switched type of power supply is used to provide ac isolation for the chassis ground and the cabinet. All dc power is provided from the switched supply and none from the flyback—a feature that is different from both Sony and Teknika. Other circuit differences occur in the horizontal and vertical sync circuits, which use an old-style sync separator and individual oscillators. For this reason, a user-operated vertical-hold control and internal horizontal-hold and vertical-size controls are needed. Both vertical and horizontal centering are adjustable by moving pin contacts to different points on the pc board.

A novel type of comb filter separates the color (chrominance) signal from the brightness (luminance) signal. Instead of a CCD (charge coupled device) IC, the Sears monitor uses a special glass delay element in combination with an adjustable tuned circuit to provide the comb filter effect. Judging by the color picture quality, this circuit works quite well.

Though there is no auto/manual switch for the color controls, the chroma processor IC provides automatic color control functions equivalent to those found in the Sony and Teknika monitors and in most recent color sets. The RGB driver transistors mounted on

a pc board at the CRT socket, the flyback and the high-voltage section are also very similar to previously described circuits.

Separate audio amplifiers, with a maximum output of five watts each, are located on the audio pc board. The volume control on the monitor is separate from the volume control system in the tuner, and it is possible to set either to maximum and the other to minimum. (There is a note in the monitor's operator's instructions to leave the volume control at maximum when the tuner is used, but how often do we read the instructions?)

Each of the two speaker assemblies included in the system contains 2 speakers: one 3⅝" in diameter; the other 1½" in diameter. The enclosures are magnetically shielded.

Laboratory Measurements. Clearly, the Sears tuner will perform well even in deep fringe areas since it has excellent sensitivity and noise characteristics, as indicated in the table of test results. In this respect the Sears tuner is definitely the equivalent of the Sony Profeel system and other high-performance TV receivers.

The video (luminance) bandwidth measurements show some 100-kHz loss when the signal passes through the tuner. This is apparent from the scope picture in Fig. 1, which shows the color-bar signal at the input and output of the tuner. Its 3.8-MHz video bandwidth is very respectable.

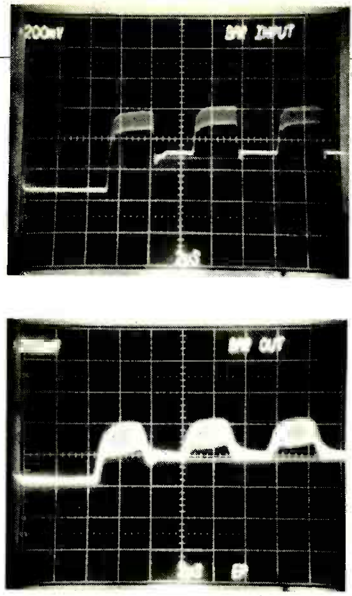


Fig. 1. Scope photos of tuner input (top) and output.

When a frequency synthesizer is used in the tuner, the r-f oscillator stability is excellent. The Sears tuner is no exception. The agc dynamic range is typical for high-performance sets, as is the dc restoration. Horizontal and vertical linearity were perfect except for a slight expansion at the very top of the screen; this was invisible on a picture, but could be measured with a grid pattern. Convergence, however, was off at the upper right and lower left of the screen, but this could not be seen on a color picture. The remaining measurements are all equivalent to the other component TV systems we have seen.

TEST MEASUREMENTS

SEARS MODEL 564 MONITOR AND TUNER

Parameter	Measurement
Sensitivity, vhf (Ch. 3):	−57 dBm
Sensitivity, uhf (Ch. 20):	−55 dBm
Noise figure, vhf (Ch. 3):	7 dB
Noise figure, uhf (Ch. 20):	11 dB
Video bandwidth to CRT (−6 dB)	3.80 MHz 3.90 MHz (monitor only)
R-f osc. stability (Ch 3):	0.05 MHz
(105 to 130 V ac, 2 hr.) (Ch.20)	0.05 MHz
Agc dynamic range:	65 dB
Dc restoration:	100%
Horizontal linearity:	100% left, 100% right
Vertical linearity:	95% top, 100% bottom
Convergence:	90% at worst area (upper right & lower left)
Audio frequency response:	100 to 16,000 Hz
Speaker impedance:	8 ohms
Dc regulation, B+: (105 to 130 V ac)	95%
High-voltage regulation: (105 to 130 V ac)	95%
Power ratings:	18 W, tuner 60 W, monitor

User Comments. The Sears System 1 performs very well, but some important features found in other systems are lacking. For one, there is no video/audio output jack on the monitor and only a single such output on the tuner in addition to the TV video/audio output. Therefore, when the tuner is connected to the monitor only one other accessory, such as a VCR or a second monitor, can be connected. Another feature found in comparable systems is a fully automatic vertical sync, while the Sears monitor requires manual vertical-hold adjustment. Also, there is no provision in the Sears monitor to accept nonstandard horizontal and vertical sync, which can come from some TV games and personal computers. While the fine-tuning control on the tuner can accommodate TV channel signals from such inaccurate sources as TV games or personal computers, the use of an up-and-down key requires some skill and judgment. In such a case, a manual fine-tuning control might be preferable.

The timer feature provided through the remote control is limited to 30, 60 or 90 minutes, which is not very handy if you know that a program has 45 minutes to run and you want to time the set to turn off when the program is over.

The Sears tuner does not include a programming feature to limit scanning only to desired channels. Its scanning feature will step through unused channels one-at-a-time and stop at the next channel that can be received, even if it is a scrambled pay-TV channel or if reception is poor. In this respect the tuner and its remote control is more limited than any of the other systems reviewed.

On the positive side we found the Sears to be a well-performing, high-quality set. In combination with the sound expander circuit and the bass and treble controls located in the tuner, we were able to obtain TV audio that sounded definitely superior to the audio normally available on a TV receiver (though no actual measurements were made on the speakers).

A comparison of picture quality with a studio-type monitor proved the Sears monitor to be excellent in terms of color fidelity. Colors of studio test pictures were accurate and landscapes also were reproduced in very natural colors. Our group of studio technicians rated the Sears color quality equivalent to that of the Sony Profeel and the RCA model VGM 2023S, the best they had seen in consumer video monitors. The price of $999.95 also makes the Sears component TV system very attractive, especially if TV reception is the buyer's primary interest. —*Walter H. Buchsbaum*

CIRCLE NO. 102 ON FREE INFORMATION CARD

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8-bit: 8085

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

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

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

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

DIAGNOSTICS:
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AVAILABLE SOFTWARE:
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*128K bytes standard.
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CIRCLE NO. 24 ON FREE INFORMATION CARD

Hands-on Reviews of the Latest Computer Game Software

MOONBASE IO

Diskette and cassette tape for Atari 400/800/1200
Program Design, Inc., 11 Idar Ct., Greenwich, CT 06830, 203-661-8799. $29.95.
Graphics ★★★★
Gameplay ★★★
Sustained Interest ★★★
Type: *Joystick action game.*
Memory Required: *16K for cassette or 32K for diskette*

This game has several unusual features. True. it's a joystick action type of game, but the background scenario is complex and is prepared with a companion audio cassette that contains an excellent soundtrack played through a TV set's speaker. The cassette also contains a control track that starts and stops the program sequences in the diskette program.

The premise of the piece is that Earth has artificial satellite stations circling three of Jupiter's moons—Io, Ganymede and Europa. There are evil alien invaders (naturally), who are trying to wrest control of these bases away from us lowly and impotent Earthlings.

First, as the newly arrived astronaut-protector of Earth's moonbases, you must successfully pilot your spaceship through densely packed minefields surrounding Io, your first moon. You shoot out mines that are blocking your way, but timing is crucial, since touching a mine destroys your ship and ends the game. You can also fly too close to the moon's surface and crash. Once you've gotten past the minefield, you have to dock successfully at the satellite station—a tricky operation, but not all that difficult.

Next, you have to get ready to defend the moon's surface against a horde of enemy attackers. You are teleported to the moon where you play shoot-'em-up with some of the fastest-moving aliens we've seen in any game. Each wave you get through earns you a bonus ship, and you need a lot of these extra ships to survive this scenario. It's very fast-moving and especially challenging.

Next stop is Moonbase Europa, requiring safe passage through more minefields and a repeat scenario of defending the planetoid's surface against all those alien invaders. Throughout all of this, you get some innovative commentary from the cassette tape, including congratulatory messages from the "President" and frenzied pleas from Earth base for you to embark on the next mission, into more personal danger from mines and enemy firepower. It's just you against all those invaders, and if it's too nerve-wracking for you, then you might try a somewhat tamer game.

The one annoying feature of Moonbase Io is that each time the game ends (which happens frequently when you're a beginner), you have to listen to the whole scenario again—sound effects and radio message tracks from Earth base. Fortunately, PDI has provided us with an abbreviated version of this tape on cassette Side B. It's much shorter than the long-winded first introduction, but is still time-consuming.

SWORD OF FARGOAL

Cassette tape for Commodore VIC-20
Epyx (Automated Simulations, Inc.), 1043 Kies Ct., Sunnyvale, CA 94086, 408-745-0700. $29.95.
Graphics ★★★★
Gameplay ★★★★
Sustained Interest ★★★★
Type: *Joystick and keyboard adventure game.*
Memory Required: *16K expansion module.*

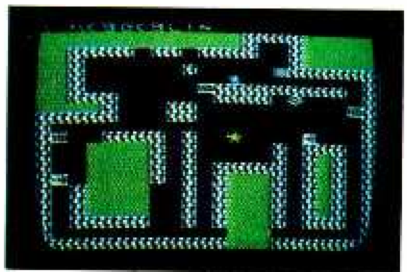
This is a game for the adventure lover extraordinaire because it ranks with the best of the breed. It also appeals to maze enthusiasts since it creates a maze-like pattern of dungeon rooms at random with each new game.

In addition, there are at least 20 levels of dungeons to explore and try to get through alive, and each of these has a totally different floor plan—different from your previous level and different from anything you may have seen before. Also randomly created are a number of evil monsters (or adversaries, if you prefer). They're evil because they attack you, the good guy, and try to kill you. Some of them even try to steal your treasures and your gold.

The baddies are too numerous to mention here, but there are both human- and non-human types. The humanoids are the worst because they're the cleverest and the hardest to kill. They're also the ones who will try to steal your goodies.

Among your treasures are healing potions, magic sacks (which let you lug more gold around), enchanted weapons and a bunch of spells: invisibility, regeneration, teleport, shield, drift and light. You can use these spells to get out of tight spots and beat the bad guys. You also collect an inordinate amount of gold, but can carry only 100 pieces of it at a time. Each magic sack that you acquire lets you carry an additional 100 pieces of gold.

Each level has one temple. When you enter the temple, you automatically make a sacrifice of all of your gold, and are rewarded with more experience



points and some more hit points (strength). You can heal and gain hit points much faster while you rest in the temple, and while there, you're invisible to all the bad guys waiting for you out there in the dungeon.

The object of the whole game is to retrieve the magic sword of Fargoal and to escape from the enchanted dungeons with it intact. None of us has gotten this far yet; it involves getting successfully through all nine dungeon levels, which is easier said than done.

Early versions of the game contain one program glitch, which prompts an error message. If you see this error message, all you have to do is type "GOTO 2" or "GOTO 3," and the game will proceed normally.

If you like adventure games and complex scenarios, and have an evening or two free to play this one, by all means get it. It's one of the best we've seen yet for *any* computer! ◇

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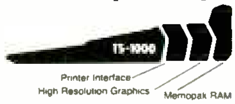

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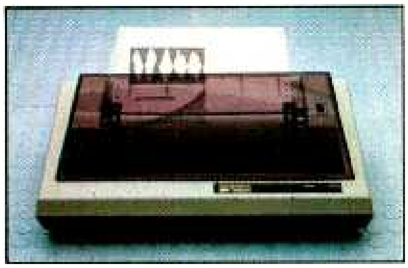

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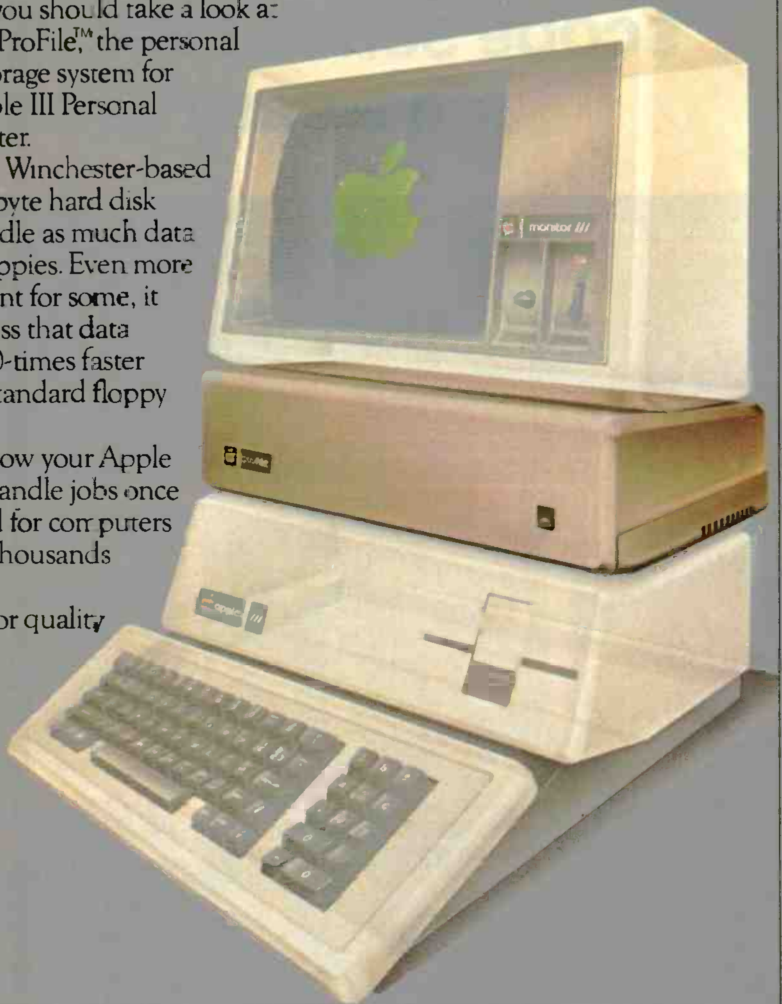

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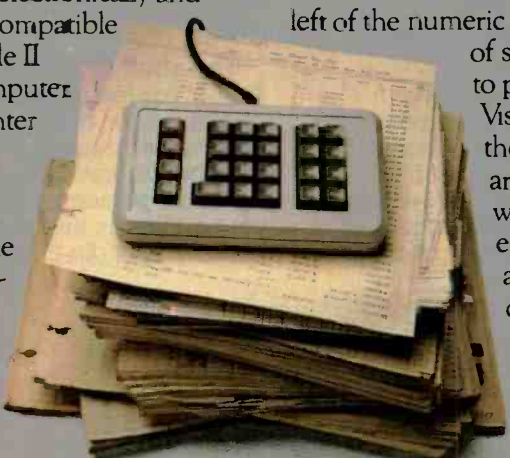

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The SOUL OF CP/M

This series of articles is condensed from a forthcoming book, Soul of CP/M, by Mitchell Waite and Robert Lafore*

CP/M (Control Program for Microcomputers, originated by Digital Research Corp.), a universal disk operating system that can be used with different-make computers that have a Z80, 8080 or 8085 microprocessor, is a boon to computerists. It manages the computer's use of applications programs available from a very large library of software packages, supports a host of high-level and assembly languages, and is modestly priced.

Most CP/M users, however, do not use the machine-independent system's full capabilities, limiting themselves to simply load, run, and perhaps disk copy operations. This, however, is only the tip of the iceberg. Underneath is enormous computing power that enables anyone to write custom I/O routines, add more power or speed to programs, handle disk records efficiently, and much more! *(Continued on p. 38)*

PART I

**To be published in 1983 by Howard W. Sams & Co., 4300 W. 62 St., Indianapolis, IN 46268. $18.95. Cat. No. 22030.*

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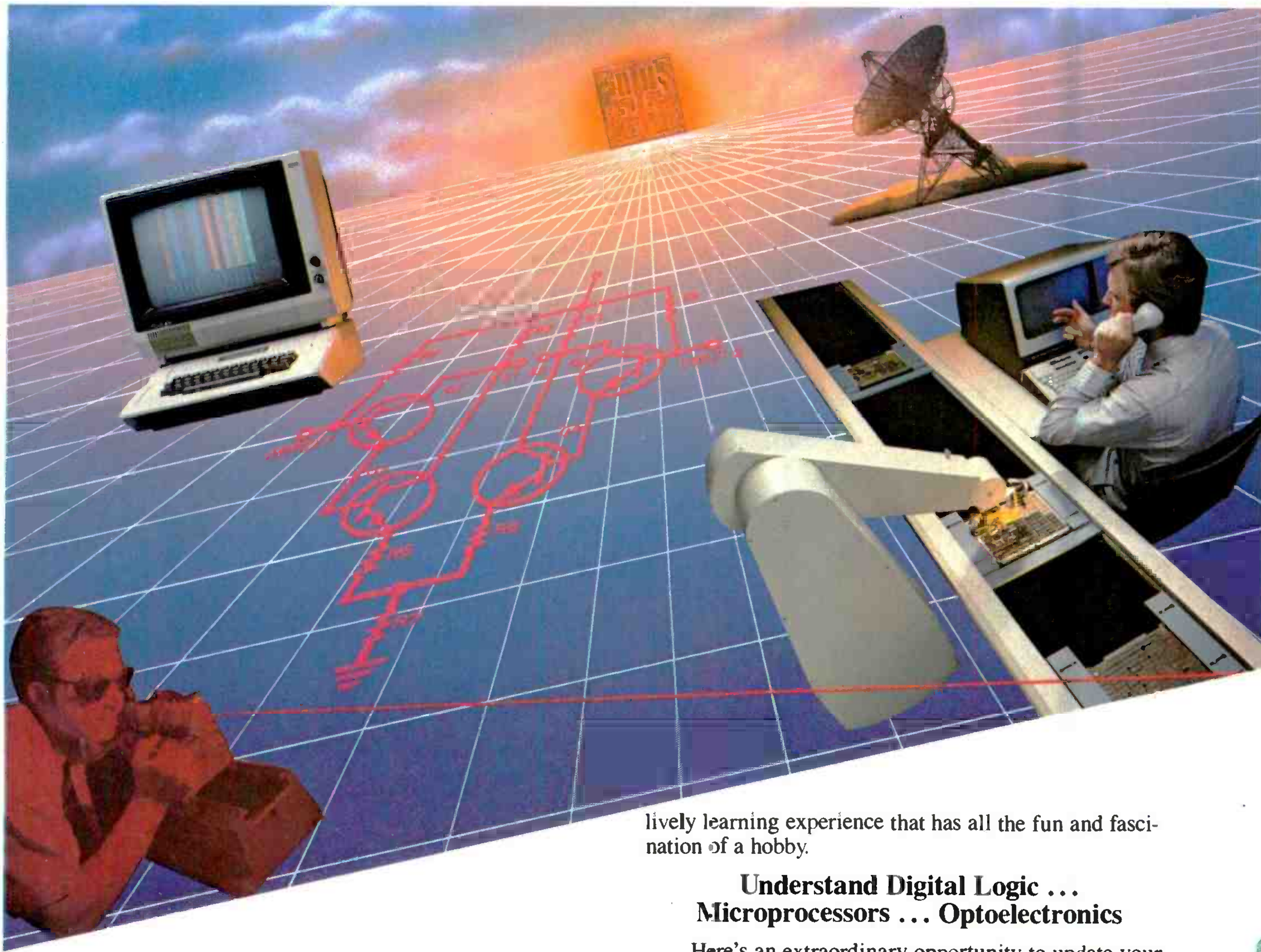

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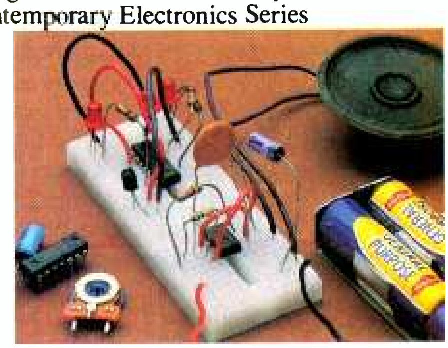

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...SOUL OF CP/M (from p. 35)

This series of articles assumes that you have some minimal experience with CP/M. If not, you should fortify yourself by reading one of the many primers on the system so that you can get the most out of this presentation. In this way, you can be the total master of the popular operating system, freed of the restraints imposed by BASIC or other languages.

IN PERSONAL computing, CP/M is the most popular operating system currently in use. One of CP/M's most pleasant features is its ease of use. Loading applications programs using such CP/M functions as DIR, STAT, and PIP, and using such high-level languages as BASIC, FORTRAN, Pascal, etc., are simple and straightforward in the CP/M environment.

In fact, this efficient facade is all that many users will ever know about CP/M. Yet, below this smooth surface, CP/M has a powerful inner structure that's easily used to do more—if you know how! It can control your computer's input and output devices with a precision and versatility impossible to obtain from high-level languages. We call this powerful level the "soul" of CP/M.

In this multi-part series, we'll start with the bare fundamentals of operating in the CP/M environment as well as some basic instructions to get you started in assembly-language programming. Sample programs and procedures for entering and modifying them will also be presented to provide hands-on experience in using the system. Using this as a foundation, later installments will reveal how to use the full computing power buried within the CP/M operating system.

System Calls. A system call is used to connect a program operating in the CP/M environment and the I/O devices the program is to use. A "call" instruction causes CP/M to jump to a subroutine (similar to GOSUB in BASIC) in the I/O section of the operating system. Since all calls are made in exactly the same way, regardless of the computer in which the program is operating, the program "thinks" it's operating in the same environment and and will work with many different computers (Fig. 1). Hence, a program run under CP/M is "transportable" from one CP/M-equipped computer to any other similarly equipped computer.

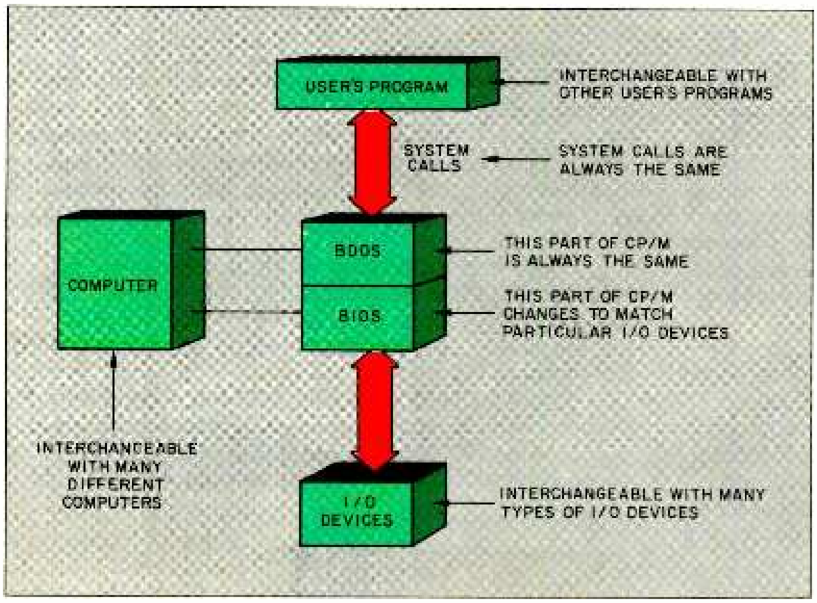

Fig. 1. How CP/M is organized.

System calls are used for printing a single character on a video monitor's screen, reading a character from a keyboard, and reading and writing records from and to disks. System calls can handle all I/O in a CP/M system. Since they must be made using instructions in 8080 assembly language, system calls are usually used in assembly-language programs, but they can also be used in BASIC and other high-level language programs.

Subroutines that a particular program calls depend on the physical characteristics of the I/O device the program wishes to use. This brings us to the second kind of transportability that makes CP/M so versatile—machine transportability. To interact with the outside world, a program uses a system call to jump to a subroutine in the I/O section of CP/M, called BIOS (for Basic Input/Output System). Since each subroutine is a separate short routine in itself, it's easy to change if a particular I/O device (printer, video display, etc.) is changed. Thus, CP/M is easy to reconfigure to make it work with different equipment and in different computers.

Parts of CP/M. The CP/M operating system is divided into several parts (Fig. 2), each of which occupies a different area of a computer's RAM memory. First is the Transient Program Area, abbreviated TPA, which is the part of memory where user programs reside. In most computers, TPA starts at memory location 100H (the H suffix throughout this series specifies a hexadecimal number; any number without a suffix is in decimal notation), which is 256 decimal. TPA size depends on how much user RAM is available in a given computer. For example, in a 64K system (the maximum that CP/M can address), TPA will be about 54K; systems with less RAM will have commensurately shorter TPAs.

The next part of CP/M is the

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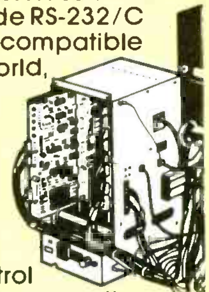

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Console Command Processor, or CCP, which deals with commands from the console keyboard. Every time you see the "A>" prompt, CCP printed it and is waiting for something to be typed in. When you type something, CCP either deals with your instruction itself if it's a "resident command" like DIR or TYPE, or calls another program if it's a "transient command" like PIP, STAT, or a nonsystem program. In a 64K RAM system, CCP might start at around DC00H and occupy about 2K bytes of memory.

Located just above CCP in memory is the part of CP/M that handles the disk system. Called the Basic Disk Operating System, or BDOS, it handles reading from and writing to disks, maintains a directory of disk files, and allocates the space these files occupy on the disk. Like CCP, BDOS is independent of the particular computer or disk system and doesn't require changing when it's moved from one CP/M-capable computer to another.

The part of CP/M that actually communicates with the outside world is the Basic Input/Output System, or BIOS. Because it's the BIOS that contains the subroutines that communicate with I/O devices, it must be modified when disk drives, consoles, printers, etc., are changed. BIOS reaches all the way to the top of RAM memory, or FFFFH (65535 decimal) in a 64K system.

A final small section of memory, the so-called "page 0", is very important to CP/M's operation. This section occupies memory addresses 0 through FFH and is located just below the TPA. This area is used by CP/M mainly for passing information of various kinds back and forth between the CP/M system and user programs. For instance, memory locations 6 and 7 contain the lowest address used by CCP. This lets a program figure out just how much room it has for itself in memory. There are also other uses for page 0 that we'll explore as we go along.

System Memory. A computer's memory consists of a large number of byte-wide locations, numbering 65535 in a 64K-RAM system. In CP/M-compatible computers, each byte consists of eight bits, where each bit is represented by binary 1 or 0. All computer programs, and much of the data upon which they operate, are stored in memory.

One of the differences between assembly and high-level language programs is that, for the latter, you don't have to know exactly where in memory a particular program or variable is stored. The language-processing program takes care of deciding where to put the program and its variables. In assembly-language programming, however, *you* must decide where to put everything. Hence, all addresses (memory locations) are numbered, starting at 0 and going up to FFFFH (in a 64K system).

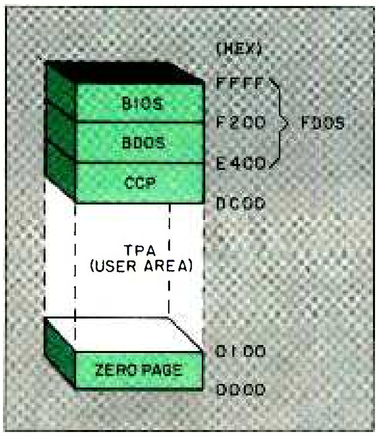

Fig. 2. Memory organization of the CP/M operating system for a 64K RAM memory.

An 8080 instruction can occupy one, two, or three locations, depending on the instruction. A piece of data, such as a number or an ASCII character, also occupies a specific place in memory. An ASCII character occupies one 1-byte location, and a number up to 255 decimal can also be represented by one byte. An address, on the other hand, or a number up to 65535 occupies two bytes. When a program is operating on data, it's often taking data out of one memory location and putting it in another.

In addition to RAM, another place a program can store data is in special "registers." A register is something like a RAM memory location, except that it usually has some special attributes that RAM locations lack, and usually processes data faster than RAM memory. A microprocessor like the 8080 consists mainly of such registers and the instruction-decoding circuits that let the chip know what must be done.

There are seven main registers in the 8080 (there are a few others, but we'll ignore them for now), designated A, B, C, D, E, H, and L. Register A is the most important. Called the "accumulator," it handles all of the 8-bit arithmetic, such as addition and subtraction, and logical ANDs, ORs, shifts, etc.

Registers B, C, D, E, H, and L can serve as temporary storage areas for 8-bit quantities. They can also be paired to accommodate 16-bit data. When used in pairs, B and C form the BC register, D and E form the DE register, and H and L form the HL register. Any 16-bit data can be transferred between register pairs or between specific register pairs and RAM memory.

Simple Program Writer. The Dynamic Debugging Tool, or DDT, is a CP/M "transient command" that makes it easier to work with a computer on a very fundamental level. DDT is able to examine and modify the contents of particular memory locations and various registers in the 8080.

If you use DDT and type "d100," for example, DDT will print out the contents of all memory locations from 100H to 1FFH, or 256 locations. You can change the contents of a memory location by typing, say, "s100" to alter the contents of location 100H. Typing "xa" permits you to examine and modify the contents of register A.

DDT has another important ability that we'll make extensive use of in this series. That is, it will assemble typed-in symbolic assembly-language instructions into a program that can be executed directly, without having to use CP/M's more sophisticated ASM (assembler) utility.

Using DDT. The first system call

we'll be using is "console output," a routine that allows a computer to send a single character from a program to the CP/M display screen. To use this call, you (1) put the number 2 in the C register; (2) put the ASCII character (it *must* be in hex notation) in the E register; (3) execute a CALL instruction to memory location 5. It's not necessary to understand anything about the actual instructions CP/M uses to send the character to a particular kind of terminal or CRT, since this is done by the BIOS routine.

In the first step, the 2 is the number of the system call in hex and is placed in the C register, which is CP/M's "mail box" for a program to tell what systems call to use. In the second step, the ASCII hex code for any desired character (codes can be looked up in an ASCII table) to be displayed is stored in and fetched from register E. Finally, in step 3, *all* system calls use a call to location 5 to enter BDOS, where the BIOS and BDOS subroutines perform whatever input or output function has been requested (in this case, print a character on the screen).

The procedure for writing these steps in a form the computer can use is as follows:

```
mvi c,2
mvi e,48
call 5
```

Here, "mvi c,2" means "move immediately the number 2 into the C register" and informs BDOS that we want to execute function 2, which is console output. (The instruction "mvi" always tells the computer that data to be moved *immediately* follows the instruction and isn't in a memory location somewhere else.) The mvi instruction is repeated on the second line and tells the computer to move into register E the hex value of the letter H (48). The instruction "call 5" is a jump-to-subroutine at memory location 5 hex, which is the entry point for all system calls. (Locations 5, 6, and 7 contain jump instructions to the actual BDOS entry point in memory.)

There are two ways to enter this program into your computer. First, you can write the program in "official" assembly language, using ASM and then execute it as a COM file (the same way systems programs are executed). However, to be able to do this, you'll have to add other instructions to the program to make it work and you'd also have to use several different programs to convert it to an executable routine. At this stage, it's more practical to take advantage of DDT's built-in mini-assembler, which can execute programs with no trouble at all. For longer programs involving lots of jumps and subroutines, however, ASM would be more practical to use.

If the above program were to be entered as is, it would simply print the letter H on-screen. By making the program slightly more complicated, we can print the word "HI" and introduce two more important concepts.

After booting up with a CP/M disk, call DDT and enter your modified program:

A>ddt	CP/M prompt; call DDT
DDT VERS 2.2	DDT sign-on
-a100	begin assembling (indicated by a) at 100H
0100 mvi c,2	put 2 in C register
0102 mvi e,48	put ASCII "H" in E register
0104 call 5	jump-to-subroutine at location 5
0107 mvi c,2	put 2 in C register
0109 mvi e,49	put ASCII "I" in E register
010B call 5	jump-to-subroutine at location 5
010E rst 7	return to DDT
010F	<return> brings back DDT prompt

(Note: in this and all subsequent programming procedures throughout this series, computer responses are shown in boldface, user responses in light-face type. Also, *all* typed-in instructions are to be followed by a carriage return.)

We've added comments to each line to make the program clearer. These comments are for your information only; you can't type them in with DDT.

This program begins at 100H because that's the standard starting address for all CP/M programs. The second "mvi c,2" at address 0107 restores function 2 to register C and permits a new character (in this case, "I," whose ASCII code is 49) to be placed in register E at address 0109 before "call 5" is used a second time at address 010B. If this isn't done, the contents of the C register will be changed, usually with disastrous results. The "rst 7" location 010E tells the system that programming is complete. Typing a carriage return when location 010F is displayed causes the DDT prompt (-) to be displayed.

You can make sure the code is set up correctly by typing in "l," followed by the address to list the program in the same format as it was typed in:

```
-l100
0100  MVI C,02
0102  MVI E,48
0104  CALL 0005
0107  MVI C,02
0109  MVI E,49
010B  CALL 0005
010E  RST 07
-
```

Note that CP/M automatically returns the program listing with all alphabetic characters in upper-case, regardless of how it was entered. Also, all numeric data has any 0s appended to it.

Now that you've entered the program, test it using DDT. To do this, use the "g" (for "go") command, followed by the address where the program starts:

-g100	runs the program at address 100H
HI*010E	prints HI and last address preceded by "*"

Now that you've written the program and know it works, you want to be able to save it on disk for use later. Type "g0," followed by a carriage return after the - DDT prompt. When the program ends and returns to CP/M, type "save 1 test.ddt" after the A> prompt. Since 0 is where the computer automatically goes to do a warm boot, typing "g0" from DDT takes you back to CP/M. "SAVE" is a transient-command utility that automatically writes to disk the program occupying TPA, starting at 100H. It saves the program under the name typed in. The "1" tells SAVE how many 256-byte "pages" of memory to save; in our case, just one page, since our program is less than 256 bytes long.

To reload the program at the same time you load DDT, type "ddt test.ddt" after the A> . Don't try to execute the program directly from CP/M by typing "test.ddt" since only files with the extension COM can be executed this way. Also, don't try to change the extension to COM; because the program ends with "rst 7" (instead of "ret"), you'll encounter problems if you attempt to execute it.

Using ctrl-s. Because it's CP/M that actually sends characters to the screen, ctrl-s follows the rules of the CP/M environment. For example, a check is made for the start/stop scroll (ctrl-s). If you press control-s (ctrl-s) as the program is running, CP/M will freeze output on the screen until you press another ctrl-s. Also, if a tab character is sent to the screen, CP/M would expand it into eight spaces (a tab).

Our sample program prints HI so fast that there's no way to check the ctrl-s function. However, if you replace rst 7 with a jump to the beginning of the program, your computer will print an endless string of HIs, which will allow you to check this function.

JMP Instruction. A jump (jmp) instruction is like a GOTO in BASIC. That is, when the program executes it, control goes to the address specified in the instruction. (In assembly language, the address is an actual memory location, not a line number as in BASIC.)

Here's how to make the change in the program. First, load the program by typing "ddt test.ddt" after the A> prompt. When the - DDT prompt appears, type "1100." Then, when the program lists, enter:

```
-a100e
010E      jmp 100           change rst 7 to
                            jump 100
-g0                         return to CCP
A>save 1 test1.ddt          save test1
A>ddt test1.ddt             return to DDT
-g100                       execute program
HIHIHIHI...etc.
```

A huge amount of HIs are sent to the screen, quickly filling it up. Press ctrl-s to freeze the display before it completely fills the screen. Press ctrl-s again to resume printing.

How do you stop the program? As it's written, you can't stop the program unless you press RESET, which will cause an exit from CP/M and require a cold boot.

Get Console Status. Sometimes called "Interrogate Console Ready," the "Get Console Status" feature is used mainly for telling your program that a key has been pressed but not *which* character key. We'll be using this feature in rectifying the endless-loop problem in our program.

First, load the program by typing in "ddt test1.ddt" after the A> prompt. Next, list the program by typing "1100" after the - prompt. Now, change the program as follows:

```
-a10e
010E      mvi c,b     put 0B (11 decimal)
                      into register C
0110      call 5      get console status
0113      ora a       OR A with itself—
                      to set zero flag if no
                      key is pressed
0114      jz 100      do again if no key is
                      pressed
0117      rst 7       return to DDT if key is
                      pressed
0118
-
```

Now line 10E doesn't simply jump back and repeat the loop. Instead, the 0B in register C sets up the Get Console Status call. Then we do a call to BDOS with call 5 to make CP/M check for a key closure.

Because we don't have to know precisely which key has been pressed, only that one has been pressed, we don't have to put anything in register E before we do a call 5. All we want to do is find out if register A contains a 0, which would mean that no key has been pressed. To be able to do this, we must use the "zero flag."

Zero Flag. Often, after performing arithmetic and logical operations on 8-bit quantities in register A, our program must know the results. In the 8080, this is determined with the zero flag, which is simply a switch in the CPU that's set to 1 whenever results of an arithmetic or

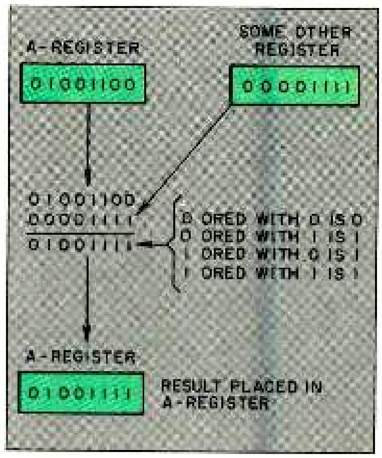

Fig. 3. Illustration of how an OR instruction is carried out.

logic operation are zero and set to 0 when they're not. Once this switch is set, it can be used to effect the results of other instructions, such as jumps, in much the same way that a BASIC statement like IF A=0 THEN GOTO 1000 is used.

When we use Get Console Status, we want to find out if the 8-bit quantity in register A is zero or not. To do this, the zero flag is tested, but *the zero flag isn't set until we perform an arithmetic operation.* So we must do some arithmetic to set the zero flag if register A is zero. An old programming trick here is to OR register A with itself.

OR Instruction. To OR two quantities means to take the bits in register A and OR them with the corresponding bits in some other register (Fig. 3), except that in this case the value of register A is ORed

(Continued on page 48)

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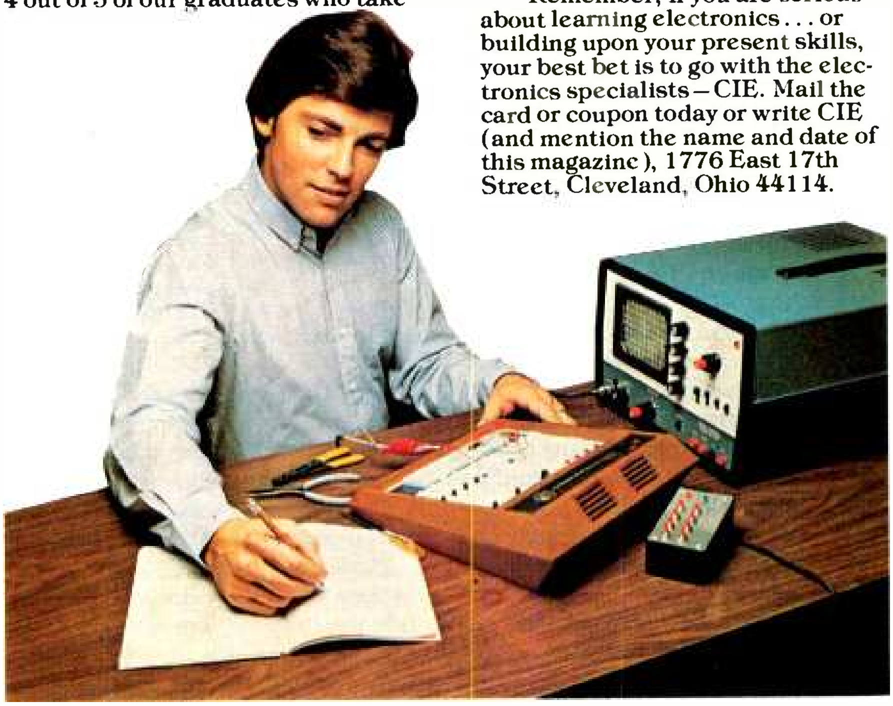

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with itself. Although ORing anything with itself produces no change in register output, it's important to bear in mind that the OR operation sets the zero flag.

Jump-on-Zero. Following the "ora a" instruction, the zero flag is *set* (=1) if register A came back from the Get Console Status system call set to zero; it's *cleared* if register A came back with a quantity other than zero. The "jump-on-zero" (jz) instruction does just what its name implies. If the zero flag is set, the instruction will cause a jump to the location specified in the instruction; if not, the program simply goes on to the instruction following jz 100.

If register A returns with zero, no key was pressed, the zero flag is set to 1, jz 100 will cause program control to go back to 100, and the program will continue to print HIs on the screen. However, if a key *is* pressed, register A will return something other than zero, the zero flag will be cleared (=0), and no jump will occur when we execute the program. Instead, the program will go to the last instruction (rst 7) and return the system to DDT.

To see this work, load DDT and, when the - prompt appears, type in "g100" to execute the program. As the screen fills with HIs, press control-s once to freeze the display and once again to unfreeze it. Now, try pressing any key. The program should come back to DDT and terminate the display as follows:

```
...HIHIHIHIHIH*(0117)
```

The prompt tells us that we're back in DDT. Save this program by typing "g0" to return to CP/M and then type in "save 1 test2.ddt" after the A>.

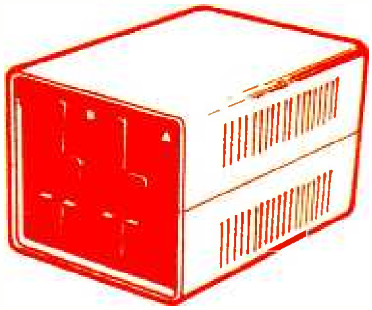
Barber Pole Program. Here's a short exercise that demonstrates the Console Output and Get Console Status functions and shows how to program a loop with a changing variable in 8080 code. This program repeatedly displays the entire ASCII set on the console. Console Output is used to send characters to the screen, and Get Console Status ends the program if a key is pressed. (**Warning:** *Do not turn on your printer. Because this program doesn't send a carriage-return/line-feed to the screen, it will cause the printhead to go to the right edge of the paper and continuously print over the same spot.*)

Get into DDT and enter this program using the A (assemble) command:

```
0100   mvi e,20   set up register E for
                  first ASCII character
0102   mvi c,2    ready for output
0104   push d     save register pair DE
0105   call 5     send character to
                  screen
0108   pop d      get DE pair back
                  (restores E)
0109   inr e      increment E by +1
010A   mov a,e    put E in A
010B   cpi 7f     127th character?
010D   jnz 102    if result not zero,
                  then no, so loop
0110   mvi c,b    check console status
0112   call 5
0115   ora a      set zero flag based
                  on contents of A
0116   jz 100     if a=0 then no key
                  pressed, so loop
0119   rst 7      return to ddt
```

Exit DDT and save this "barber-pole" program by typing "save 1 barber.ddt." The program can be called by typing "ddt barber.ddt." It can then be executed by typing "g100" after the - DDT prompt.

Push, Pop, Stack. Notice in our program that there are a number of new instructions. The first is "push d" at location 104. Before we get into a discussion of this and the "pop d" instruction at location 108,



you must know about the "stack" (Fig. 4).

The stack can be thought of as a memory device in which the contents are stacked. As the contents of each register pair is put into the stack, it goes on top of the previously stored contents. (This kind of stack is called "LIFO," for "last in, first out.")

The stack is a series of memory locations somewhere in your computer's memory. Often, the program you're using takes care of figuring out what memory locations to use for the stack. Let's assume this is true for the moment. To store the contents of a register pair in the stack, we use "push x," where *x* stands for the first letter of a register pair. To get the quantity back, we simply use "pop x." In our barber-pole program, we must save the contents in register E each time we call Console Output because this register is used to hold the ASCII value of the character to be printed. (Actually, we save the contents of register *pair* DE, but D is along just for the ride.)

Every time Console Out is called, we want to increase the ASCII value of the contents in register E by one to print the next character. Because Console Out destroys the con-

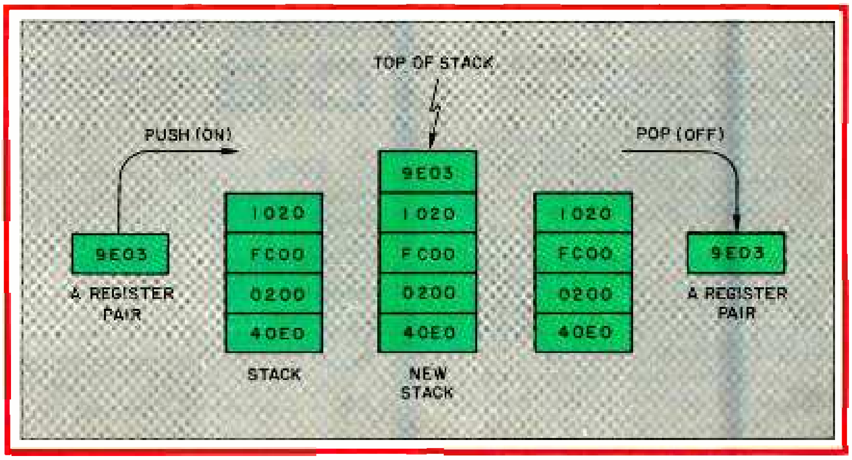


Fig. 4. Stack manipulation.

tents of register E when called, we save register E with "push d" before calling Console Output and restore it afterwards with "pop d."

INR Instruction. The way we increment the contents in register E is with the "inr e" instruction. (The *e* here can be replaced by any 8-bit register.) It's this instruction that adds 1 to whatever is in the register.

DCR Instruction. This instruction is the opposite of inr; that is, it *decrements* the number in the specified register.

MOV Instruction. While mvi will take a fixed 8-bit number and put it in a register, "mov" takes the 8-bit contents of a register and puts it in another register. This instruction can be used to MOVe data from any 8-bit register to any other 8-bit register. In the format "mov x,y," the contents of register *y* are moved into register *x*. In our program, "mov a,e" puts the quantity in register E into register A.

CPI Instruction. Not all hex numbers are printable ASCII codes. In fact, the printable ASCII codes run from 20 hex (a space) to 7f hex (rubout). Sending numbers less or greater than these to your console device or printer is likely to cause unpredictable results. Thus, you want to start your program by sending 20 hex to the console and then after sending 21 through 7f to start over again with 20 hex. The first instruction in the program, "mvi e,20," starts us off with 20, then the "cpi 7f" takes over. (CPI stands for ComPare Immediate.) CPI does what can be considered a sort of "phantom" subtraction of a fixed 8-bit quantity from register A, because contents aren't actually changed. This makes the zero flag (and various other flags) *act* as though subtraction has occured.

The cpi 7f instruction performs this phantom subtraction of 7f from the contents of register A. The first time through the loop, register A will contain 20 because register E contains 20; so the result of subtraction will *not* be zero. The next time, register A will contain 21, and so on, until the count reaches 7f. When register A's quantity reaches 7f, the results of subtraction will be zero (although the contents of register A won't actually be changed), and the zero flag will be set.

JNZ Instruction. This instruction, which stands for "jump-on-not-zero," is similar to jz, except that it jumps if the zero flag is *not* set. Otherwise, it goes on to the next instruction in the program. In our case, the CPI instruction will result in the zero flag not being set until all ASCII characters from 20 to 7f have been printed. So each time the jump will take us back to the location 102 instruction.

When all ASCII characters have been printed, the program goes to location 110, where it performs the Get Console Status system call to see if any key has been pressed. If not, it starts the program over; if so, it returns to DDT.

Console Input. This is perhaps the most-often-used CP/M function call. Its purpose is to get a character from the keyboard into your program and is used by almost all programs that run under CP/M in which user input from the keyboard is required. It works much like BASIC's INKEY$ statement. When called, Console Input reads the next console character into register A and "echoes" it to the screen. It won't echo control characters, but it will react to many of them.

There are some special features of the Console Input function about which you should be aware. Most important is the way it responds to CP/M control characters. *It does* not *respond to a warm-boot* control-c *or printer-stop/start scroll* control-p. This makes sense, since you often don't want users to be able to warm boot the system or turn on the printer from inside your program. When you do want the user to have such control, you can use CP/M's Read Console Buffer function. This call comes with a complete set of editing commands and is used by many of the CP/M utilities.

Beep Program. Here's a simple program with console input. It causes CP/M to echo every keyboard entry onto the screen and sound a beep if your console has this facility. First, bring up DDT and enter the program:

```
0100   mvi c,2    set up for console
                  output
0102   mvi e,7    ASCII 7=bell
0104   call 5
0107   mvi c,1    set up for console
                  input
0109   call 5
010C   cpi 3      check to see if A=3
010E   jnz 100    if not, repeat loop
0111   rst 7      A=3, so end
```

The instruction at location 010C, "cpi 3," allows you to halt the program when a ctrl-c is detected and takes your back to DDT. The rst 7 instruction in location 0111 then returns to DDT. The ASCII code for ctrl-c is 3 hex.

Save the program with "save 1 test3.ddt" and then run it under ddt by typing "g100." As the program is running, each time you press a key, the console will beep and the character will appear on-screen.

Executing From CP/M. So far, you've executed the programs presented here from DDT. Many times, however, you'll want to be able to execute a program directly from CP/M simply by typing the name of the program after the A> prompt. In theory, this is simple: write the program in DDT, save it as a .COM file, and execute it directly. However, if your program contains an rst 7 instruction and an attempt is made to execute it directly from CP/M, the system will probably "crash" (cause error messages to appear on-screen, followed by a cold boot). CP/M, remember, doesn't respond to rst 7 the same way DDT does. The remedy is to replace rst 7 with a "ret" instruction.

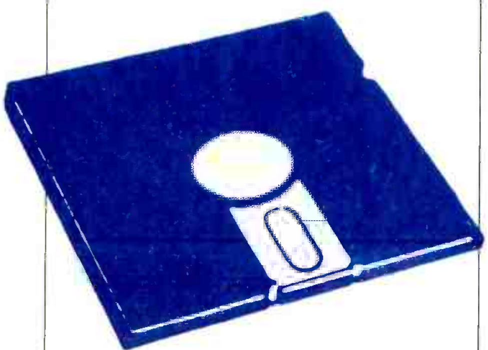
RET Instruction. A ret instruction is usually used to return to the calling program from a subroutine. Since CP/M thinks of the program we've written and are attempting to execute as a subroutine, it wants to

see a "ret" at the end of the program.

Before you can use any of the programs we've presented so far in a direct CP/M mode, you must change the rst 7 instructions. Do this with the last program example by calling DDT and enter "ret" in location 0111, replacing the rst 7 already there. Then go back to CP/M and save the program as a .COM file by typing "save 1 test4.com." Now, you can execute the program directly from CP/M simply by typing "test 4."

System Reset—Warm Boot. System reset is used for obtaining a warm boot from a program and reinitializing the disk subsystem (FDOS, which stands for Full Disk Operating System and is simply BIOS + BDOS). The reason you want to know how to perform a warm boot is that sometimes you need as much RAM memory in TPA as you can get. To maximize TPA, you can remove the entire CCP from RAM and still use all system calls, provided you don't wipe out FDOS. When you want to return to CP/M, perform a System Reset to reload CCP and reinitialize FDOS. System Reset works just like ctrl-c from the keyboard.

Here's a short program that will generate a warm boot (system reset). Don't try to test it from DDT because it wipes itself out in the process of resetting the system. Start by entering the program from DDT. Then exit the program with a "g0" (which also generates a warm boot and replaces DDT with CCP). Save the program and then run it to observe the warm boot:



```
-a100
0100  mvi c,0   set up for system reset
0102  call 5    call BDOS
0105  ret       return to CP/M

-g0

A>save 1 test5.com

A>test 5        test program

A>              hear disk click
```

Now you know how to make your program go back to reinitialize CP/M whenever you wish. With this procedure, you can run programs that use the memory space usually occupied by CCP and be assured you can reinitialize the system later.

BDOS Base Address Locator. To take advantage of the space used by CCP, you must know two things: where CCP starts and where it ends. Then you can let your programs extend from 100H all the way up to the beginning of BDOS, which is the same as the end of CCP. CCP typically starts 800H (2048 decimal) bytes below BDOS.

One way you can find where BDOS starts is by looking in the CBIOS.PRN (printing) listing that comes with your CP/M. Just look for the listing that has been assembled and has addresses in the left column. Look in the beginning of the listing for the four-digit hex address to the left of the label CCP or BDOS. In a 56K CBIOS system, CCP starts at BC00 and BDOS at C406. (Most CCPs are about 800H bytes long; so they extend up to BC00 + 800, or C400.) Therefore, you could use the area BC00 to C400 without damaging CP/M.

The second way to find the address of the beginning of BDOS is to use DDT to examine the value stored at addresses 6 and 7. Location 5 contains an 8080 jmp instruction (C3), while locations 6 and 7 contain the actual place we'll jump to, with location 6 containing the low-order, or least-significant, byte of the address and location 7 containing the high-order, or most-significant, byte. The low-order byte is usually 0, since programs generally start at the beginning of a 256-byte page.

Bear in mind that DDT overlays CCP, which causes any calls to BDOS (call 5) to end up in DDT. So if you look in location 7 with DDT, you'll see an entry point to DDT, not BDOS. Our 56K system tells us that location 7 contains B4, which when combined with the 00 in location 6 gives an address of B400. This is considerably below any normal CCP and obviously tells us we're entering DDT.

Here's a short program that will locate the base address of BDOS:

```
0100 lda 7          put value in 7
                    into register A
0103 mov e,a        put value in A
                    into E
0106 mvi c,2        do Console Out
0109 call 5         call BDOS
010A ret            return to CP/M

A>save 1 test6.com  save program

A>test6             run program

D                   prints letter D

A>                  returns to CP/M
```

LDA Instruction. This instruction lets us move the contents of a *memory location* to a register. LDA means "load the contents of the memory location specified in the instruction into register A." In DDT, we specify a desired memory location by a hex number. The hex value the ASCII capital D is 44H. The Console Out routine always ignores the high-order bit of the number sent to it. We can guess that this bit must have been set in this case. Therefore, we add 80H to 44H and obtain B4H, which is the same thing as our CBIOS.PRN listing told us. You can subtract about 800H bytes from this to determine the bottom of CCP.

Coming Up. We've covered a lot of ground in this first part, enough to get you started in assembly-language programming. Having introduced you to console system calls and more than a dozen 8080 instructions, you now have enough knowledge of CP/M to begin writing your own complicated programs. Next month, we'll be focusing on advanced console system calls. ◇

ONE-UPMANSHIP FROM RADIO SHACK

Its new Model 100 briefcase computer combines word processing on an 8-line display, an auto-dial modem for networking, scheduling and address programs, and real up-to-32K computing power in a fresh all-in-one CMOS-design package

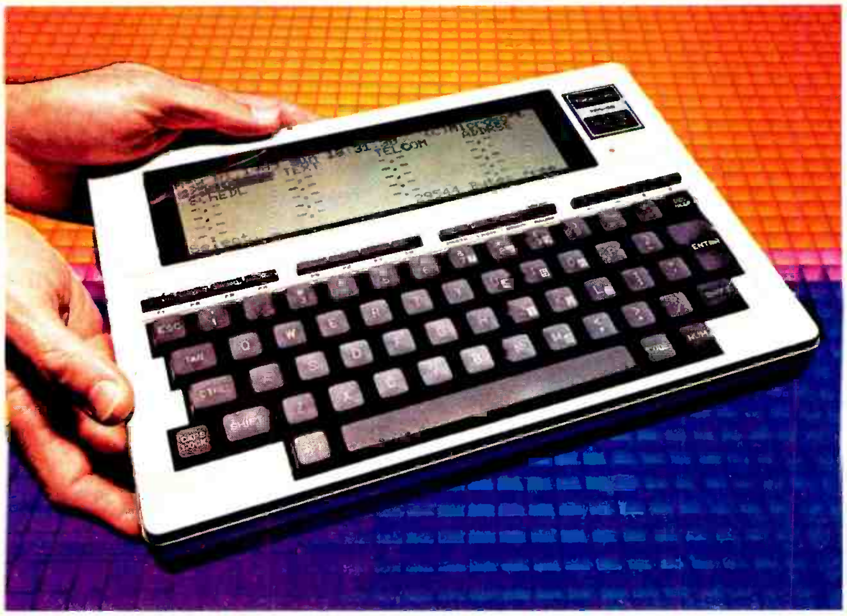
IT was 3 p.m. when the Chief called me into his office and told me to go to Fort Worth the next morning to test some new machines from the Radio Shack stable.

The Whisperjet touched down at D/FTW Airport at 10:08 a.m. Central Time and I deplaned. Leaping over the Hertz counter gracefully, I caught the big yellow bus to the parking lot and picked up a gleaming red Ford Fairmont. Tooling out of the airport, I floored the car and soon saw the glass towers of Tandy Center.

It took only a few minutes to find the parking entrance to Tandy Tower and ascend to the 19th floor office of Ed Juge, who heads Computer Marketing at Radio Shack. There under canvas wraps were the new 1984 models. Before removing the covers, Ed made me sign nondisclosure agreements, and in a few minutes I saw two of the Shack's latest entries in the computer market race.

The first model released for testing was a subcompact called the TRS-80 Model 100. When Ed whisked off the covers, my eyes swept over the gleaming off-white and black body and chassis, the full keyboard, and the extra large LCD window. Looking at all the switches and connectors mounted around the lower half of the body, I realized that this was no ordinary subcompact I was about to put through its paces. This was a briefcase-size, full computer system! Before turning me loose with the Mod 100, Ed explained some of the standard features and options in the new machine.

The 40-character, eight-line LCD display and the full QWERTY key-



board with 16 function and control keys were obvious improvements over any portable made before that. However, it is what's under the hood that makes this little machine a rare jewel. It is powered by an 8-bit 80C85 CPU, a CMOS version of the 8085 CPU. I asked Ed why Radio Shack had departed from its usual practice of building Z80-powered computers. He told me that the 80C85 was the only CMOS microprocessor that had multiple sources of supply and Radio Shack didn't want to put all its eggs in one basket. I mention this as an illustration of the kind of deep planning that has gone into the new design.

The Model 100 is available with either 8K or 24K of CMOS memory and it can be expanded to 32K by having 8K memory modules installed. The operating system and BASIC language are in ROM so that all of the RAM can be used to hold programs and data. The CMOS memory is kept energized by NiCd batteries so its content is not lost when the computer is off.

One of the less obvious features is a built-in direct-connect, auto-dial modem that can also be used as an automatic dialer to store hundreds of telephone numbers. Another is the ability to interface with any printer or with any other Radio Shack computer.

The built-in operating system includes an address program, a schedule program, and a word processor and text editor. Who could ask for anything more?

The LCD, a 40-character by 8-line flat screen, has a viewing-adjustment dial on the left side of the case. The dial permits a viewer to lighten or darken the display to suit any viewing angle. This is a feature that addresses previous complaints about LCD viewing screens. In this case you merely adjust the dial and the image becomes clear.

On earlier models of handheld computers, there was a single line of text in the LCD display. The Epson HX-20 changed that to a four-line, 20-character display that was an improvement but still not enough for word-processing applications.

The Model 100 is different. Its 40-character by 8-line display is sufficient to show a paragraph of text or several lines of a program. Moreover, the screen is large enough to show a graphics display—an important plus since the Model 100 can provide such displays.

The keyboard can be used exactly like a typewriter since it has a standard QWERTY arrangement, and keys are large enough for a touch typist to use. However, there are a few special keys, including eight programmable function keys (F1 through F8); four command keys (PRINT, LABEL, PASTE, and PAUSE) and four cursor movement keys. (See the photo for special key functions.) Although the keys are smaller than standard typewriter keys, they seem comfortable enough for normal use.

In addition to the function and cursor movement keys there are terminal control keys such as: CTRL (Control), TAB, CAPS LOCK, SHIFT, ENTER, BKSP (Backspace), and DEL (Delete). These help give the Model 100 its interface capabilities since they match identical keys on other TRS-80 computers.

There are some other special keys that extend the keyboard functions. When the NUM key is pressed, it converts the keys that have numbers in the lower, right-hand corner into a 10-key numeric keypad. The GRAPH key is pressed in conjunction with another key to display one of 41 special graphics characters. Pressing the SHIFT and then GRAPH keys, followed by another key, provides 32 additional "block" graphics characters.

Another 31-character extension of the character set is obtained when the CODE key is pressed. If SHIFT, CODE, and another key are pressed, even more special characters are enabled. In fact, the Model 100 is one of the few computers that can generate all of the 256 ASCII character set from the keyboard.

Special Features. As you read the following discussion of controls, connectors and switches on the Model 100, you will begin to learn about some of the inside features of this computer. We will also tell you more about them later.

There is an RS232 (DB25) connector on the rear panel for serial interface to a modem or any other serial device. The Model 100 can be directly connected to another TRS-80 computer through a simple null modem.

The printer interface connector is a Centronics type and the Model 100 will interface to any Radio Shack printer including the daisy-wheel models.

The Model 100 contains a built-in direct-connect, automatic-dial, originate/answer modem, and there is a DIN connector on the rear panel to connect the Model 100 Direct Connect Modem Cable (RS 26-1410) to the computer.

Data and programs can be saved or loaded through the use of a cassette recorder. A DIN connector is provided on the rear panel for the cable connection. The standard TRS-80 cassette cable is used.

On the left side of the computer are two switches and a connector. One switch is for selecting the use of either the built-in direct-connect modem or an optional acoustic coupler modem. The second switch is for selecting the modem's mode of operation. You can select an originate or answer mode.

You can choose an acoustic coupler for use with hard-wired telephones, too. This is a good idea because many public and hotel telephones do not provide modular jacks for the direct-connect modem.

The connector is really interesting; it is a "D" connector for a Bar Code Reader (more about this later). The power on/off switch is located on the right side of the computer, next to the connector for the external power supply. The control for the LCD is also located on this panel.

If you turn the computer upside down, you will see some compartment doors and a recessed switch. One compartment door is for the AAA alkaline operational batteries. Four are used, and they automatically power the computer when the external power supply is not used. Inside the computer there are NiCd batteries that keep the memory energized when the computer is off. They are recharged from either the external power supply when it is

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This new book is a must for all Sinclair and Timex Sinclair 1000 owners! Taken from the first six issues of *Sync* magazine, *The Best of Sync* covers: Games, Math and Math Graphics, Software Programming Techniques, Translation, Graphics, Machine Language, Hardware, Resources, Reviews, Glossary—and more! Get more from your computer with these hard-to-find programs, procedures and techniques—get *The Best of Sync!*

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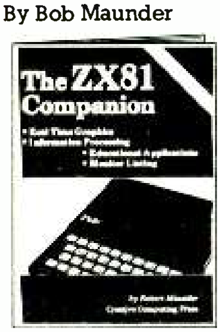
The ZX81 Companion

By Bob Maunder



The ZX81 Companion follows the same format as the very popular *ZX80 Companion*, and assists the ZX81 or Timex Sinclair 1000 user in four applications areas: graphics, information retrieval, education and games. This practical guide contains scores of fully documented short routines plus complete programs and a disassembled listing of the ZX81 ROM Monitor. "Thoughtfully written, detailed, and illustrated with meaningful programs."—MUSE

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By Tim Hartnell

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The Gateway Guide to the ZX81 and ZX80

By Mark Charlton

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By Sally Larsen

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plugged in or the AAA batteries when the unit is operating on battery power. The recessed switch is for de-energizing the NiCds when the computer is to be stored. If set to the OFF position, the memory is shut down and it forgets everything!

There is a low-battery indicator lamp on the front panel to warn you when the AAA batteries need to be changed. If the computer runs on batteries one hour a day, the AAA cells can be expected to last about 20 days. If used about 4 hours per day on battery power, they will only last 5 days.

The other compartment contains a ROM socket to install additional ROM-based programs. There is also a socket in this compartment to extend the 40-pin bus of the computer. This may be connected to an extension box through a special cable. None of the Radio Shack people would tell me what the expansion unit would contain, but some of the possibilities include more memory, video interface, and disk drives.

The mere idea of the expansion capabilities of this unit is tremendous. Suppose you have a box on your desk with a set of disk drives and additional memory. It is connected to a cable that plugs into your Model 100, which sits in front of you ready to use as a word processor/computer. When you leave, you unplug the cable and slip the Model 100 into its case to take with you.

When you return, you upload the data stored in the CMOS memory files to your disk drives or print out hard copy. The expansion unit could also be connected to a video interface for viewing complete pages or electronic spreadsheets. If you own another TRS-80, you can do this type of thing with your Model 100 without having an expansion box by using connecting cables.

Operation. Having been checked out on the controls, indicators, connectors and special features, I was ready to turn on the Mod 100 and experience its operation. Seated at a desk, I reached over and turned on the power. The LCD display came on with a menu screen. On the top line were the date, time, and source of the software: Feb. 03, 1983 Tues 01:23:35 (Microsoft)

The second line (and part of the third) listed the names of the built-in application programs: BASIC, TEXT, TELECOM, ADDRSS, SCHEDL.

Next are four columns listing the programs stored in the memory. There are four lines of either four or five spaces for listings—a total of 24 spaces in the menu for listing files, including the standard built-in ones.

The bottom line of the menu allows you to select a text file or program by entering its name alongside the prompt "SELECT:". It also gives you the amount of memory (in bytes) that is free for your use.

The cursor is a shaded area placed on the character position. To move the cursor, one of the movement arrow keys is pressed. To select a main menu option, the cursor is placed over the name of the menu option and the ENTER key is pressed.

I spent a day working with the Model 100 and became rather proficient in its operation. First I set the time-of-day and the calendar date. Once set, this remains unless the NiCd battery switch on the bottom is turned off. Every time you turn on the computer you will find that the time and date are current.

I used the built-in Text program which is both a word processor and a text editor for creating files for Schedl, Addrss and Telecom. To make it easy to use, the function keys F1 through F8 have single key definitions in the program. If the LABEL key is pressed, the functions are shown on the bottom line of the display. When the text is typed in, the system will continue the lines on the next line after 40 characters have been entered (automatic wrap around). It is in effect unless the ENTER key is hit where a paragraph break is wanted.

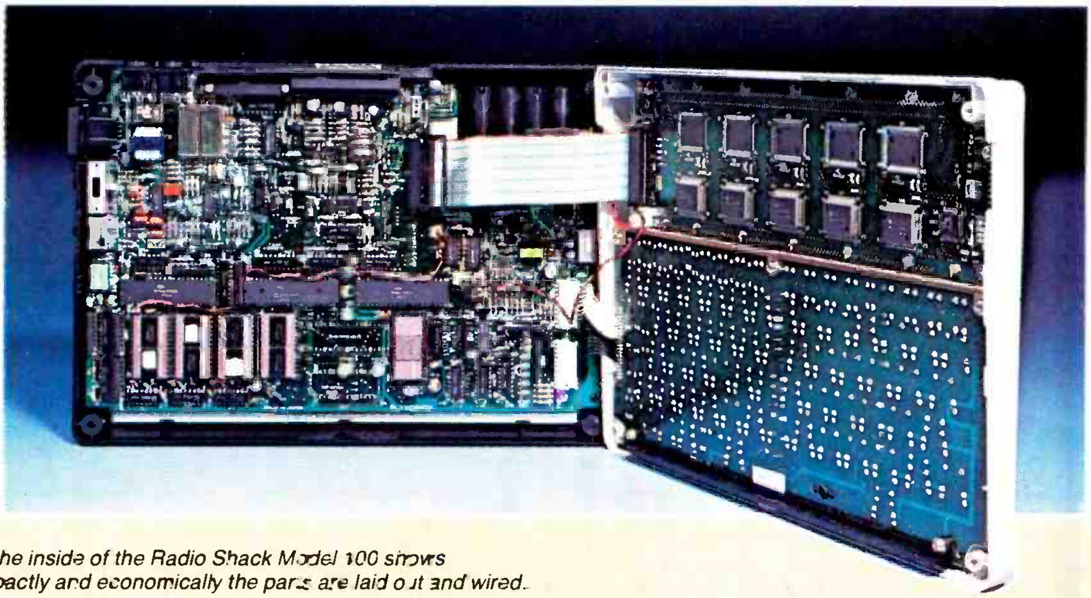


Photo of the inside of the Radio Shack Model 100 shows how compactly and economically the parts are laid out and wired.

The fact that the display is 40 columns wide has no effect when printing, since a print width from 1 to 132 columns can be selected. The Text program has all the features usually found in a large word-processing program, including global search and replace, block move, and CUT, PASTE, and COPY (all single-key functions). The completed text files can be saved to a cassette tape or in memory as long as desired. They can also be dumped to a TRS-80 disk system.

After being amazed at the built-in Text program, I brought up the Schedl program. This keeps track of dates and times for appointments or events. It also locates them in the file and keeps records of such things as expense accounts.

To use the program, a file is first created using Text. This file is titled NOTE.DO and it is added to by extending the schedules and kept current by removing old items. The function keys have single-key functions in this program. F1 finds an entry, F5 lists it on the printer, and F8 exits the program.

Having mastered the Schedl program, I next tackled the Addrss program. In a short time, I had completed the sample sessions in the manual and was selecting and retrieving names and addresses. Great program! I've used many similar ones on larger computers and I must say that this one is as good (especially considering that it is truly portable with no external software required).

I was getting very excited about this little computer as I tried the Telecom program. This has two modes as previously mentioned. In the Entry mode, a telephone number is automatically dialed for either normal conversation (you pick up the phone) or computer-to-computer communications. The second mode is the Terminal mode, in which the Model 100 communicates with another computer or network system. When the Telecom program is started, it is automatically in the Entry mode. This is a "stand alone" feature, with the Model 100 being used as an automatic dialer. This feature is only available when a special Model 100 Modem Cable (RS 26-1410) is used. The Terminal mode is for interactive communications. It can be used to automatically call up a network system and log-on to the system, with the Model 100 supplying your ID# and password. Acoustic cups are optional for use with hard-wired telephones and a Null Modem is optional for use in computer-to-computer communications. They've thought of everthing!

I set up my CompuServe ID# and password and in a very short time I was on the network. Now, I have used the Panasonic Link, the IXO, and the Epson HX-20 for working the network. I frankly do not especially care for any of them for this use. However, I would gladly settle for the Model 100 as my only networking computer.

I do not have to say much about the omnipresent Microsoft BASIC, except that it is there in ROM and it works like any TRS-80 BASIC (except for disk commands). It can be saved to a cassette or a RAM file.

Conclusions. They had a hard time prying my fingers loose from the Model 100. I really didn't want to let it go! I don't often get this high on a computer anymore—with good reason, I think. I work with at least one new one each month and, usually, some plug-in feature or an important piece of software has not yet caught up with the basic machine. With the new Radio Shack Model 100, I had no preconceived notions about what it could or could not do. I was certainly impressed by its immediate usefulness.

It can do all of the things that one of the new integrated systems on much larger machines can do. When it gets its expansion interface and disk upgrade, this small machine will be an even more powerful system than it is—which is saying a lot.

Clearly, Radio Shack has not been sitting on its hands. This fact will be further emphasized next month when I will be permitted to disclose information about the other new computer revealed to me during my whirlwind trip.

—*Stan Veit*

PULSE DURATION COUNTER

Measures positive- or negative-going pulses independent of repetition rate

By Roy Hartkopf

FREQUENCY counters are ideal for measuring the *number* of pulses per unit of time contained in a given signal. However, there are occasions when the *duration* of a pulse must be measured—something a standard frequency counter can't do.

Timers often require that a pulse be of fairly precise duration, with the duration independent of the repetition rate. If, in fact, the pulse in question is triggered on when some other event takes place, the repetition rate may appear to be random. For reasonable repetition rates and reasonably narrow pulses, an oscilloscope can be used. Random timing and long pulse duration require the use of an expensive storage scope.

The low-cost Pulse Duration Counter described in this article will measure pulse *duration* from microseconds to seconds accurately to three digits. It can measure either positive- or negative-going pulses and is completely independent of the repetition rate of the pulses.

In essence, an incoming pulse opens a gate that allows a crystal-controlled frequency to be incremented on a counter and displayed on three 7-segment LED displays. When the pulse stops, the gate closes and the count remains on the readout until it is reset.

Circuit Operation. As shown in Fig. 1, the pulse to be measured is applied via *J1* to *Q1* with diodes *D1* and *D2* in conjunction with *R1* limiting the signal swing. Because of this protection, the circuit will accept signals with maximum amplitude of 50 volts. The trigger level is dependent on the *Q1* gain, and is typically about 2.5 volts. The output of *Q1* is applied to the combination of *IC1C, IC1D, R3* and *D3*, which form a Schmitt-like trigger circuit to produce a clean negative- and positive-going pulse selected by *S2*. The selected pulse drives flip-flops *IC3A* and *IC3B* via gate *IC2B*.

The Q outputs of *IC3A* and *IC3B*, along with the pulse selected by *S2* and the crystal-controlled time base signal, are used as the four inputs to *IC2A*. Each time the output of *IC2A* (pin 6) goes high, it increments the count in the three-digit counter formed by *DIS1, DIS2,* and *DIS3*. These particular devices include a counter, decoder, driver, and seven-segment display all in one package. The first two input pulses from *J1* set up the correct flip-flop conditions to gate *IC2A*, while the third input pulse is the one that is measured.

The time base consists of a 10-MHz crystal-controlled oscillator formed by *IC1A* and *IC1B* and their associated components. This oscillator drives a series of decade counters formed by *IC5* through *IC8* to deliver pulses at 1 and 10 microseconds, and 0.1 and 1 millisecond, selectable via *S3*. The selected clock signal is fed to *IC2A*.

Thus as long as *IC2A* is properly driven, the readouts will continue to increment for the duration of the pulse present at input connector, *J1*. When the input pulse ends, *IC2A* is disabled, the count to the display stops, and they remain in their last state until the RESET pushbutton is depressed. The duration of the input pulse can be read off the displays as microseconds or milliseconds as indicated by *S3*.

The latches formed by *IC4A*, *IC4B*, and the RESET pushbutton *(S1)*, along with *IC4C*, *IC4D* and *Q2*, are used to reset the flip-flops and the displays. The circuit is arranged so that contact bounce will not produce false signals.

The power supply (not shown) can be any type that provides 5 volts at about 1 ampere.

Construction. The circuit can be assembled using point-to-point wiring or a pc board. For the latter, use the pattern shown in Fig. 2. The display foil pattern is shown in Fig. 3. The component layout for both boards is shown in Fig. 4.

If desired, the three displays *(DIS1* through *DIS3)* can be replaced by any decade counter/latch/driver/7-segment display combination.

Once the circuit has been built, it can be mounted, along with a power supply, in any suitable enclosure. The front panel should have a cutout large enough to accommodate the three LED displays, the polarity switch, and the time switch.

Operation. Set polarity switch *S2* for either "–" or "+," depending on the polarity of the pulse to be measured. Set the time range switch, *S3*, to some convenient value, and apply the pulse whose width is to be measured to connector *J1*.

PARTS LIST

- C1—100-pF disc capacitor
- C2—3-30-pF trimmer capacitor
- C3—0.001-µF disc capacitor
- C4 through C7—0.1-µF disc capacitor
- C8—220-µF, 10-V electrolytic
- DIS1 through DIS3—TIL307 numeric display
- D1 through D4—1N914
- IC1, IC4—7400 quad 2-input NAND
- IC2—7420 dual 4-input NAND
- IC3—7473 dual JK flip-flop
- IC5 through IC8—7490 decade counter
- J1—RCA phono connector
- Q1,Q2—2N3565 transistor
- R1,R6,R7—10-kilohm resistor
- R2—1.8-kilohm resistor
- R3—680-ohm resistor
- R4,R5—470-ohm resistor
- S1—Spdt press switch
- S2—Spdt toggle or slide switch
- S3—Single-pole, 4-position rotary switch
- Misc.—Suitable enclosure; 5-V, 1-A power supply; press-on type; etc.

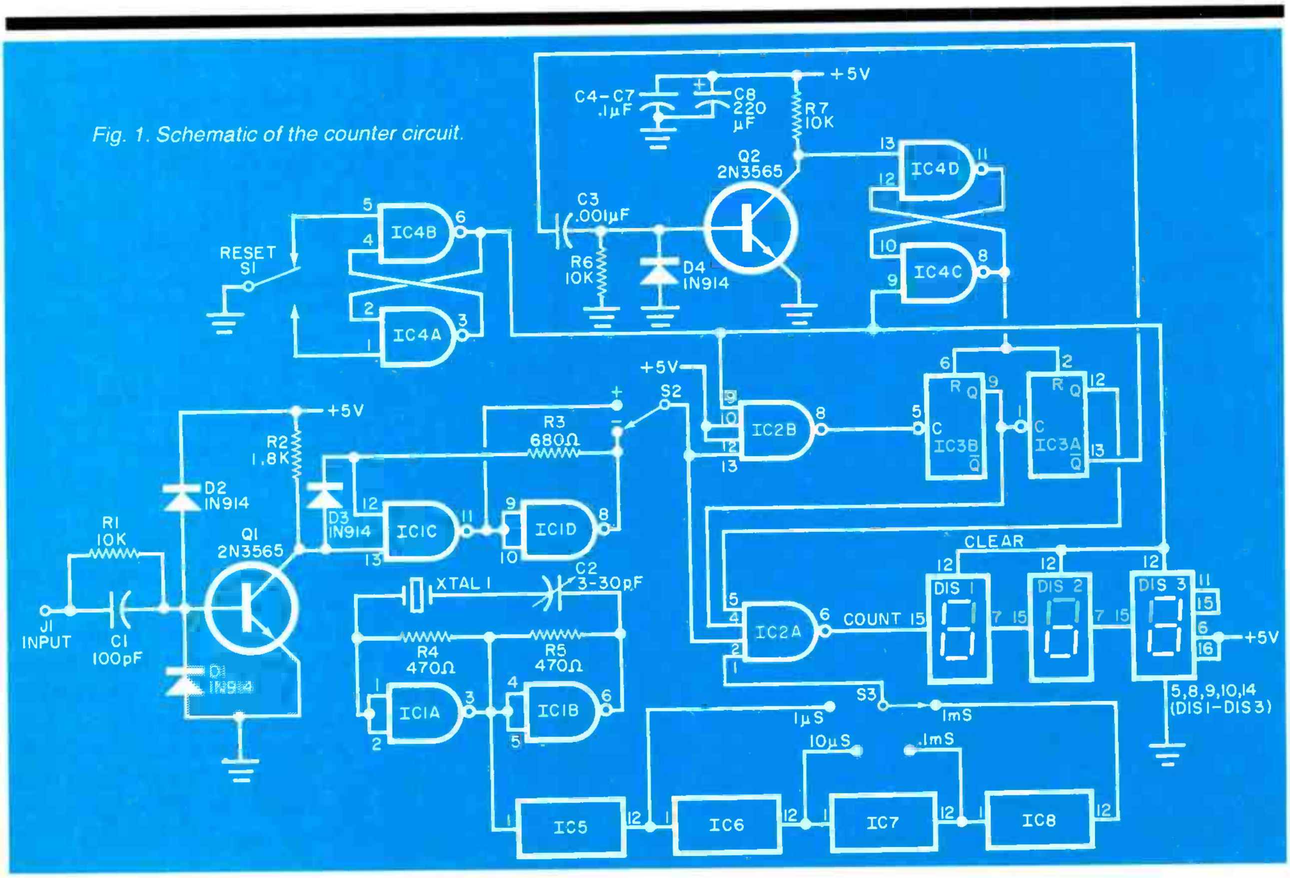


Fig. 1. Schematic of the counter circuit.

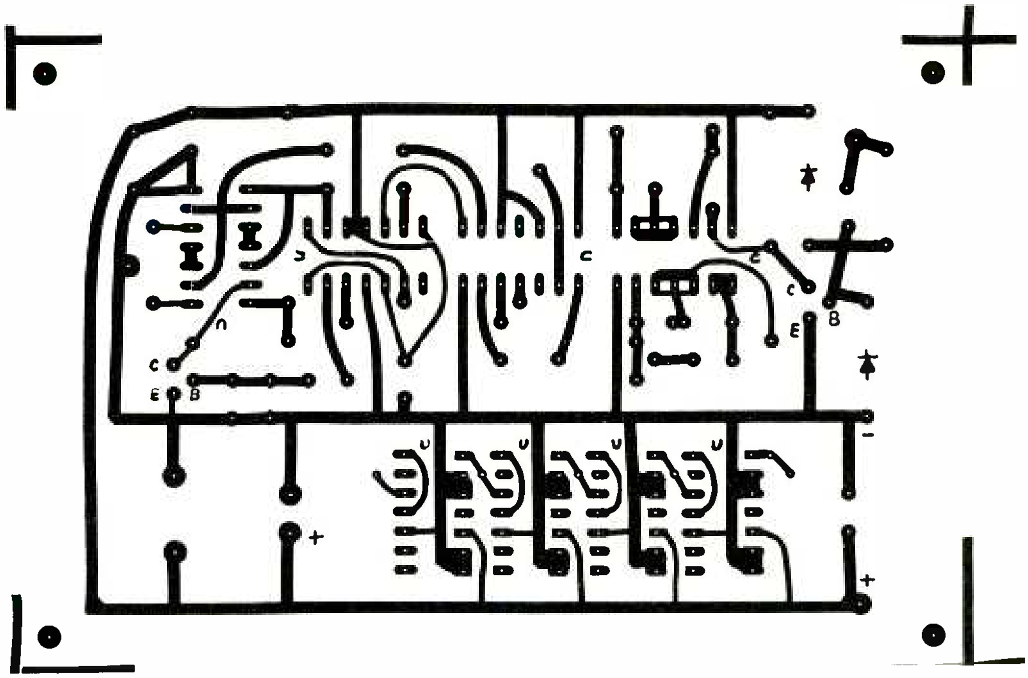


Fig. 2. Foil pattern for a pc board is shown above.

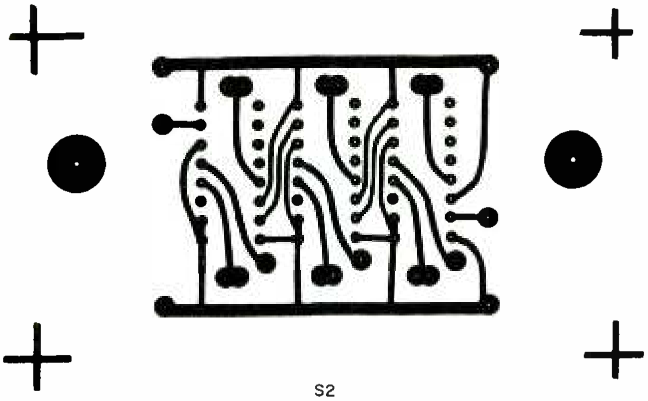
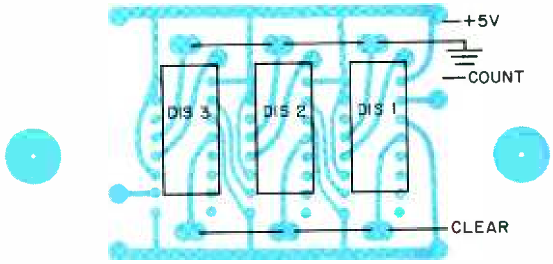


Fig. 3. Foil pattern at left is for display board.



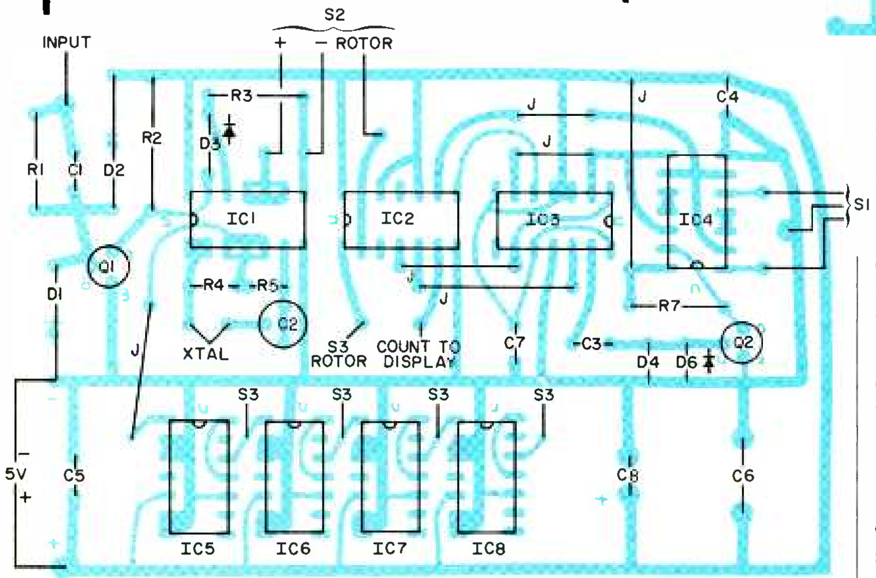


Fig. 4. Component layout for the display board (above) and the main counter pc board (left).

Once a display is shown, it will remain visible until the RESET pushbutton is depressed. Reset the time range switch until the display indicates within its range. Keep in mind that it is the third input pulse whose width is being measured.

It is possible to measure pulse durations to six digits by using a higher range on *S3* and shifting the most significant digits to the left of the display. ◊

SUPER HOLD: A TELEPHONE PERIPHERAL

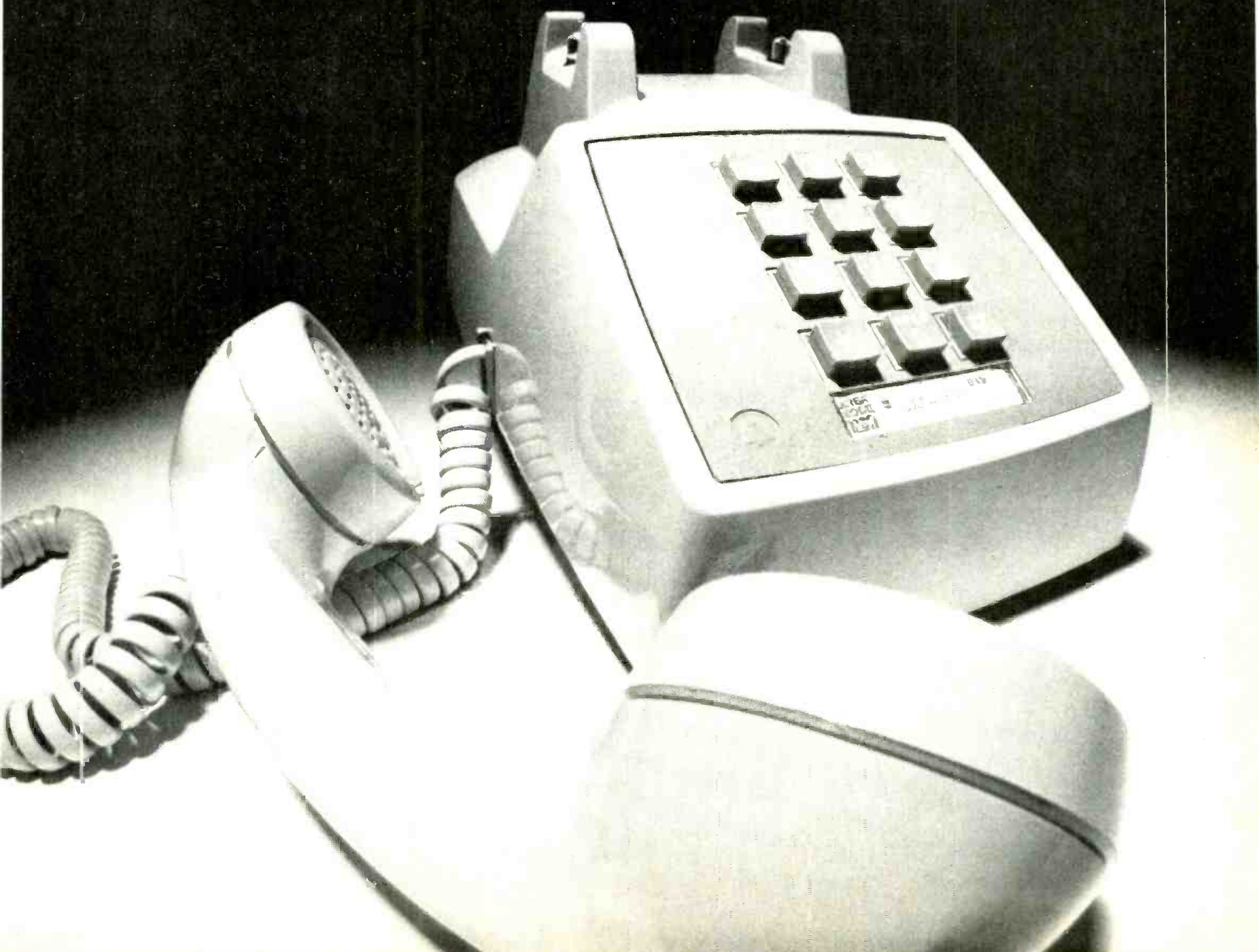
Allows a hold function on any touch-tone phone and has provisions for music during the hold

By Thomas E. Black

IF YOU want to add a "hold" feature to your touch-tone phone, it means adding circuitry, or disassembling and modifying an existing phone. Most telephone companies object to this.

The Super Hold described here requires no modification of the telephone, can be connected anywhere on the telephone line, and can even be used to provide music to the person on hold. (As good as Super Hold is, some telephone companies may require special compliance rulings for such a change, so be sure to check local ordinances with the telephone company before connecting anything to the telephone line.)

Super Hold is essentially a dual-tone decoder that monitors the telephone line and responds to the two frequencies that form the "*" signal (941 and 1209 Hz). Although it is necessary to use a touch-tone



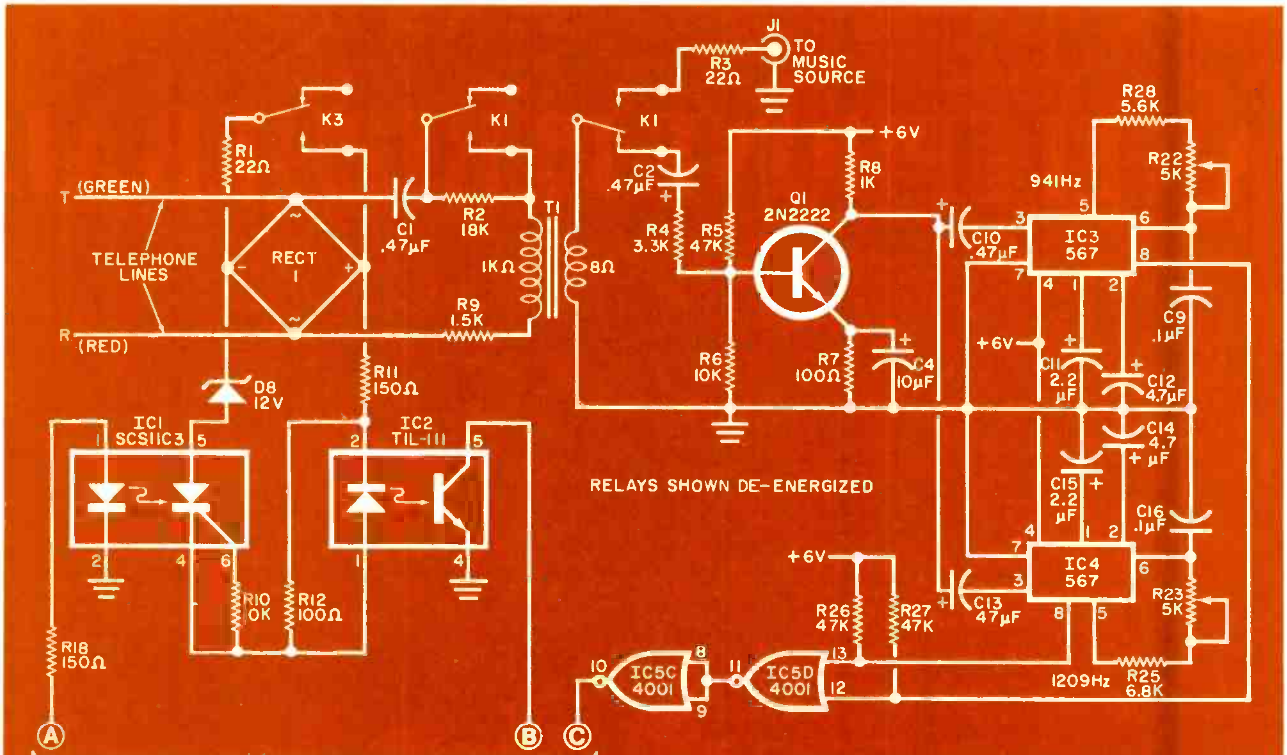


Fig. 1. This circuit is connected across the phone line and is normally quiescent with the phone on the hook.

phone to place a caller on hold, any type of phone can be used to return to the caller and remove the hold condition. Power is supplied by a conventional line-operated supply.

With Super Hold installed, to place someone on hold, simply depress the * pushbutton, then hang up immediately (within five seconds). To return to the holding party, just pick up any phone connected to the same circuit. The complete schematic is shown in Figs. 1 and 2.

Circuit Operation. Super Hold is wired in parallel with the telephone line via the connections marked "T" and "R" shown in Fig. 1. In the non-hold (illustrated) condition, relays *K1, K2,* and *K3* are de-energized and the SCR in *IC1* is nonconducting.

In this mode, no dc current flows through the circuit, so the line behaves as if Super Hold does not exist. With the telephone "on hook," the phone line has 48 volts dc provided by the telephone company's local office. When a phone is taken "off hook," this potential drops to something less than 12 volts, but more than 4 volts. At this lower voltage, 12-volt zener diode *D8* does not conduct. Therefore there is still no current path to Super Hold and the circuit is still "invisible." However, capacitor *C1* provides enough ac coupling to pass all the audio from the telephone line to the primary of transformer *T1*. The contacts of de-energized relay *K1* provide an audio path from the secondary of *T1* to amplifier *Q1*, whose output is sufficient to drive parallel-connected tone decoders *IC3* and *IC4*.

These two tone decoders are preset to respond to the frequencies associated with the two tones (941 Hz and 1209 Hz) generated when the * button is pushed, *IC3* responds to 941 Hz, while *IC4* responds to 1209 Hz. When these two tones (and only these two tones) are present at the inputs of the decoders, each output (pin 8) goes low. NOR gate *IC5D* has its two inputs pulled high via *R26* and *R27*. Thus, its output at pin 11 will be low.

When the two inputs (from the two tone decoders) go low at the same time, the output of *IC5D* goes high. After inversion by *IC5C*, the resulting low is applied to the trigger input (pin 2) of timer *IC6*, as shown in Fig 2. Upon receipt of the input trigger, pin 3 of *IC6* goes high and remains high for the five-second interval determined by *R20* and *C8*. The high on pin 3 performs two simultaneous functions—it drives *Q4* to energize relay *K3* and it enables *IC1*.

When relay *K3* is activated, low-value resistor *R1* is placed across the phone line through *RECT1*. This action greatly reduces the touch-tone level to prevent it from annoying a listener. At the same time, the high at *IC6* pin 3 is applied to the anode of the LED within *IC1* (Fig. 1), causing it to glow. The photosensitive SCR within *IC1* does not latch since there is not enough voltage across the line to cause zener diode *D8* to conduct. To make this zener conduct, the handset must be hung up, and five-second timer *IC6* allowed to time out. When the phone is hung up, *R1* is still across

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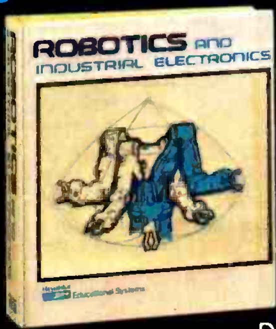

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the line. Hence, no current flows through *D8*. When *IC6* times out, relay *K3* de-energizes, removing the *R1* load from the line. Capacitor *C6* momentarily provides enough current to keep the LED within *IC1* glowing, while *K3* is de-energizing. This ensures that the SCR within *IC1* will latch when *D8* conducts. This latter event occurs as the line voltage increases when the load is removed. With *IC1* enabled, a current path exists across the line, and the incoming call is placed on hold.

With *IC1* latched, current also flows through the LED within opto-coupler *IC2*. When this opto-coupler latches on, it provides a low to *IC5A* via diode *D1*, and to *IC5B* via diode *D2*.

IC5A inverts the low to turn on *Q2* which, in turn, operates relay *K2*. The contacts of this relay can be used to turn on an (optional) tape recorder or radio to feed music to the line (via *J1*) while on hold. The low at *D2* cathode also discharges *C5* via *R16*. After the brief discharge interval, *IC5B* pin 3 goes high, turning on *Q3* and energizing relay *K1*. The delay associated with *C5* and *R16* allows the optional tape deck to get up to speed before applying the tape-recorded music to the phone line. This prevents "slurred" music as the recorder reaches proper speed.

With *K1* energized, the music

PARTS LIST

C1—0.47-μF, 200-V Mylar capacitor
C2, C10, C13—0.47-μF, 16-V electrolytic
C3—Not used
C4, C17—10-μF, 16-volt electrolytic
C5, C8—33-μF, 16-V tantalum capacitor
C6—220-μF, 16-V electrolytic
C7—22-μF, 16-V electrolytic
C9, C16—0.1-μF, 16-V metal film
C11, C15—2.2-μF, 16-V electrolytic
C12, C14—4.7-μF, 16-V electrolytic
C18—1000-μF, 25-V electrolytic
D1 through D4, D8, D9—1N914 or 1N4148
D5 through D7—1N4001 diode
D10—12 V, 1-W zener diode
F1—½-A fast-blow fuse
IC1—SCS11C3 opto-coupler (Radio Shack 276-136)
IC2—TIL-111 opto-coupler (Radio Shack 276-132)
IC3, IC4—LM567 tone decoder
IC5—4001 quad two-input NOR gate
IC6—555 timer
IC7—7805 5-V regulator
J1, J2—Miniature phone connector
K1—Dpdt subminiature relay, 5-V coil (Radio Shack 275-215)
K2, K3—Spdt subminiature relay, 5-V coil (Radio Shack 275-216)
LED1—Red light emitting diode
Q1 through Q4—2N2222 transistor
The following are ¼-W resistor unless otherwise noted:
R1, R3—22 ohms, ½-W
R2—18 kilohms
R4—3.3 kilohms
R5, R13, R16—47 kilohms
R6, R10, R15—10 kilohms
R7, R12—100 ohms
R8, R21—1 kilohm
R9, R14, R17—1.5 kilohms
R11, R18, R24—150 ohms
R19—180 kilohms
R20—68 kilohms
R22, R23—5 kilohm potentiometer (Radio Shack 273-1380)
R25—6.8 kilohms
R26, R27—47 kilohms
R28—5.6 kilohms
RECT1—200-V, 1-A diode bridge
RECT2—50-V, 1-A diode bridge
T1—Audio transformer, 1000:8 ohms, (Radio Shack 273-1380)
T2—Power transformer, 12.6 V at 300 mA
Misc.—Suitable enclosure, fuseholder, rubber grommetts, music source, mounting hardware.

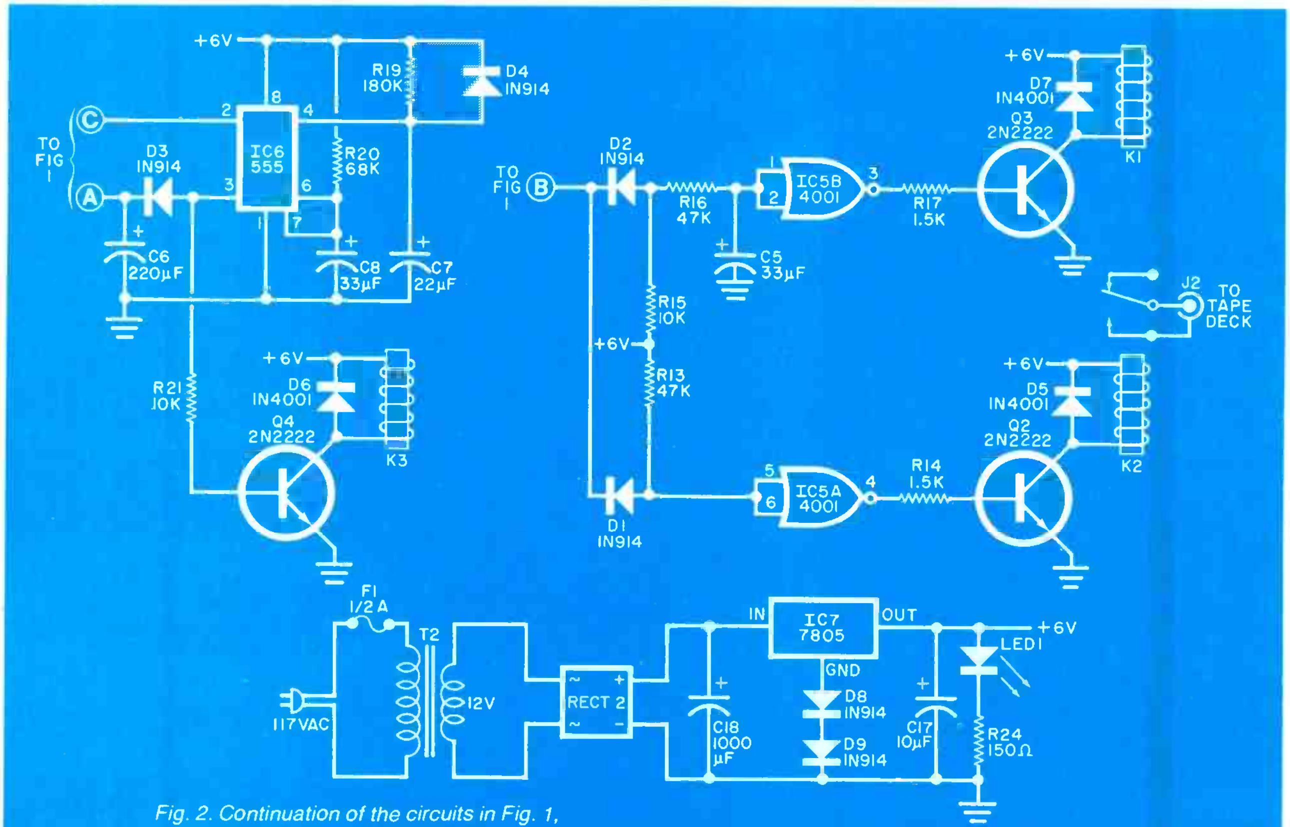
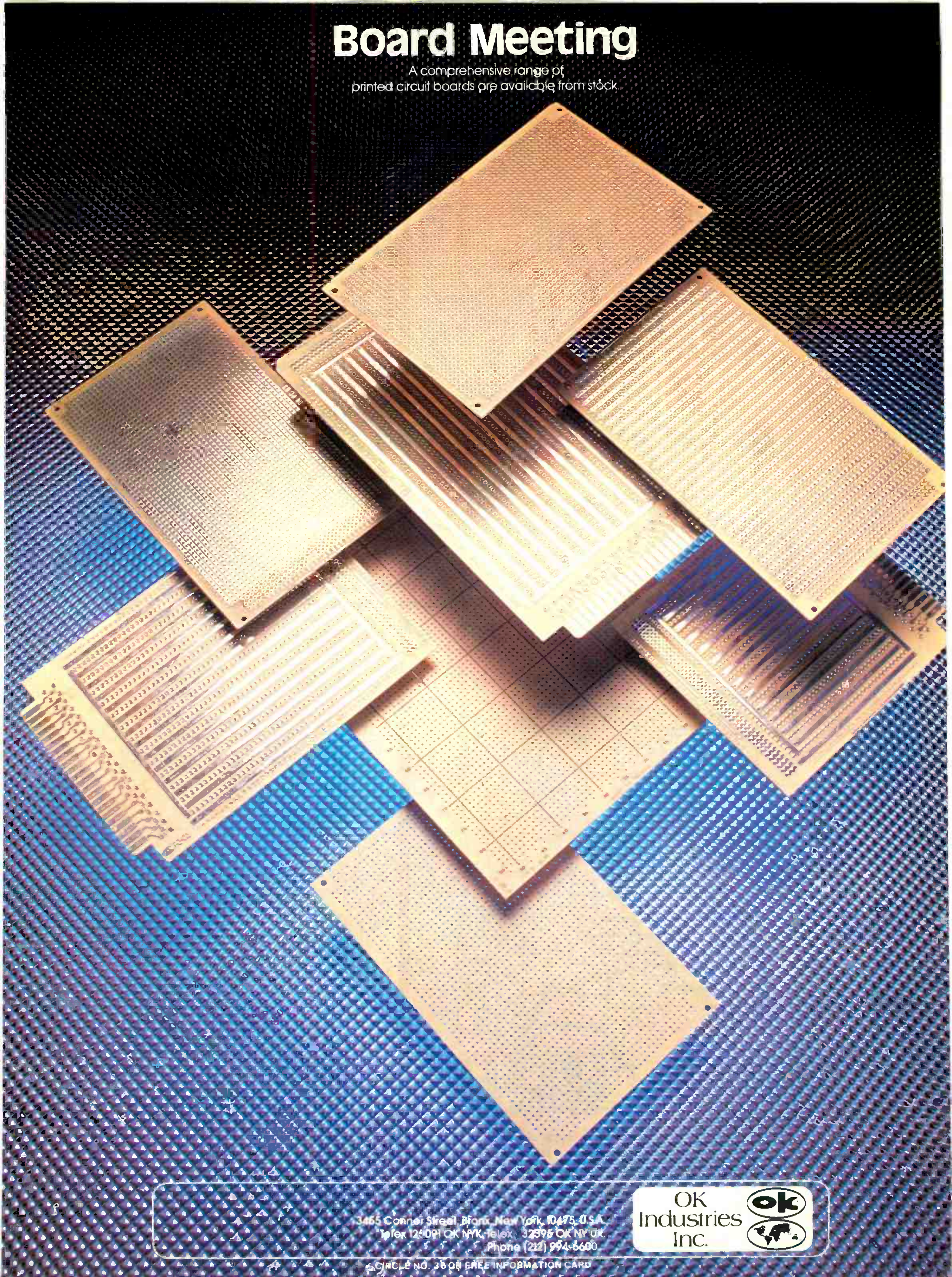


Fig. 2. Continuation of the circuits in Fig. 1, with a suitable power supply circuit.


Board Meeting
A comprehensive range of printed circuit boards are available from stock.
OK Industries Inc.
3465 Conner Street, Bronx, New York 10475, U.S.A.
Telex 125091 OK NYK, Telex 232395 OK NY UK.
Phone (212) 994-6600
CIRCLE NO. 36 ON FREE INFORMATION CARD

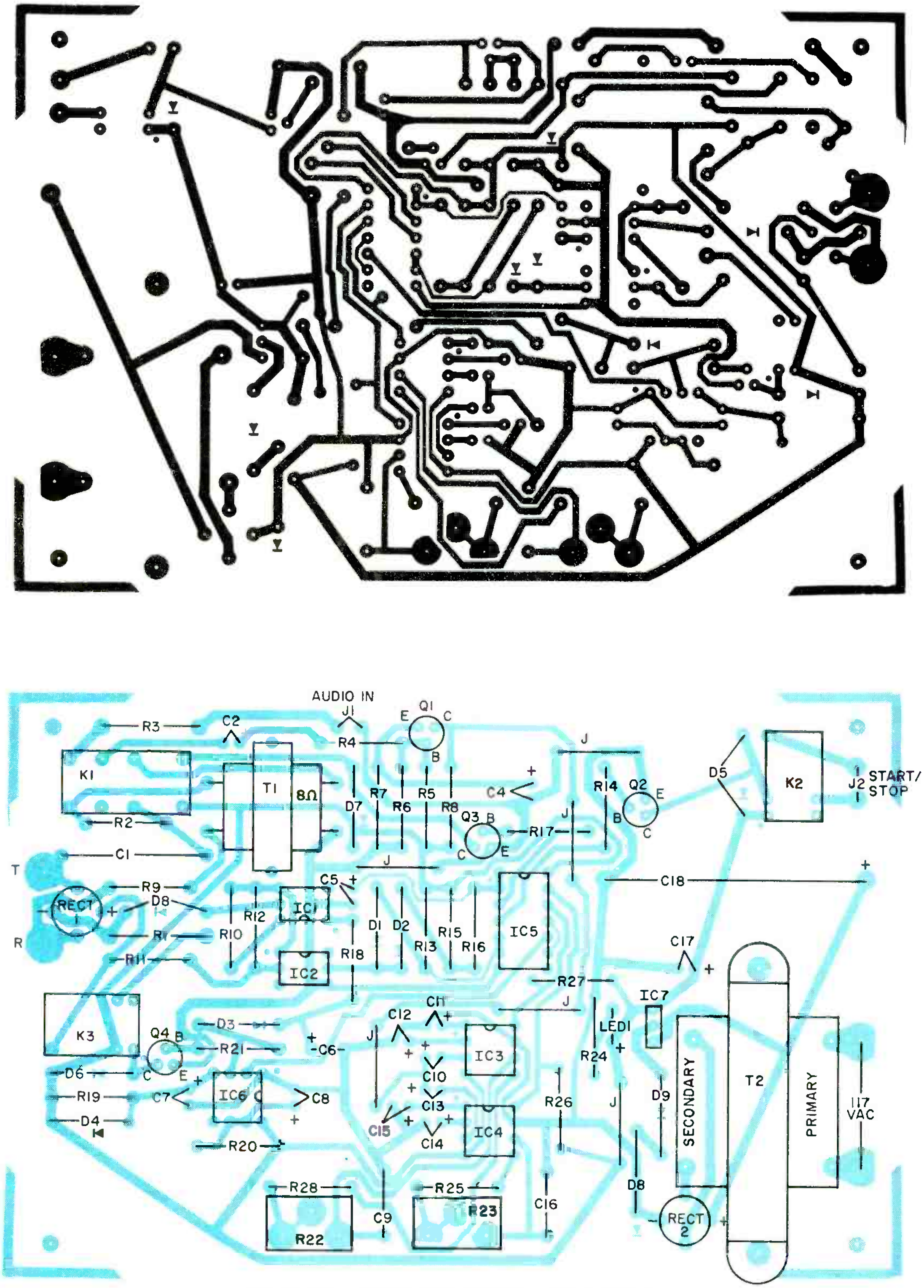


Fig. 3. Same-size foil pattern (top) and component layout for a printed circuit board for the Super Hold.

source is applied to *T1* via *R3*, while other contacts of *K1* short resistor *R2* to prevent attenuation of the music.

To exit the hold condition requires that the SCR within *IC1* have its current interrupted. This can be accomplished in two ways. When the handset is picked off the cradle, the reduced line voltage causes *D8* to stop conducting. This will unlatch the *IC1* SCR and remove power from the LED within *IC2*. Thus, the outputs of gates *IC5A* and *IC5B* go low, de-energizing *K1* and *K2*.

The other source of hold termination may not occur in all telephone districts. If available, the telephone company provides a momentary current interruption to the line when the holding party hangs up. This momentary interruption will reset the *IC1-IC2* loop. In some instances, the current interruption may not occur until a minute or so after hangup or may not occur at all. In any case, picking up the telephone handset will always reset the hold condition.

Construction. Although any form of construction can be used, a pc board using the foil pattern of Fig. 3 is recommended.

Using sockets for all ICs, install all components except *R1* (which will be installed after calibration). Use a heat sink on regulator *IC7*. and mount the fuseholder, jacks *J1* and *J2*. and power transformer *T2* in a suitable enclosure. Mount *LED1* in a grommetted hole, and provide grommetted holes for the power cord and telephone cable.

After temporarily mounting the board (remember that *R1* is missing), turn on the power and note that 6 to 7 volts dc exists across filter capacitor *C17*. Diodes *D6* and *D7* are used to modify the output of the 5-volt regulator to provide about 6 volts.

Calibration. The easiest way to calibrate *IC3* and *IC4* is to use a frequency counter. Connect the high-

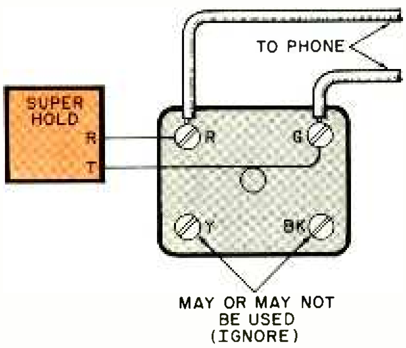


Fig. 4. Use this simple connection while calibrating the Super Hold circuit.

impedance probe to *IC3* pin 6 and adjust *R22* for 941±10 Hz. Move the probe to *IC4* pin 6 and adjust *R23* for an indication of 1209±10 Hz.

The other approach is to connect the Super Hold to the telephone line as shown in Fig. 4, call a friend on the phone and have him remain silent during the following calibration procedure.

Connect the positive lead of a dc voltmeter to *IC5* pin 13 and the negative lead to ground. The meter should indicate about 6 volts dc. Depress the * button on your phone and adjust *R23* until the meter indication drops to about 0.5 volt. Release the * key and note that the voltage increases. Depress the 7 key and note the voltage drop to about 0.5 volt. If not observed, return to the * key and adjust *R23* for a 0.5-volt indication. Depressing the 7 key should cause a drop from 6 to about 0.5 volt dc. This calibrates *IC4*, the 1209-Hz tone decoder.

To adjust *IC3*, the 941-Hz decoder, place the voltmeter positive lead at *IC5* pin 12, depress the * key, and note the voltage drop to about 0.5 V. Release the * key and depress the # key. The meter indication should drop to 0.5 V.

If not, depress the * key and adjust *R22* for a meter indication of about 0.5 V. Depressing the # key should also produce the voltage drop. This calibrates *IC3*, the 941-Hz tone decoder.

Connect the voltmeter to *IC5* pin 10 and note about 6 volts dc on this pin. Depress the * key and note that the voltage drops to about 0.5 V. No other key should produce this effect. If any does, then both *IC3* and *IC4* must be re-calibrated.

Terminate the phone call, remove all test equipment, and disconnect the power. Install *R1* in the circuit. Then connect the Super Hold back to the telephone line and turn on the power. Lift up the phone, depress the * key, and hang up the handset. Relay *K3* should have energized as soon as the * key was depressed. After about five seconds, *K3* should drop out and *K2* (if installed) should be energized. A couple of seconds later, *K1* will also be energized. Picking up the telephone handset should cause relays *K1* and *K2* to be de-energized.

When all works well, install the board in a suitable enclosure, connect *J2* to the tape-deck power on/off, and connect the audio output of the tape deck to *J1*.

Phone a friend, depress the * key to put him on hold, replace the phone in its cradle, and let him listen to the music for a few moments to check the volume. If necessary, re-adjust the volume. If desired, the tape deck components (*Q2* and its associated components) can be left off the circuit and a conventional line-powered radio used as the music source for *J1*. ◇

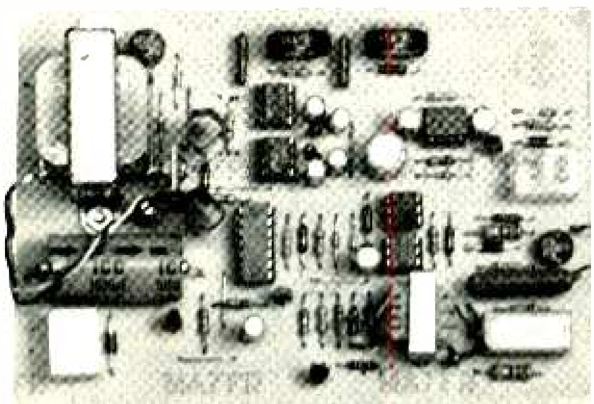


Photo showing layout of the printed circuit board in the author's prototype.

COMPUTER-AIDED LOGIC DESIGN

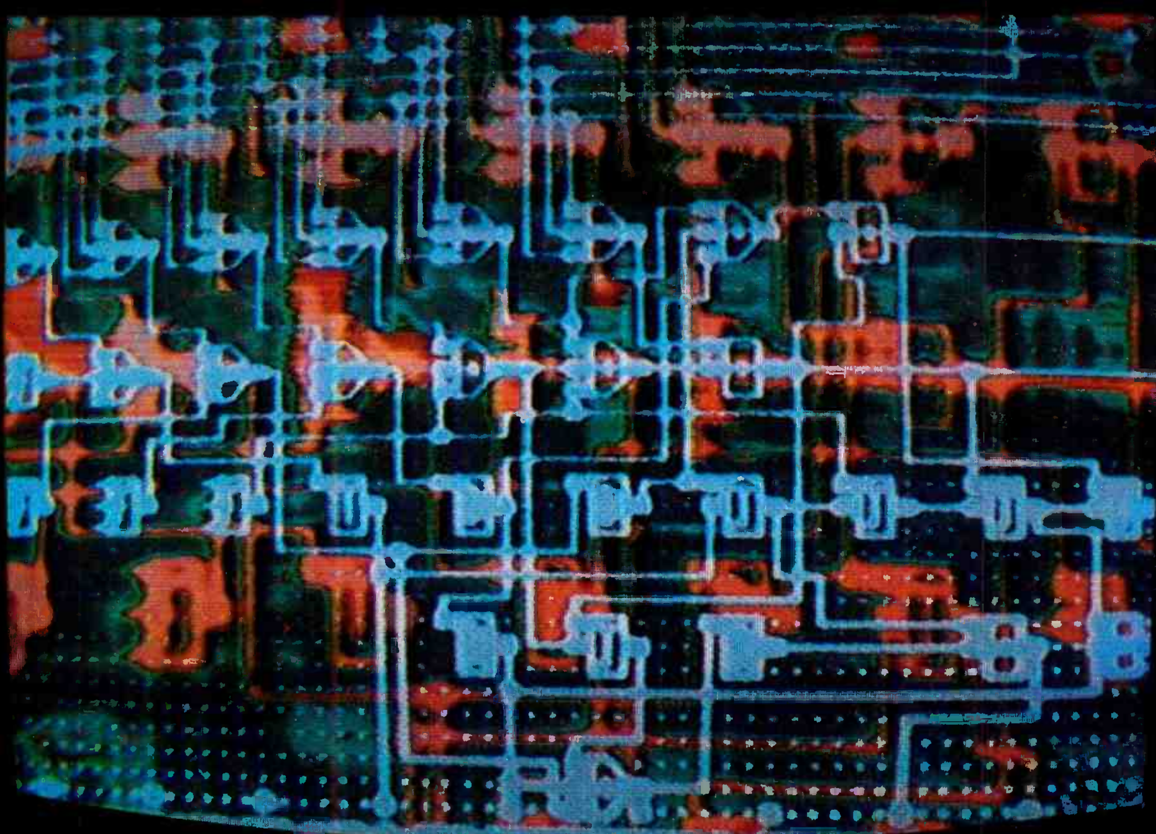
How two important CAD programs can be used for digital circuit design on personal microcomputers

By Charles Rubenstein

COMPUTER aided design (CAD) programs have been used by electronic engineers for years. Until recently, though, these programs were available only for mainframe and minicomputers at a cost of tens of thousands of dollars. Nowadays, CAD programs for both digital and analog circuits are available for popular microcomputers at a cost of just a few hundred dollars. In this article, we'll discuss and evaluate CAD programs for digital circuit design.

What's a CAD System? In general, a CAD system consists of a graphics terminal, light pen or digitizing tablet printer and plotter connected to a mainframe or minicomputer under the control of a CAD program. The program accepts inputs that affect circuit parameters such as type or value of a component, etc. These inputs and subsequent changes and modifications are simultaneously analyzed and evaluated for optimal performance, and the revised circuit or output is displayed.

Using such a system, an engineer can easily try several types of circuits and, in a few hours at the terminal, arrive at the best solution to the original requirements. Also popular on mainframe computers is



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computer aided manufacturing (CAM), which takes the results of the CAD program and directly, or indirectly through NC (numerically controlled) tape generation, controls the part or circuit fabrication.

The μCAD/μCAM programs currently available for 8-bit microcomputers are relatively interactive, miniature versions of their mainframe counterparts. We will concentrate here on two programs covering digital logic circuit design: Logicsim and Logic Designer/ Logic Simulator. We will present a tutorial of the programs, as well as a review and comparison of their strengths and weaknesses.

Logic Circuit Simulation. Textbooks stress that any logic circuit can be constructed using only the simplest small-scale integrated circuit (SSI) NAND and NOR gates. These can be combined into medium-scale integrated circuits (MSI) such as flip-flops, adders and subtractors, and counters and shift registers; large-scale integrated circuits (LSI) such as arithmetic logic units (ALU); and even very-large-scale integrated circuits (VLSI) such as microprocessors and computers.

In our analysis of digital logic simulators we will show how to generate an Exclusive OR gate (Fig. 1A), and compare the simulated Exclusive OR with the program's built-in function. We will then construct a synchronous up/down counter (Fig. 1B). In each case we will follow the step-by-step analysis technique, check the truth table and timing-diagram outputs, and finally compare them with expected results.

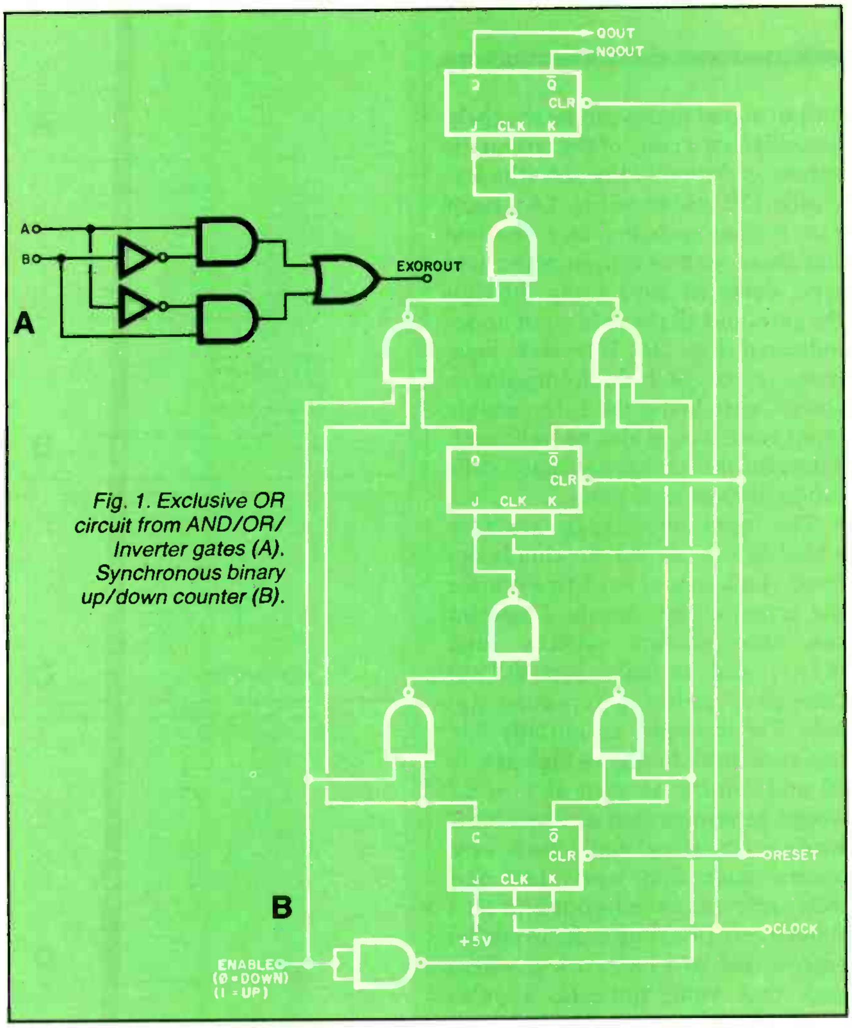


Fig. 1. Exclusive OR circuit from AND/OR/ Inverter gates (A). Synchronous binary up/down counter (B).

Logicsim

LOGICSIM™ (version 5.0), by E/Z Associates, is a semi-interactive professional logic simulator written by Eddy Ozomaro, Ed Sliger, and Ziya Boyacigiller. For this article, Logicsim was run on a Superior Control Systems Model 2810 microcomputer with CP/M and 64K memory. The Wordstar™ word-processing program was used to create the circuit files, and an IBM Selectric was used for output. Logicsim includes a library of 7400-series TTL gates and some CD4000-series CMOS gates.

The operation and use of Logicsim are covered in a manual that carefully describes how to enter circuit parameters and format output truth tables and timing diagrams. An additional manual is included that covers the TTL 7400 series of integrated circuits. Available separately is a CMOS IC macro library and manual. Also built into the program is a plotter package that allows realistic timing diagram printouts on dot-matrix printers.

Setting up Logicsim. Microcomputer aided design programs usually require a user to break up the input information (schematic or logic diagram) into a series of parameters that can be translated into a simulated circuit. Some programs require each point to be clearly identified and each function not in the self-contained library to be specified each time used. Logicsim, however, not only includes the basic 7400 series of TTL logic gates, but also allows a user to create a library of customized macro programs. Thus the user can merely assemble the program parameters and interconnections as if a simple flowchart were being evaluated. Each subcircuit can be evaluated separately, tested, and then added to the library.

Let's see how to create some simple simulations and verify that they behave properly. There are three basic parts needed in a Logicsim program: logic circuit definition and interconnection, signal input specification, and output signal formatting.

First, the logic diagram must be defined as a set of input and output 'nodes' acted upon by a standard logic gate. The interconnection nodes, input signal nodes, and the output signal nodes can be uniquely identified on a copy of the circuit diagram as shown in Fig. 2A (the Exclusive OR circuit of Fig. 1A). Each gate is then evaluated as a one-line statement with its output node, gate type, delay (if any) going through the gate, and all the gate input nodes indicated (Fig. 2B). If tri-state logic (one, zero, and high-impedance states) were being used, the enable input node would also be indicated. There must be at least as many definition lines as logic gates.

The input line signals are now added as a series of individually defined clock inputs used to simulate the actual circuit inputs. Logicsim can accommodate initially high (CLK1) and initially low (CLK0) "one-shot" pulses or repeating signals. For example, an initially low one-shot pulse that goes high at t = 20 and returns to zero at t = 22 would be represented as CLK0 20 22, while a repeating signal such as a square wave that starts low and then cycles between its one and zero states every two time units would be represented by CLK0 2 4 R 2, where each time value indicates a pulse transition and R indicates a repeating waveform.

Lastly, the output processing is configured. The total time for processing, the increment at which the user wants to see an output, and the initial time (if it is not t = 0) can be defined by using a time statement (.TIME 32 4). The user has the choice of outputting a truth table (.PRINT), or plotting the output on the screen or on a character printer (.PLOT). For those with dot-matrix printers, a separate print statement that yields a more oscilloscope-like output on the printer is included. In either case, the user describes in the output statement the format and order of presentation of the output.

For this particular problem the .PRINT command was used to view the truth table (Fig. 2C), and then the .PLOT command was used to see the timing diagram (Fig. 2D). In both cases, input signals AIN and BIN were used. Finally, outputs OUT (from the logic diagram) and

A

```
$ EXCLUSIVE OR CIRCUIT ANALYSIS

$FORMAT
$OUT-GATE-DELAY-INPUT NODES

N3   INV  Ø    BIN
N4   INV  Ø    AIN
N5   AND  Ø    AIN  N3
N6   AND  Ø    BIN  N4
OUT  OR   Ø    N5   N6
$BUILT-IN EXCLUSIVE OR FUNCTION
XROUT EXOR Ø   AIN  BIN

$INPUT TEST SIGNAL
AIN  CLKØ 4 8  R 4
BIN  CLKØ 8 16 R 8

$COMMAND STATEMENTS
.TIME 12 4
.PRINT BIN AIN .SKIP OUT XROUT
.END
```

B

```
           BA  OX
           II  UR
           NN  TO
                U
                T
   TIME
     Ø     ØØ  ØØ
     4     Ø1  11
     8     1Ø  11
    12     11  ØØ

Total Iterations:        24
```

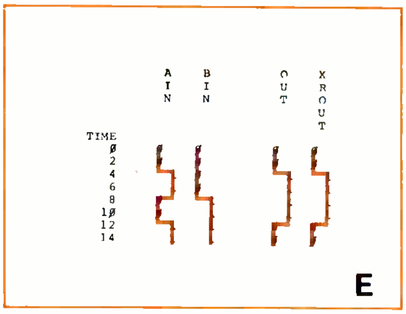
C

```
$ EXCLUSIVE OR CIRCUIT ANALYSIS

            A     B          O     X
            I     I          U     R
            N     N          T     O
                                   U
                                   T
   TIME
     Ø      Ø     Ø          Ø     Ø
     2      Ø     Ø          Ø     Ø
     4        1   Ø            1     1
     6        1   Ø            1     1
     8      Ø       1          1     1
    1Ø      Ø       1          1     1
    12        1     1        Ø     Ø
    14        1     1        Ø     Ø

Total Iterations:        26
```

D



E

Fig. 2. Node identification for Exclusive OR (A). Logicsim Exclusive OR program (B). Truth table for Exclusive OR (C). Exclusive OR timing diagram (D). Timing diagram rotated 90° and marked (E).

XROUT (the built-in function) were compared. Figure 2E shows how the .PLOT output can be marked and rotated 90° to show the more acceptable clock-transition timing diagram, which roughly approximates an oscilloscope pattern.

After creating the Exor program on paper, Wordstar was used to create an Exor.Ckt file and Logicsim was used to analyze it. The "conversation" with Logicsim is shown in Fig. 3A. First the user is asked to indicate which Library File of prewritten logic circuit networks (macros) he wishes to use. At this point he simply presses RETURN for the 7400 TTL library (NET.LIB or a custom file; with a filetype assumed). Logicsim then prompts for the name of the Output File. RETURN is pressed for screen output; LST: is typed in for CP/M list device output; or a file name in which the program output will be saved is typed in (under an .LST filetype).

Next the user is prompted for the name of the Input File to be analyzed. In this case Exor is typed in (the .CKT filetype is assumed).

In the above analysis, all files were assumed to be resident on the logged-on drive. If another drive were desired as the source of the input or location for the output files (i.e. the B drive), the format would have been @B ADDSUB, etc.

Although not required in this simple case, the user can verify the correctness of the circuit by checking how Logicsim evaluated the inputs. Using the .VERIF command will output a connection map (Fig. 3B). After checking this map with the original circuit, the analysis can be continued. For those interested in a more complete analysis of the inputs, outputs, etc., the .LIST command can be used (Fig. 3C).

From time to time one may wish to evaluate several output formats and commands. This is most easily done by omitting the .END statement from the program and thereby forcing the program into a keyboard entry mode. While in this mode, minor changes of gate patterns, as well as different output commands can be entered and processed after entering the .END command from the keyboard.

Using the same techniques as above, the synchronous up/down counter of Fig. 1B was analyzed. The up/down counter makes use of macro files (Fig. 4) since it uses the J-K flip-flop as a circuit element. This simplifies the program in that the macro does not have to be repeated each time a flip-flop element is needed. Figures 5A and 5B show

the node identification and circuit program (lines with an asterisk indicate that a macro definition is being used). Figure 5C is the truth table for the counter and Figs. 5D and 5E prove out the circuit's function using timing diagrams. The Logicsim analysis of this circuit took less than 15 minutes (after correcting a few typos and format "errors" to get the output just right).

Debugging Logicsim. The compiler nature of Logicsim makes it somewhat tedious to debug the program. Of course, all the error messages you could ask for are there; but I found I had to exit Logicsim, "repair" the net list with my word processor (Wordstar in my case), and then re-enter and try again. A simple way to change signals and output formats is to leave the .END statement off of the file and supply overriding commands from the keyboard. You can, of course, see the results of the simulation by defaulting to screen output initially; but this too becomes frustrating as there is no interactive screen editor built into Logicsim to allow adding and deleting specific lines, etc. The speed of debugging and revising is thus dependent on how fast you can get into your word processor and then back into Logicsim. I would estimate something like 2-5 minutes per iteration.

The only Logicsim technical problems that I am aware of are those common to most simulation programs. That is, they cannot handle the possibility of an output and input signal appearing simultaneously, or else they oscillate trying. This dc convergence problem is avoided by incorporating delays through feedback gates. When using delays through gates, it is important to use a minimum time step of two times the longest delay to allow settling of the output. Also important is to reset all flip-flop clears for one clock pulse before beginning a simulation so that indeterminate outputs are avoided.

Logicsim for the IBM-PC. By the time you read this, the IBM-PC version of Logicsim will have been released. This program takes advantage of the IBM PC's 16-bit power. It integrates Fortran and machine language into an extremely sophisticated design package that allows the user to simulate up to 4000 nodes, rising/falling edge effects, and real-time graphics.

An additional IBM-PC package allows the user to enter a "snapshot mode" during the real-time execution of the timing diagram, which simulates an oscilloscope output. In this mode, a series of control characters will "dump" the screen's "snapshot" onto a printer (Fig. 6). Truly the matchup of Logicsim with the IBM-PC assembles a $30,000 to $60,000 logic analysis system at one-tenth the cost.

```
LOGICSIM Version 5.Ø
Copyright (c) 1982 By Eddy Ozomaro
Copyright (c) 1982 By E/Z Associates
All Rights Reserved. September-3-1982


Library File:

Output  File:

Input   File: EXOR

 !Compiling EXOR    CKT !

     $ EXCLUSIVE OR CIRCUIT ANALYSIS

      $FORMAT
      $OUT-GATE-DELAY-INPUT NODES
      $EXCLUSIVE OR FROM AND/OR/INVERTER GATES:
      N3    INV   Ø     BIN
      N4    INV   Ø     AIN
      N5    AND   Ø     AIN   N3
      N6    AND   Ø     BIN   N4
      OUT   OR    Ø     N5    N6
      $BUILT-IN EXCLUSIVE OR FUNCTION
      XROUT EXOR Ø   AIN   BIN

      $INPUT TEST SIGNAL
      AIN   CLKØ 4 8  R 4
      BIN   CLKØ 8 16 R 8

      $COMMAND STATEMENTS
      .TIME 12 4
      .PRINT BIN AIN .SKIP OUT XROUT
      .END
*WAIT* Loading LOGØ2.OVL
Network Checking Begins ...
Network Checking Complete ...
  Ø Error(s) Detected
  Ø Warning(s) Detected

Network Preprocessing Begins ...
Preprocessing Complete ...
  Ø Fatal Error(s) Detected

!Analysis Begins!


$ EXCLUSIVE OR CIRCUIT ANALYSIS


                BA OX
                II UR
                NN TO
                    U
                    T
        TIME
           Ø    ØØ ØØ
           4    Ø1 11
           8    1Ø 11
          12    11 ØØ

Total Iterations:          24

No Output File Generated

Analysis Terminated....
```

A

```
Output Connection Map++++
Gate Name      Output Connections

N3             N5
N4             N6
N5             OUT
N6             OUT
OUT
XROUT
AIN            N4         N5         XROUT
BIN            N3         N6         XROUT

Program Storage Utilization++++

Standard Gates & clocks:     8
Logic  Nodes Processed:      8
Macro Definitions:           Ø
Total Macro Expansions:      Ø
Total ROM/RAM Gates:         Ø
Total ROM/RAM Storage:       Ø
```

B

```
Level Symbols ++++

FLOW  = Ø   FHIGH = 1   FINDET= *
LOW   = Ø   HIGH  = 1   INDET = *
ZLOW  = Z   ZHIGH = Z   ZINDET= Z


LOGICSIM Standard Gates++++


INT.   LABEL      GATE     DELAY      INPUT(S)
 *     N3         INV        Ø        BIN
 *     N4         INV        Ø        AIN
 *     N5         AND        Ø        AIN      N3
 *     N6         AND        Ø        BIN      N4
 *     OUT        OR         Ø        N5       N6
 *     XROUT      EXOR       Ø        AIN      BIN
Print Time ++++
Max. Time      Delta      Min. Time

  12             4           Ø

Print and Plot Output Specifications++++

BIN        AIN        OUT        XROUT

Input Clocks++++

Init.   Name        Switching Timepoints

 Ø        AIN          4      8
     Repeat From       4
 Ø        BIN          8     16
     Repeat From       8
```

C

Fig. 3. A conversation with Logicsim (A). The "-VERIF" output (B). The ".LIST" output (C).

Logic Designer/ Logic Simulator

VOLUMES I and II of the Spectrum Software Electronics Series comprise a pair of programs that allow owners of Apple or IBM-PC microcomputers to create digital logic circuit designs using semiinteractive, computer-aided graphics techniques. The programs consist of the graphic display designer, Logic Designer, and the network list simulator, Logic Simulator, operating under menu control. The programs were reviewed on a dual-drive, 64K RAM Apple II+ using an Epson MX80FT printer.

Both programs include enough word processing to handle the creation and modification of files from within the program. It should be noted that the programs could have been run on a 48K system since many of the files are loaded only when actually needed. However, although it is possible to use the Logic Simulator program on a single-drive system, the Logic Designer (graphics program) requires a data disk for the storage of hi-res graphics and is tedious to use with only one drive. Unlike Logicsim, there are no true macro files and thus no IC library files available.

Using the Logic Designer. The Logic Designer program allows you to create a logic diagram right on the video display screen. A completed diagram may be as large as six pages (screens) and contain up to 77 gates per page. Each page uses a 40 × 70 grid as a workspace. The program has a built-in Help function to remind you of how to create your design. The gates available are the OR, AND, NOR, NAND, and Exclusive OR. All gates have 3 inputs. (Thus, for larger fan-ins, you may have to OR the outputs, etc.) Since there are no inverter gates, they must be configured by using one input of a NOR gate.

There are no tri-state gates, and no provision for wired ORing of the outputs of two or more gates. Each gate has a '0' delay; and there is no provision for adding the delays necessary to create flip-flops or adjust the circuit for dc convergence where feedback is used. Rather than arbitrary inputs, you must use signal sources (defined later) for your inputs.

Also available are the D, T, and JK flip-flops. These do not have provision for presets, clear, or clock inputs, and only have Q outputs. (The not-Q output is obtained by passing the Q through a NOR gate). One can also implement up to 32-bit-long shift registers and can use any of 16 user-definable 8-bit by 1-bit ROMs called *macros* (Fig. 7). Note in this case that only macros 0 to 10 have been defined. The manual suggests "using the D flip-flop with macros to create any desired logic function." (I for one was unhappy with the prospect of forming a multiple gate and D flip-flop circuit *each* time I wanted a JK with preset and clear, etc.)

Other than a "beep" that occurs when the user tries to pass the cursor through a logic gate on the grid, there is no error detection on the screen-generated circuit. For example, a user is not warned against connecting an input and output of the same gate except in the general guidelines given in the manual.

There doesn't seem to be an easy way of using entire circuits as if they were (Logicsim-like) macros. Thus it would seem that the program is a one-person type that requires you to modify and manually add-on any additional circuits.

It is important to realize that the picture drawn on the screen is used only to generate the net list for the circuit, and cannot be printed. The Logic Designer program, albeit a very nice display tool, takes about ten times longer to implement a circuit's net list than the line-by-line method. Figure 8A shows the Exclusive OR circuit created with Logic Designer, while Fig. 8B shows the net list automatically generated by the program.

Using The Logic Simulator. With the Logic Simulator program, you can create, modify, save, or retrieve a network list or signal source pattern for a logic circuit. The Logic Simulator Main Menu is:

1: REVIEW/EDIT NETWORK
2: REVIEW/EDIT PATTERNS
3: DISK OPERATIONS
4: START A SIMULATION
5: SELECT PRINTOUT NODES
6: REVIEW/EDIT MACROS
7: FAN-OUT REPORT
8: RETURN TO DISK MENU

In addition to a network file (choice #1), the user has to generate a pattern file (choice #2), and select the order of the output nodes (choice

ABOUT THE PRODUCTS

Logicsim™

By E/Z Associates, 5589 Starcrest Dr., San Jose, CA 95123 (408-578-8096)

East Coast Distributor: Applied Research Engineering Associates, 1289 E. 91 St., Brooklyn, NY 11236 (212-241-1016)

Software Formats Available:
(1) 8" IBM 3740 Format, 56K + CP/M; $276
(2) Apple II+, 64K, CP/M; $276
(3) IBM-PC; $495
IBM-PC graphics option; $150
IBM-PC TTL Library/Manual; $75

Includes: Logicsim, TTL 7400-series Library, Dot-Matrix Plot Routine and Manuals.

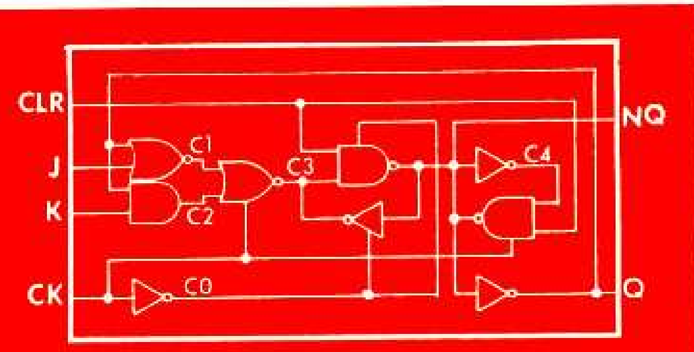
Macro Library Options:
CMOS IC Library and Manual; $75
NMOS IC Library and Manual; $75

Logic Designer/Logic Simulator

By Spectrum Software, 690 W. Fremont Ave., Suite #11, Sunnyvale, CA 94087

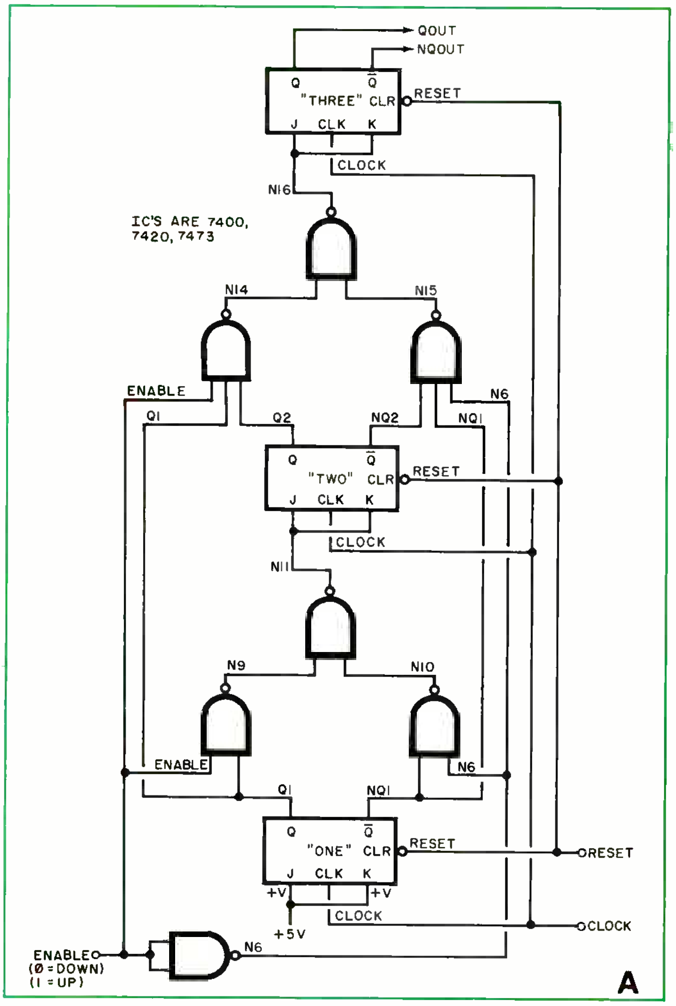
Software Formats Available:
(1) Apple II+, 1 or 2 drives; $250
(2) IBM-PC; $250

Includes: Logic Designer & Logic Simulator program and manual.




```
.MACRO JKC CK J K CLR Q NQ
C0 INV 0 CK
C1 NOR 0 J Q
C2 AND 0 K Q
C3 TNOR 0 CK C1 C2
NQ TNAND 1 C0 CLR C3
C3 TINV 0 C0 NQ
C4 INV 1 NQ
NQ TNAND 0 CK CLR C4
Q INV 0 NQ
.EOM JKC
```

Fig. 4. JK flip-flop with clear macro definition.




```
$ SYNCHRONOUS BINARY UP/DOWN COUNTER

$CIRCUIT DIAGRAM
N6     NAND Ø     ENABLE      ENABLE
$MACRO FORMAT FOR 7473 TYPE FLIP-FLOP
$NAME-JKC-CLOCK  -  J  - K  - CLR  -  Q -  NQ
*ONE JKC  CLOCK      V+    V+    RESET   Q1    NQ1
N9    NAND Ø     ENABLE      Q1
N1Ø   NAND Ø     N6          NQ1
N11   NAND Ø     N9          N1Ø
*TWO JKC  CLOCK      N11   N11   RESET   Q2    NQ2
N14   NAND Ø     ENABLE      Q1    Q2
N15   NAND Ø     N6          Q1    Q2
N16   NAND 0/     N14   N15
*THREE JKC  CLOCK    N16   N16   RESET   QOUT NQOUT

$INPUT SIGNALS AND CLOCKS
V+          CLK1
CLOCK       CLKØ   2   4   R   2
RESET       CLKØ   4   6Ø  62
ENABLE      CLK1   34  6Ø
$ENABLE =1 FOR UP COUNTER; =Ø FOR DOWN COUNTER

$OUTPUT COMMAND STATEMENTS
.TIME 1ØØ 2
.PLOT ENABLE .SKIP RESET .SKIP CLOCK .SKIP Q1 Q2 .SKIP QOUT
.END
```

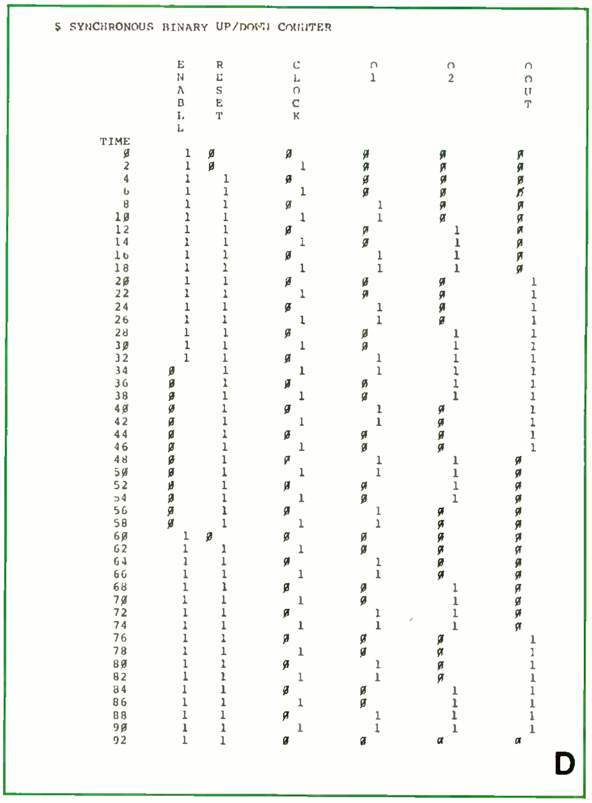
B

```
$ SYNCHRONOUS BINARY UP/DOWN COUNTER

                 ER C O O O
                 NE L 1 2 O
                 AS O     U
                 BE C     T
         RESET   LT K
                 E
      TIME
        Ø        1Ø Ø Ø Ø Ø
        4        11 Ø Ø Ø Ø
        8        11 Ø 1 Ø Ø
       12        11 Ø Ø 1 Ø
       16    UP  11 Ø 1 1 Ø
       2Ø        11 Ø Ø Ø 1
       24        11 Ø 1 Ø 1
       28        11 Ø Ø 1 1
       32        11 Ø 1 1 1
       36        Ø1 Ø Ø 1 1
       4Ø        Ø1 Ø 1 Ø 1
       44   DOWN Ø1 Ø Ø Ø 1
       48        Ø1 Ø 1 1 Ø
       52        Ø1 Ø Ø 1 Ø
       56        Ø1 Ø 1 Ø Ø
       6ØRESET   1Ø Ø Ø Ø Ø
       64        11 Ø 1 Ø Ø
       68        11 Ø Ø 1 Ø
       72        11 Ø 1 1 Ø
       76        11 Ø Ø Ø 1
       8Ø    UP  11 Ø 1 Ø 1
       84        11 Ø Ø 1 1
       88        11 Ø 1 1 1
       92        11 Ø Ø Ø Ø
       96        11 Ø 1 Ø Ø
      1ØØ        11 Ø Ø 1 Ø

Total Iterations:           351
```

C



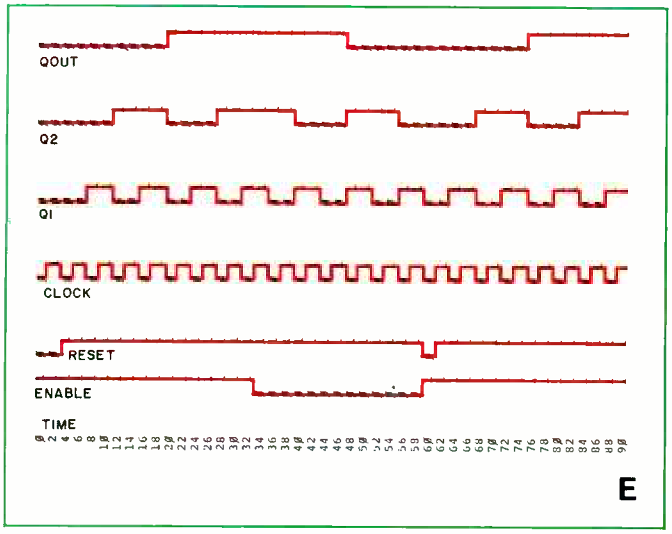


Fig. 5. Synchronous binary up/down converter with node identification (A). Logicsim for synchronous binary up/down counter (B). Truth table for synchronous binary up/down converter (C). Timing diagram for synchronous binary up/down converter (D). Rotated/marked timing diagram (E).

#5) prior to doing an actual simulation (choice #4). If macros are to be used, they may need editing (choice #6); and as a pre-simulation check, the user may decide to check the gate fan-outs (choice #7).

A network file that is created in the Logic Designer mode can be saved. This is done by selecting choice #3, Disc Operations. The Disc Operations menu allows the user to save, retrieve, and delete networks and patterns. The Logic Designer network can be saved on drive one since it doesn't take up too much space.

It is important to note that the net list generated by the Logic Designer is not optimized in that it does not remove "vacant nodes" from the wire list (Fig. 8B). This results in a waste of space and also makes it difficult to understand the net list. When a gate-by-gate analysis of the Exclusive OR circuit was done with the Logic Simulator, a much more compact, easier to understand network listing was generated (Fig. 9A). For each source on the network list, column A shows its number. For each logic gate on the list, columns A, B, and C show the nodes connected to that gate's inputs. Note in Fig. 9A that nodes 1 and 2 are sources 1 and 2. Nodes 3 through 7 represent the Exclusive OR network. Node 8 is the built-in Exclusive OR, whose inputs are connected to nodes 1 and 2 (the sources).

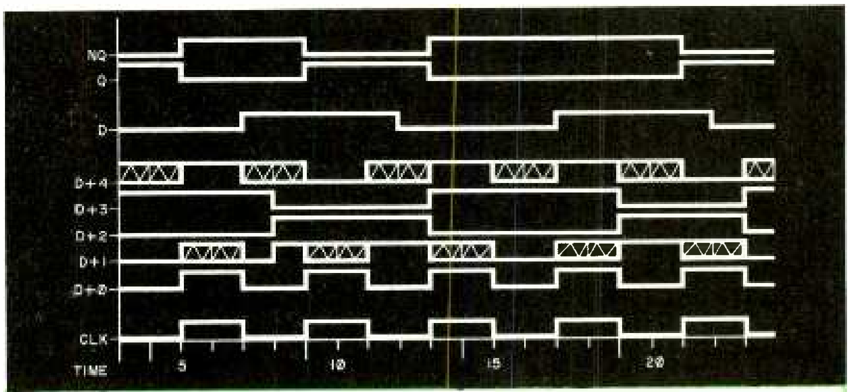


Fig. 6. IBM-PC "Graphics Option" screen dump of Type D flip-flop test circuit.

```
$D-FLIP/FLOP TEST CIRCUIT
.SET SDUMP=25
CLK      CLK0 2 4 R 2
D        CLK1 3 9 R 1
D+1      PXFR 1 CLK D
D+2      RES 0 D+1
D+2      AND 0 D+1
D+3      INV 0 D+2
D+4      UXFR 0 CLK D+3
NQ       RES 0 D+4
NQ       AND 0 D+4
Q        INV 0 NQ
.FHIGH .DFLT
.TIME 200
.GPLOT CLK , D+1 D+2 D+3 D+4 , D , Q  NQ
.SPICE
.END
```

Having stored a net list derived from either the Logic Designer or the Logic Simulator program, the next step that must be completed prior to running the simulator is to create a pattern file for the Signal Source inputs (Fig. 9B). The pattern editor allows a user to configure up to 18 individual signal sources. The signals can be random patterns of zeroes and ones, set to any arbitrary pulse series; or, more often than not for truth table generation, they can be a binary pattern. Once set, a pattern can be stored in much the same way as the network listings. There are a total of 32 "pages" of 8 clock times each, or 256 clock times usable as inputs to the network under simulation. The exact number of clock times viewed is defined after the simulation is run. The user must now decide how to present the output nodes.

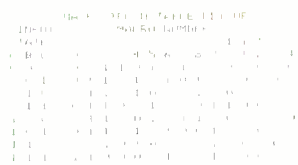
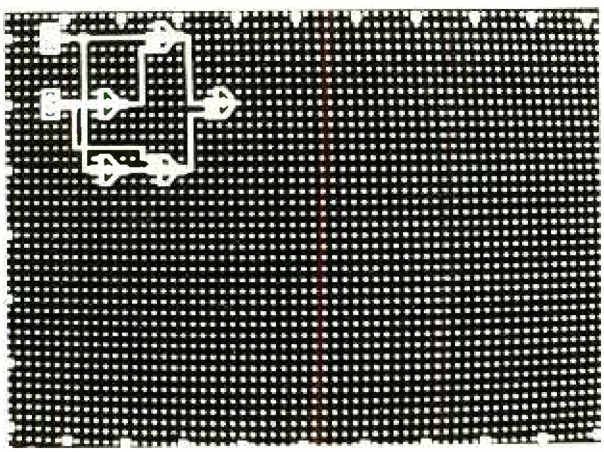
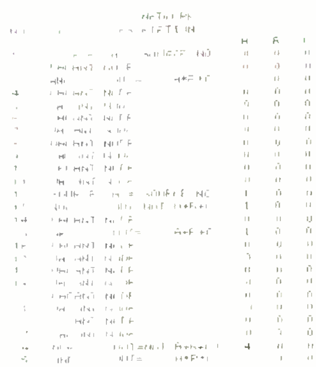


Fig. 7. Logic Simulator macrofiles.

Note again, you must have a network listing, a pattern, *and* have defined the order of output node display in memory *before* invoking the simulator. If any portion is missing, your RUN will bomb-out requiring a RESET and PR#6 and then a repeat



A



B

Fig. 8. Exclusive OR graphic (A). Net list generated by Logic Designer (B).

of the file retrieval procedure. When the Logic Simulator program is run, the output node listing appears on either the CRT or the printer unless an error was made in logical design or construction. Then perhaps a few output lines will appear, after which the program will halt, waiting for the outputs to stabilize.

Before running the simulation, the net listing can be checked using the fan-out routine (Fig. 9C). For each node, the gate number driven and pin number are shown. When a simulation is run, the output node display shows the bit time and nodes monitored (Fig. 9D). In this case, nodes 1 and 2 are the signal sources, node 7 is the output from the Exclusive OR circuit and node 8 shows the output from the built-in Exclusive OR. (Outputs 7 and 8 are equal.)

The Logic Simulator was used not only to generate a line-by-line net list for the Exclusive OR circuit, but for the binary up/down counter (Fig. 10A). The pattern file was created (Fig. 10B) and fan-out routine was checked (Fig. 10C) prior to doing a simulation of the logic circuit (Fig. 10D). It is important to note that the input signals XIN and YIN from the Logicsim program correspond to the signal sources 1 and 2 in each case.

Since the Logic Simulator does not use clock, clear, or preset signals, only an enable (signal source #1) and a V+ (signal source #2) are generated with the pattern file for the up/down counter. Reviewing the results of these circuits, it appears that the simulation will run all right unless there are implied flip-flops. Obviously, there is no way to specify a name for an input or output signal. Only the network listing node numbers are used. The nodes can be sequenced differently for output, but naming of the I/O lines is still not possible.

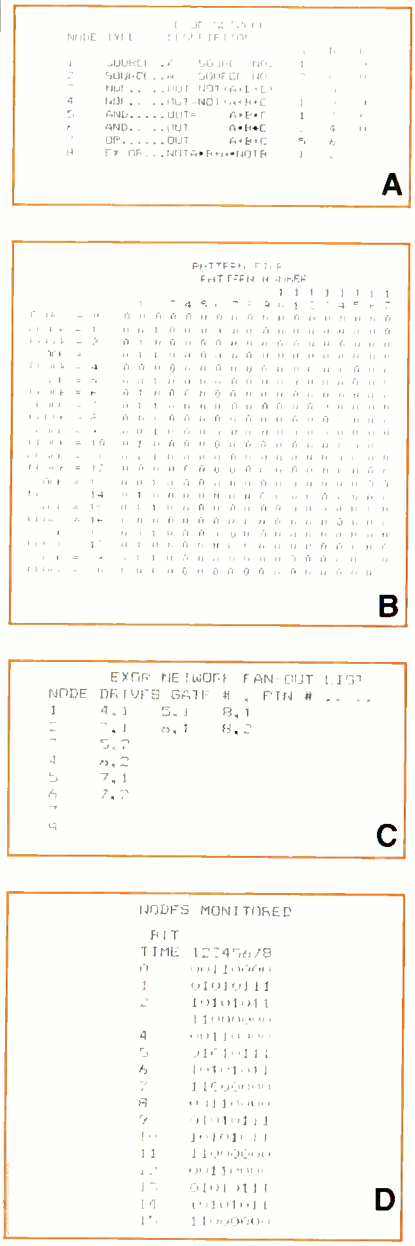


Fig. 9. Exor network (A). Pattern file for Logic Simulator Exclusive OR (B). Exor network fan-out (C). Exor nodes monitored (D).

Evaluation

Logicsim Evaluation. Logicsim gets good marks for its straightforward "easy to get going with" manual, directness of circuit net list generation, extensive 7400-series IC library, ease in creating unlimited numbers of dedicated macro files that allow the breaking up of a large circuit into many smaller macro files for testing before re-assembly, and freedom of choice as to input signals and output formats.

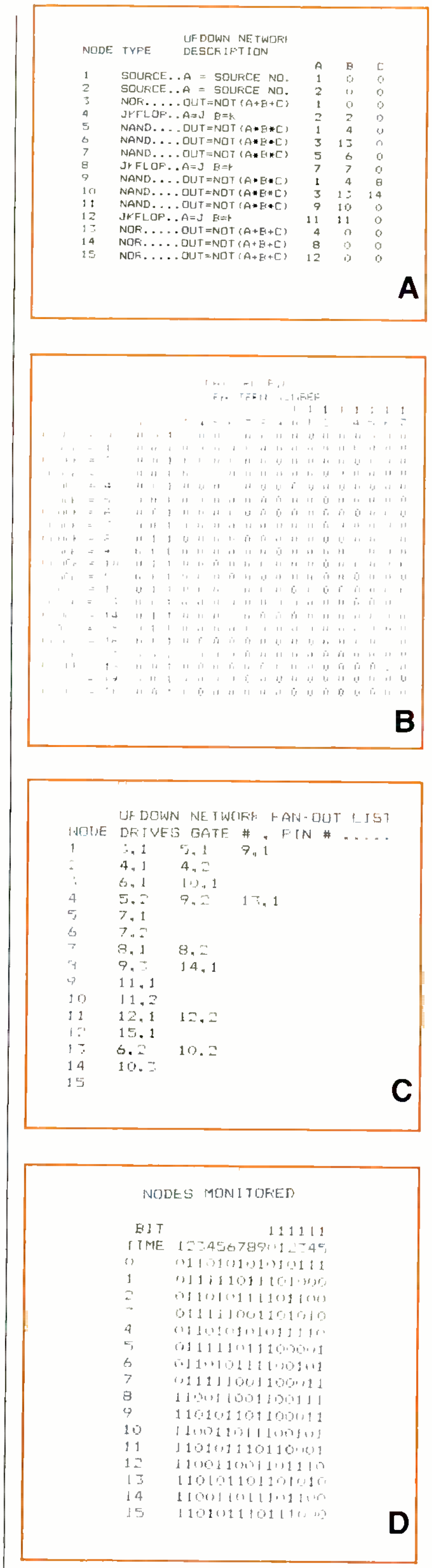


Fig. 10. Up/down network description (A). Up/down network pattern file (B). Up/down network fan-out list (C). Outputs (D).

Logicsim's only weakness seems to be its design as a compiler without an integral text editor, as opposed to an interpretive program (a la BASIC). Almost any modification requires exiting the program, entering a word processor to correct the problem, then re-entering the program. It's the frustration of the 'batch' method of punched-card data entry revisited.

If only it were an interpreter that gobbled up the net list, gave the results, and then asked if you wanted to change anything. As noted before, leaving off the .END statement will allow you to continually retest the same net file for different input and output patterns, but be sure to include a .LIST and print out the input net list or you won't know what you have accomplished.

All in all, the program was easy to learn, fun to use, and I wish that I had had it years ago when I studied logic gates.

Logic Designer/Logic Simulator Evaluation. As noted previously, the major strength of this program lies in its use as a semi-interpreter with a built-in editor. The Logic Designer enables the designer to create/view logic circuits directly on the screen, while the network listing is automatically generated. I liked very much the menu-oriented, user-convenient programs, although I sometimes wished that there was a non-reset way to get out of the program and back to the menu during the generation of output tables. The fan-out chart can be very helpful as it may be used for wire-wrapping and assembly of the logic circuit. Once you get used to it, the ability to have several signal patterns saved for instant callup is a very helpful feature, as is the use of the same signal pattern, using different network lists, for outputs similar to a truth table.

Unfortunately these features are just not enough to offset the many inconveniences that the program presently offers. First and foremost is its inability to create real macro files that can be called from a library of ICs or subcircuits. Just as important, the manual is good, but poorly organized as to what steps should be done first and other points of organization. It does not indicate who wrote or published the software, doesn't give the company address, etc.

A major drawback of the Logic Designer is that the network lists generated from it are full of vacant nodes. Next are the frustrations of a very limited set of gates and flip-flops without the preset/clear/clock/not-Q signal capabilities needed for the easy configuration of decade counters, etc. There is no provision for ROM/RAM evaluations (other than an 8-bit by 1-bit ROM macro). Although a designed graphic diagram can create a network list, the latter is not enough to generate a graphics output screen. No delays are possible for adjusting feedback paths, and there are no error routines to inform the user of "illegal" connections, etc. In fact the only way the user finds out if the network is capable of simulation is to run a simulation and have the program bomb.

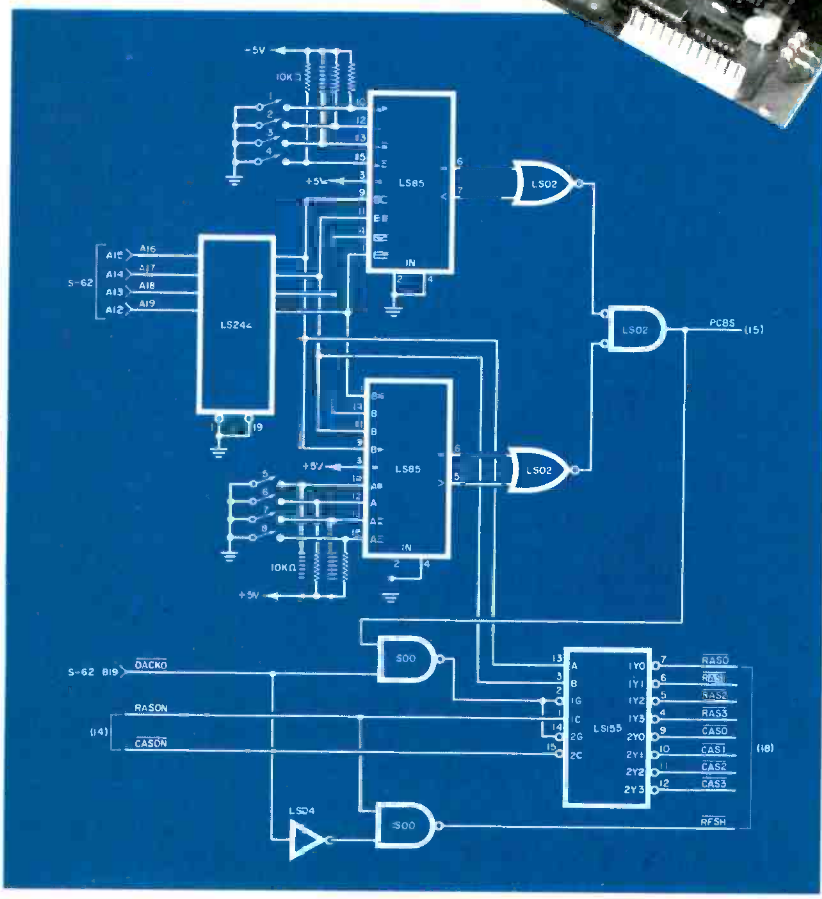
One other plus for the program is the demo disk that is available separately. The demo was mesmerizing. I just sat and watched as it "drew" a 40-gate logic array on the Apple monitor and then proceeded to show me the output signals for the network. What a beautifully impressive way to show a prospective user the power in the machine at his/her fingertips.

Logicsim vs. Logic Designer/Logic Simulator. Having used both programs, it seems to me that the Logicsim program has much greater power than Logic Simulator. The hassles with getting into and out of the word processor notwithstanding, Logicsim still wins the contest because of level of circuit complexity possible, macro libraries, error handling, input/output signal formatting for clarity (using signal names), ability to account for dc convergence and feedback via delays in feedback gates, and (with the IBM-PC graphics option) screen dumps of the "actual" timing diagrams. If I could buy only one, it would be Logicsim. It's well worth the few extra dollars. ◇

Learning 16-BIT MICROCOMPUTER TECHNOLOGY

Part 3: How the programmable DMA controller works

By George Meyerle



THIS third part of our series on the construction of an 8088-based microcomputer compatible with the IBM-PC continues a discussion of the major circuit elements of the system. Also included are schematics of the 64K RAM/RS232C port board and system power supply (Figs. 13 through 19), which were briefly described in Part 1.

8237A-5 Programmable DMA Controller. The DMA controller (Fig. 3, *IC27*, and Fig. 20) appears complex at first glance. (Note: Figs. 1 through 9 and Tables 1 through III appeared in Part 1 of this series.) However, breaking down its functions into smaller parts and knowing the bus signals described last month makes it easy to understand.

A DMA (direct memory access)

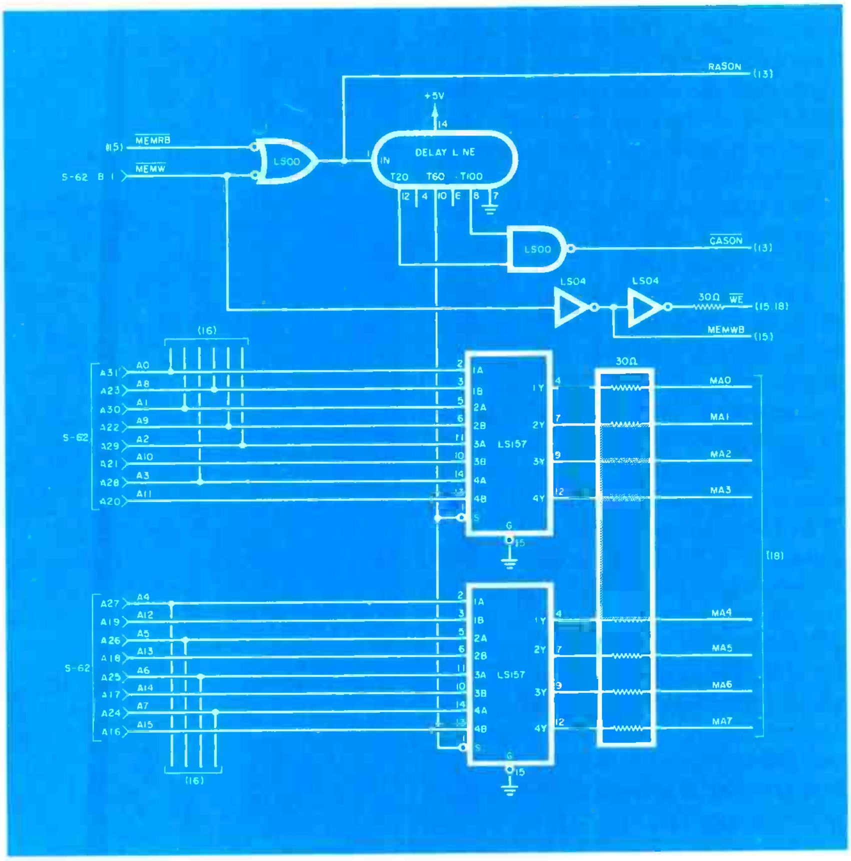
Fig. 13. Address generator uses RAS/CAS to bank select to one megabyte in 64K-byte steps.

operation allows a direct transfer of data between a peripheral and the memory. During a DMA cycle the microprocessor and its associated bus signals are disconnected from the bus and become inactive as far as the DMA process is concerned. The 8237 then generates the necessary bus-control signals to accomplish the direct transfer.

This scheme can be considerably faster than a processor-controlled transfer. The time required by the micro to fetch the instructions, move the data from memory to the CPU, and then from the CPU to the target device (or vice versa) is eliminated because the transfer instructions, including address and number of transfers, are programmed into the 8237.

The 8237 has four separate channels with channel 0 having the highest priority and channel 3 the lowest. DMA channel request 0 (DREQ0, pin 19) is used in this design to provide memory refresh (dummy read) cycles. The memory's chips must be read (or refreshed) periodically to preserve or maintain the stored data. The DMA controller channel 0, driven by the 8253-5 timer, performs this task automatically. The remaining DMA channels are available for use by the I/O bus (channel 2 is reserved for use by the floppy disk system).

The following is a step-by-step operation of the DMA controller as it is used to refresh the system dynamic RAM. DMA controller *IC27* is designed to transfer data on 64K page boundaries in this one-megabyte system. Therefore, the first step is to initialize page boundary register *IC18* (Fig. 3) to a specific 64K value. This value is set to 0 for this operation because the scheme used to refresh all one-million bytes requires addressing only the low-or-



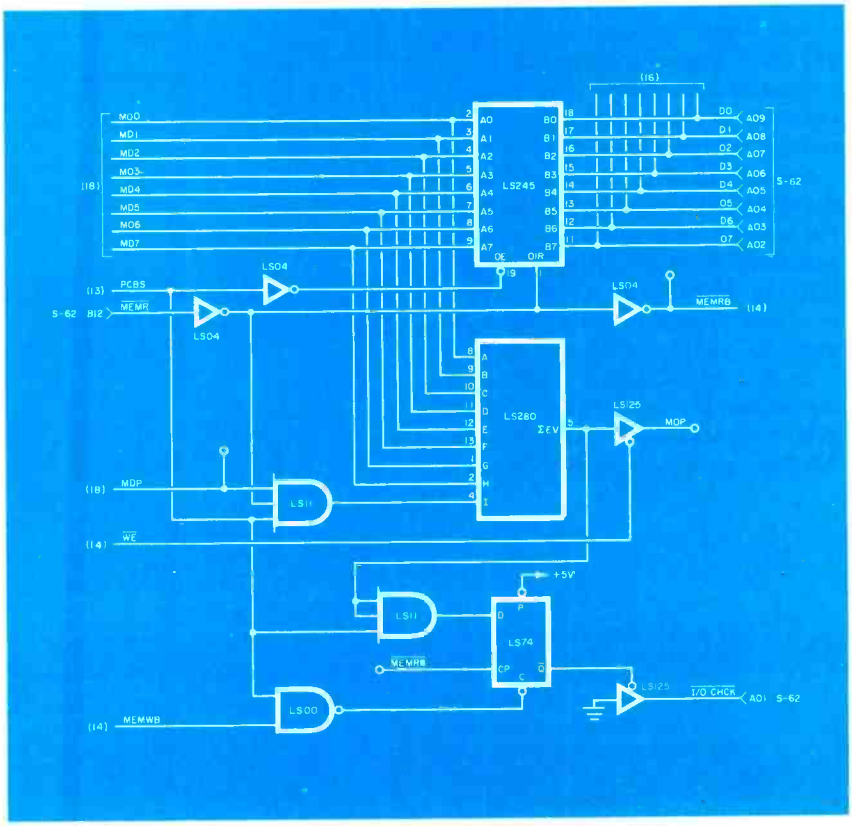


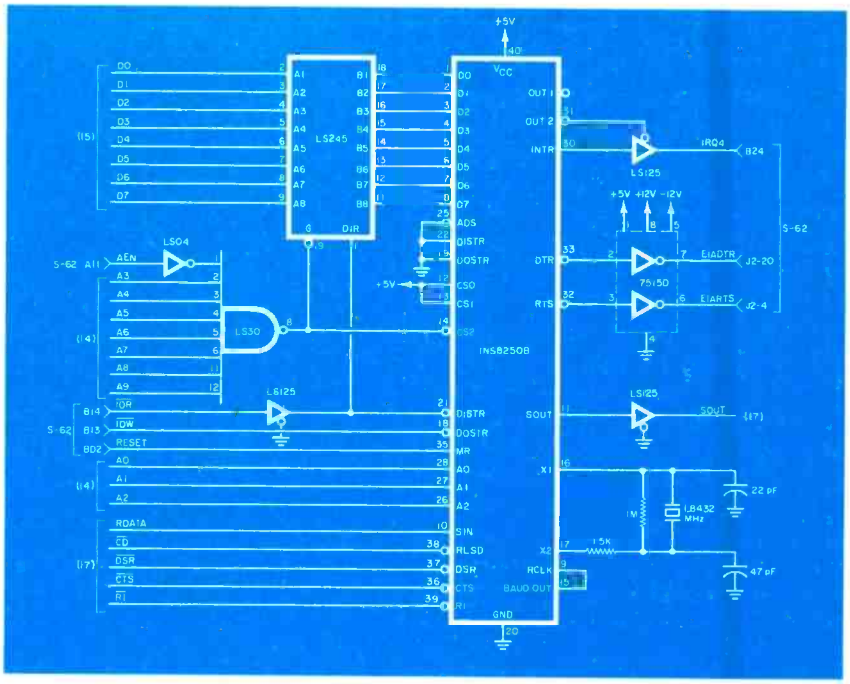
Fig. 14. (top) Address multiplexer converts address bus from 16 bits into two 8-bit slices.
Fig. 15. (right) Bidirectional buffer and parity generator/checker.

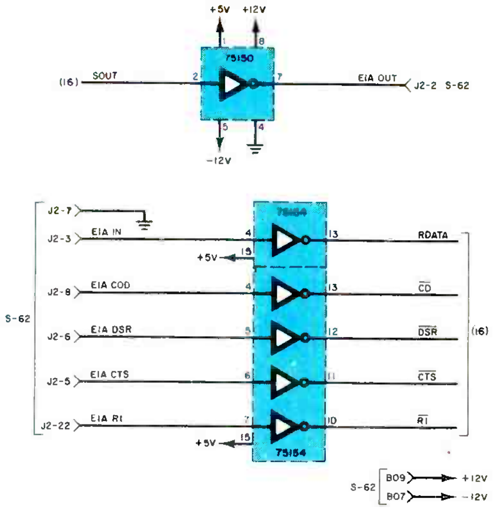
der addresses. It should be noted that if transfers are to occur at other than the base of memory, *IC18* has to be set to the page required. This register supplies address lines A16 through A19 for each of the four DMA channels. The DMA page registers are I/O ports located at I/O addresses 80 through 83.

Let's now look at timer *IC30* (Fig. 4), which has been initialized to produce a pulse (at a predetermined interval) at pin 13. This pulse clocks a high-level output onto pin 9 of flip-flop *IC42* (Fig. 4). This signal is the refresh request line (DRQ0) that is connected to *IC27*, pin 19. When this line goes high (DMA requested), *IC27* issues a HRQ (hold request signal) to *IC44A* (Fig. 7). A timing sequence is set up by *IC5*, *IC36A*, and *IC42* (Fig. 7) dictated by *IC3* (Fig. 2). (Note that S0, S1, and S3 processor status lines at *IC5* assure that the DMA wait signal to the clock generator and the HOLDA signal to the DMA controller occur at the proper times).

The HOLDA signal indicates to *IC27* that *IC3* has given up control of the buses and that the DMA cycle can begin. The DACK0 (*IC27*, pin 25) resets requesting flip-flop *IC42* and is also channeled to the expansion bus to act as a device select for the peripheral being accessed by *IC27*.

Once activated, *IC27* addresses the data to be transferred directly. All address and control signals are generated by *IC27*. Data lines DB7 through DB0 (pins 21-30), when not used to input instructions, are used to supply memory address lines A15 through A8. These lines are latched into *IC17* (Fig. 3) by the ADSTB signal (pin 8). Address lines A0 through A7 are supplied direct-





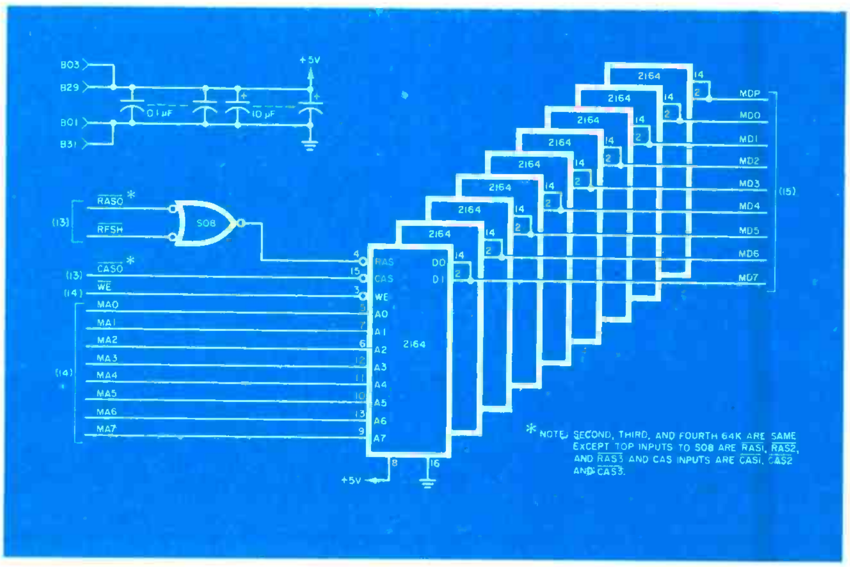


Fig. 16. (top) Pin identification and connected circuitry for the RS232 communications port. Fig. 17. (center) Driver circuit for the communications port. Fig. 18. (bottom) First 64K-byte RAM bank. Note gives arrangement for further 64K banks.

ly by pins 32 through 40 and are bus buffered by *IC16* (Fig. 3). As noted before, *IC18* supplies address lines A16 through A19. All three address drivers are enabled via the DMA AEN signal.

The I/O and memory read and write signals are also generated directly (see pins 1 through 4). The DMA controller is programmed via ports 0 through F (see Table II, I/O map). The mode and nature of transfer, including source or destination addresses and word count, are programmed into *IC27*'s registers. When a transfer is completed, *IC27* resets the request line. If the *autoinitialize* feature is enabled, *IC27* will automatically reload the inital parameters so that a repeat operation is performed when the DMA channel is called again. An EOP (end of process) signal is also generated which is used to notify the expansion bus that the DMA operation is completed. ◊

(To be continued)

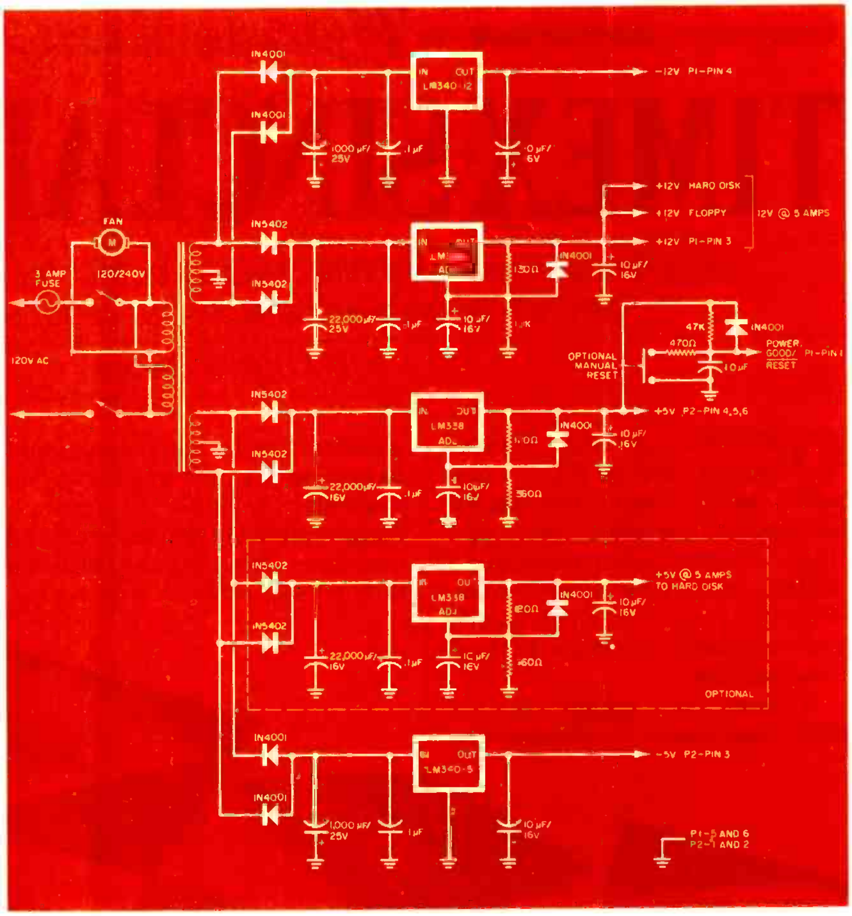


Fig. 19. Schematic of the system power supply.

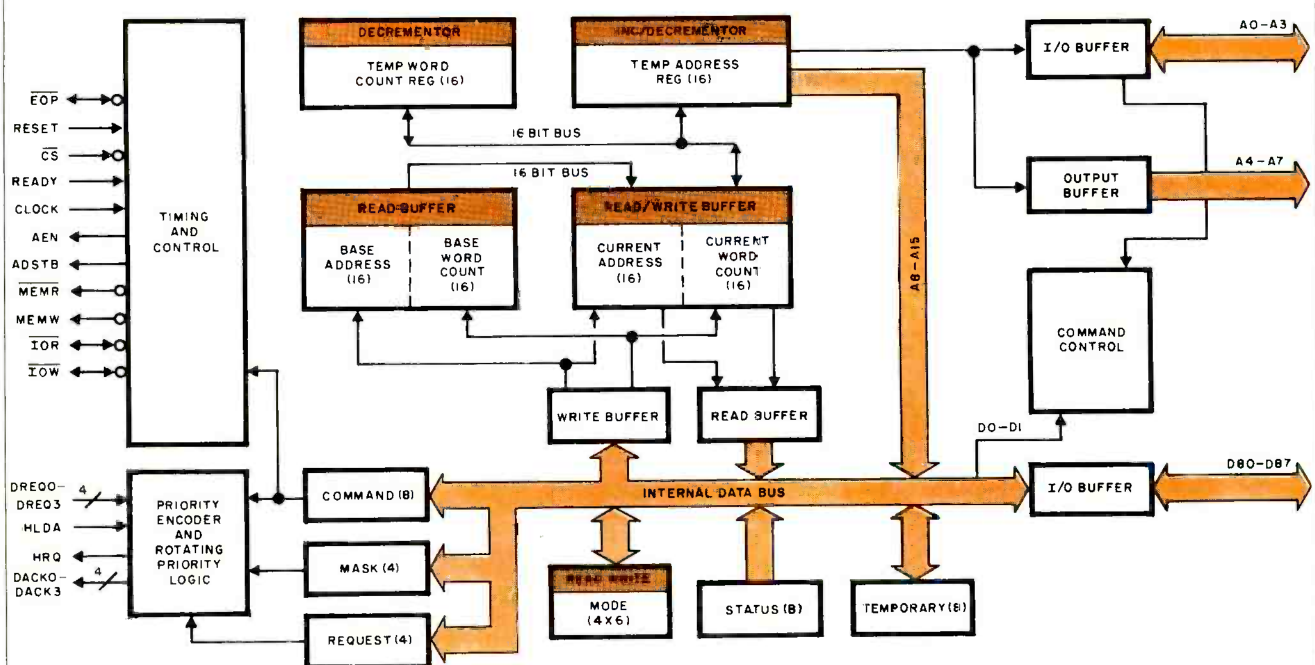


Fig. 20. Block diagram of the 8237A programmable DMA (direct memory access) controller. Connections to it are shown in Fig. 3 in the first part of the series.

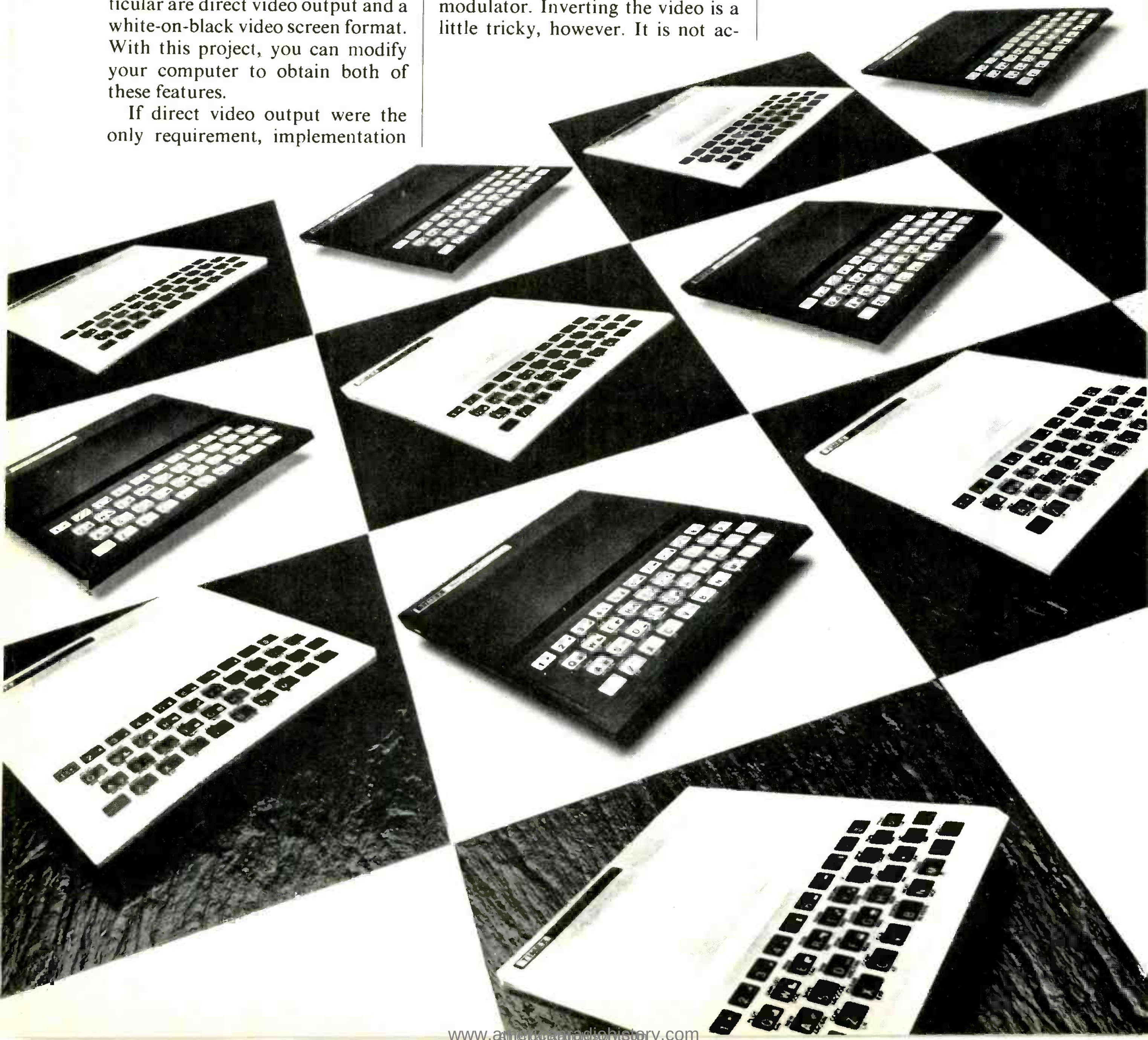
Upgrading TIMEX-SINCLAIR VIDEO

Modification provides direct video output for crisper characters and white-on-black display for reduced eyestrain

By Steve Pence

OWNERS of the Timex/Sinclair 1000 or ZX-81 computers sacrifice many features for the benefit of low price. Two in particular are direct video output and a white-on-black video screen format. With this project, you can modify your computer to obtain both of these features.

If direct video output were the only requirement, implementation would be simple since it only would be necessary to add an emitter-follower stage to buffer the signal already being fed to the computer's r-f modulator. Inverting the video is a little tricky, however. It is not acceptable to simply invert the entire signal as this would also invert the



PARTS LIST

C1—0.1-μF, 50-V ceramic disc capacitor
D1,D2,D4—1N4148 diode
D3—1N6263 diode
IC1—74S86 Exclusive OR
Q1,Q2,Q3—2N2222 transistor
The following are ¼-W, 5% carbon resistors:
R1—1.3 kilohms
R2—220 ohms
R3,R6—1 kilohm
R4,R5—390 ohms
R7—5.6 kilohms
R8—10 kilohms
R9—75 ohms
S1—Spdt miniature switch
Misc.—RG174U coax (36"), RCA phono plug, 4-40 × ½ machine screw (2), 4-40 hex nut (2), #4 fiber washer (4), pc board, etc.

Note: The following is available from Random Access, Box 41770P, Phoenix, AZ 85080: complete kit of parts (DVC-2) for $18.95 plus $1.50 shipping and handling. Also available separately is the printed circuit board (DVC-2B) for $5.95. Arizona residents add 4% sales tax.

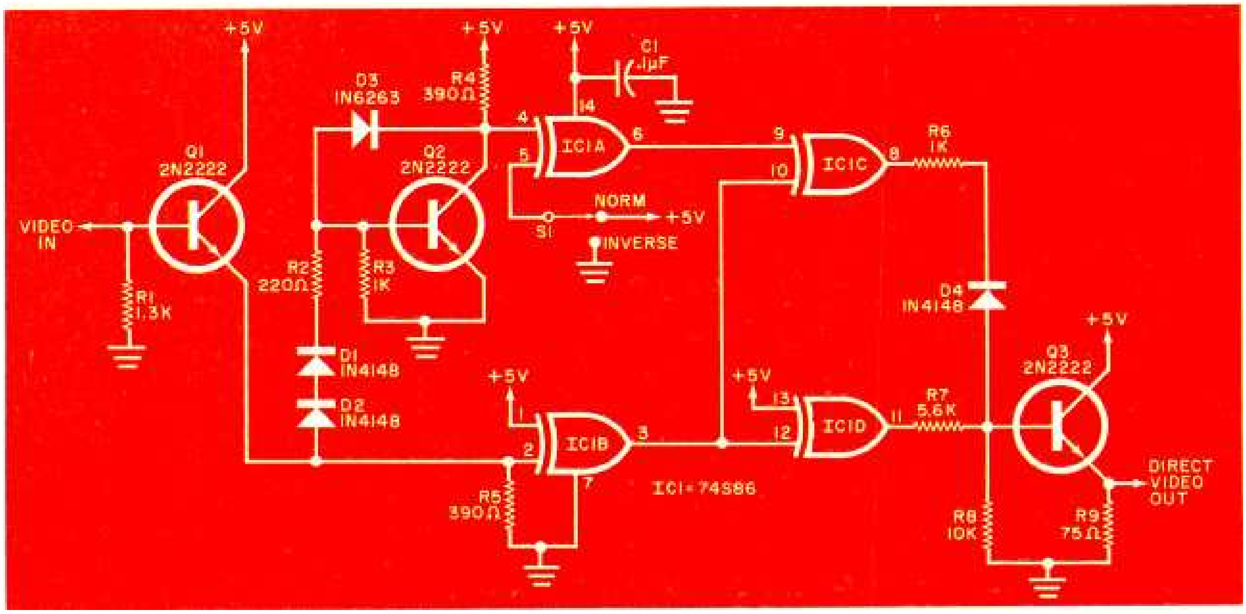


Fig. 1. Switch S1 determines whether the output is normal or inverse. In this circuit, only the video portion is inverted.

sync pulses, making it impossible for the monitor's sync separator to operate properly.

To do the job right the two components of the composite video signal must be separated, and only the video portion inverted, leaving the sync pulses as they are. Next the proper ratio of sync pulse amplitude to video amplitude must be maintained. Finally the correct peak-to-peak amplitude and output impedance suitable to drive a standard video monitor must be provided.

Circuit Description. As shown in Fig. 1, the first stage, *Q1*, is a buffer amplifier that has a low output impedance capable of driving the stages that follow. The input impedance is controlled by *R1*.

The composite video signal from *Q1* is applied to pin 2 of *IC1B*, a 74S86 Exclusive OR chip. This gate actually performs two functions. First it acts as a simple inverter, providing an output that is 180° out of phase with the input. Second, it acts as a comparator to separate the sync pulses from the video. Each sync pulse brings pin 2 to ground potential. The video, however, never drops below 2 V. This means that as far as the gate is concerned the input is always high except during sync pulse time. The output at pin 3 is therefore an inverted version of composite sync containing no video.

Transistor *Q2* converts the composite video signal into a logic compatible format in which both sync pulses and video information are the same amplitude. This is done by dropping most of the sync pulse voltage across diodes *D1* and *D2*. As a result *Q2* will not begin to conduct until the signal voltage reaches a level of approximately 2.1 V (three diode drops). Since the video voltage is active at 2 V, *Q2* switches for both video and sync voltage.

Diode *D3* is a Schottky type with a forward drop of 0.3 to 0.4 V. Its purpose is to increase the switching speed of *A2* so that full video bandwidth will be obtained. It does this by preventing *Q2* from saturating, thus eliminating the long storage time that would otherwise occur. As *Q2* turns on and attempts to saturate, *D3* becomes forward-biased and begins to bleed off base drive. The collector of *Q2* can never get any lower in potential than the difference between its forward V_{be} drop and the forward drop of *D3* (about 300 mV). This effectively prevents saturation and eliminates storage time.

The logic level signal at the collector of *Q2* next goes to pin 4 of *IC1A*, which is configured as a programmable buffer. With *S1* in the NORM position, *IC1A* acts as an inverter, but with *S1* in the INVERSE position it performs as a noninverting buffer.

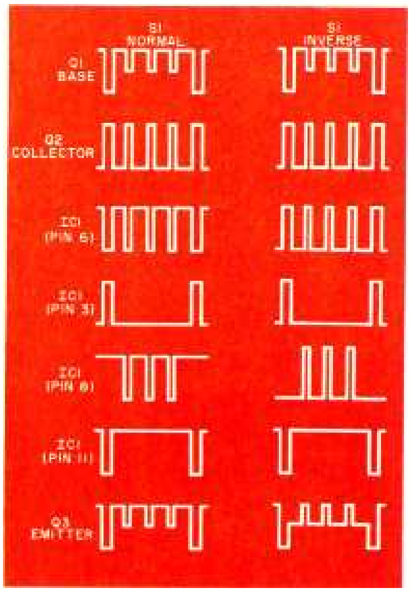


Fig. 2. Waveforms for the direct and inverse signals at various points in the circuit.

Pin 9 of *IC1C* receives a composite signal consisting of both video and sync pulses. Pin 10 sees only the inverted sync from pin 3 of *IC1B*. The Exclusive OR action of *IC1C* cancels out the two sync pulses at the input leaving only the video signal at the output. The sync pulses are inverted for the second and last time by *IC1D*.

The two outputs from *IC1C* and *IC1D* are combined by the scaling network consisting of *R6, R7, R8,* and *D4.* This network provides the proper ratio of sync pulse to video and applies the result to the base of *Q3,* a high-input-impedance, emitter-follower stage. Transistor *Q3* has a 75-ohm resistor in its emitter leg to provide the proper impedance for driving a standard video coax and monitor. Waveforms for this process are shown in Fig. 2.

Construction. The direct video converter is best built using a printed circuit board. The foil pattern is shown full size in Fig. 3. with the component guide given in Fig. 4. Be sure to orient *IC1* properly. Also, mount the three transistors as close to the pc board as possible.

Installation. Begin the computer modification by drilling a ¼" hole in the side of the computer's case (upper right, top half) for miniature toggle switch *S1.* Next, on the opposite side, drill a #32 hole approximately ⅝" to the right of the indentation for the 9-V connector. Drill the hole in the center where the two halves meet.

Disassemble the computer by removing the five screws holding the two halves together (three of the screws are under the rubber feet). Pull the bottom half off and set it aside. Remove the two screws holding the pc board and lift it up. Be extremely careful working with the loose circuit board. The flex print connecting the keyboard to the computer is very fragile and easily damaged. Do not attempt to remove it from its connector, as this will increase the likelihood of damage.

Referring to Fig. 5 remove *R31, R32,* and *D9* from the computer's circuit board. This network is used to scale the video voltage applied to the r-f modulator and is no longer needed. The video signal from the conversion board is already scaled properly and is applied directly to the modulator input. Next, install four wires, each at least 8" in length by soldering them to the four feedthrough holes indicated. One of the holes, the input to the modulator, is accessible as a result of the removal of *R31.*

Position the completed video circuit board as shown in Fig. 6. Mark the inside of the case through the mounting holes of the pc board, and drill two #32 holes at these marks.

Now the wires can be connected as shown. Use RG174U coax for the direct video output as this type is only about $^{1}/_{10}$" in diameter and therefore very easy to work with. Tie a knot in the cable at the point at which it will exit the computer (the #32 hole you drilled near the 9-V connector) to act as a strain relief.

Mount the conversion board to the inside of the top half of the computer's cover using two #4-40 × ½" machine screws. Be sure and place two fiber insulating washers over each screw before installing the conversion board. This will prevent the bottom of the board from being shorted by the aluminized coating on the inside of the cover.

Using the Computer. After reassembling the computer, you are ready to connect it to your video monitor. If you are using a black-and-white TV that has been modified for direct video, you will obtain the best results with the contrast control set nearly fully counter-

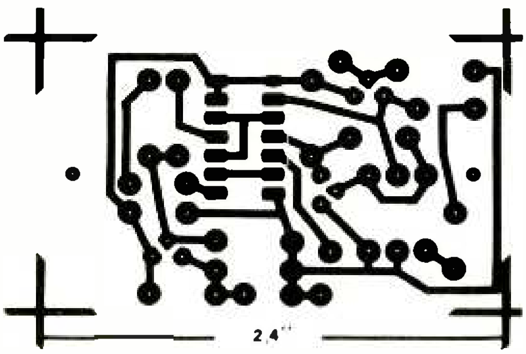


Fig. 3. Foil pattern for the printed circuit board.

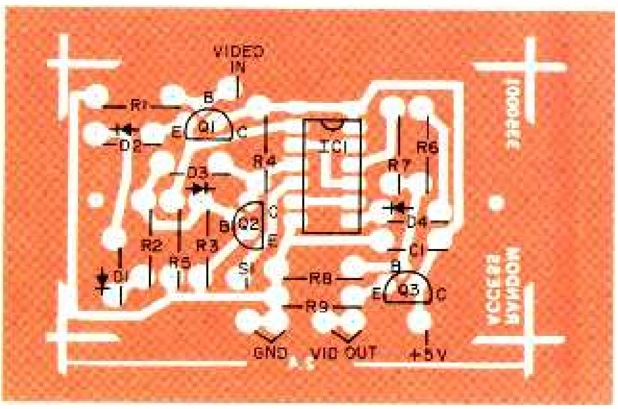


Fig. 4. Follow this diagram to lay out the components on the pc board.

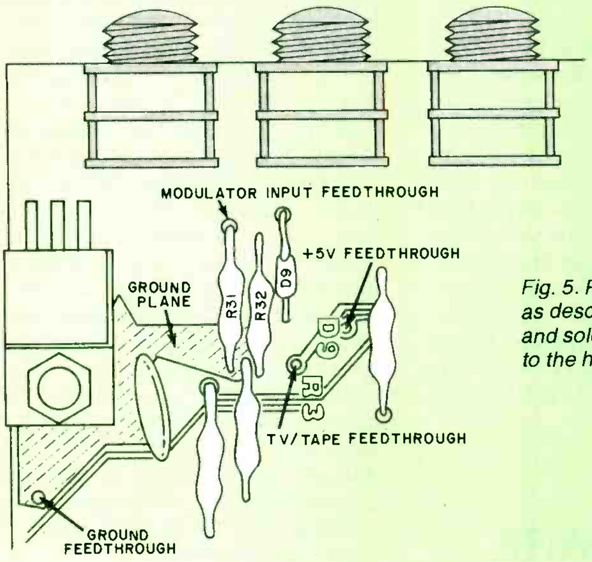


Fig. 5. Remove components as described in the text and solder four wires to the holes as indicated.

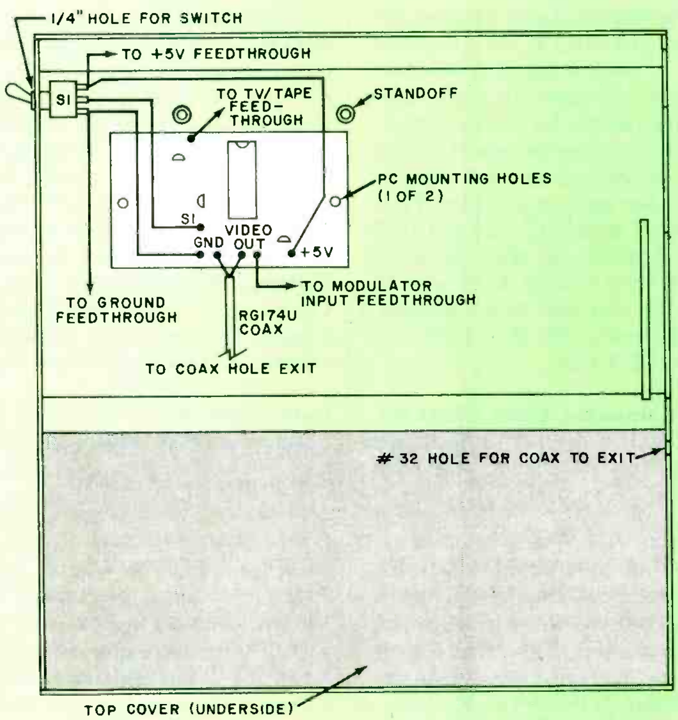
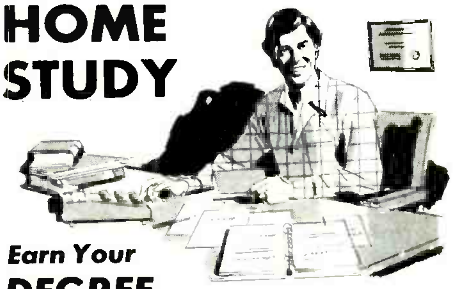


Fig. 6. Position the circuit board and connect the wires as shown here.

clockwise (minimum video amplifier gain) and the brightness control set a little bit lower than normal. If your monitor does not employ dc restoration (most do not), you will have to readjust the brightness control each time you switch from normal to inverse video or vice versa.

As a final note, you may find it interesting and useful that the size of the pixels that make up the characters can be controlled to some extent by varying the values of resistors *R1* or *R2*. Resistor *R1* can be adjusted between 1 and 2 kilohms and *R2* varied from 75 ohms to 1 kilohm or so. What this does is change the dc bias point and thus modify the amount of time that *Q2* has to react to the video voltage. ◊



COMPUTER SOURCES

HARDWARE

Large-Screen Monitor. The Quad-Screen is a 17" monochrome display that can support 160 characters on 64 lines for a total of 10,240 characters. Designed for the IBM-PC, this video monitor also has 64K of memory and, during each application, each of the nearly half-million dots can be individually addressed. Bit-mapped graphics allow dot addressable resolution of 960 horizontal by 512 vertical. It includes IBM PCDOS/BIOS compatibility, P4 or P39 phosphor, reverse video, forward or backward scrolling, and its own character set. $1950. **Address:** Quadram Corp., 4357 Park Dr., Norcross, GA 30093 (Tel: 404-923-6666).

Apple Speech. The SSB-Apple is based on the TI TMS5220 speech synthesis device and plugs into any Apple slot. It has a built-in 325-mW audio amplifier to drive either the Apple speaker or any external 8-ohm device. A socket is provided to expand the synthesis memory by adding a TI TMS6100 chip. Included are a $5^1/_4$" floppy diskette containing a 1200-word dictionary in digitized form, a manual, and a stand-alone speaker. Included on the diskette are three Chinese lessons. Other languages including French, German, and Spanish are available from TI. $195. **Address:** Multitech Electronics Inc., 195 W. El Camino Real, Sunnyvale, CA 94086 (Tel: 408-773-8400).

ZX81 Peripherals. A new EPROM programmer interfaces to the ZX81 via three parallel I/O ports. It comes assembled and tested with software to program 2716s. $79. The nonvolatile memory and I/O unit has six parallel ports for interfacing to other devices and sockets for up to four extra chips either 2716 EPROM, 2K × 8 static RAM, or other 2K × 8 nonvolatile memory. $79. **Address:** Wisconsinc Electronics, PO Box 332, Milton, WI 53563.

S-100 D/A. The SB-32-DA board is IEEE-696 compatible and has 32 12-bit D/A output channels. Each channel has its own 16-segment waveform generator. The master processor can set 16 points on a waveform and 16 associated timing components. There are provisions for repeating waveforms, generating an interrupt upon completion of a waveform and disabling any waveform generator so a channel can perform like a conventional memory-mapped DAC. Besides the on-board RAM, the master may also directly access the boards RTC, three 16-bit counters, two time-of-day alarm comparators, three 8-bit ports, and eight frequency-counter channels. Five switchable uni- and bipolar ranges are available and each output can drive a 1K load. Accuracy is 0.02% absolute. $825. **Address:** Digital Multi Media Control, 92972 River Rd., Junction City, OR 97448 (Tel: 503-998-6575).

SOFTWARE

Commodore Sales/Expense Program. The Sales/Expense Program for Commodore 64 and VIC-20 computers is a home or small-business system that maintains a full calendar year's sales and expense records for each month by 3 sales and 10 expense categories. Totals are calculated each month, and monthly and yearly averages are provided. Print routines work with VIC-1515 and 1525 printers. Requires an 8K expansion when used with VIC-20. $7.95 plus $2 handling for cassette tape. **Address:** RAK Electronics, PO Box 1585, Orange Park, FL 32073.

New TI Computer Uses CP/M-86. The Texas Instruments Professional Computer supports Digital Research's CP/M-86 and Concurrent CP/M-86. It will also run MS-DOS (the same as IBM's PC-DOS) and will use software developed for the IBM-PC and other 16-bit computers. TI has also signed an agreement with Softsel to stock third-party software for TI dealers. Some software covered is from Ashton-Tate, Digital Research, Peachtree, Micropro, Sorcim, and Software Publishing.

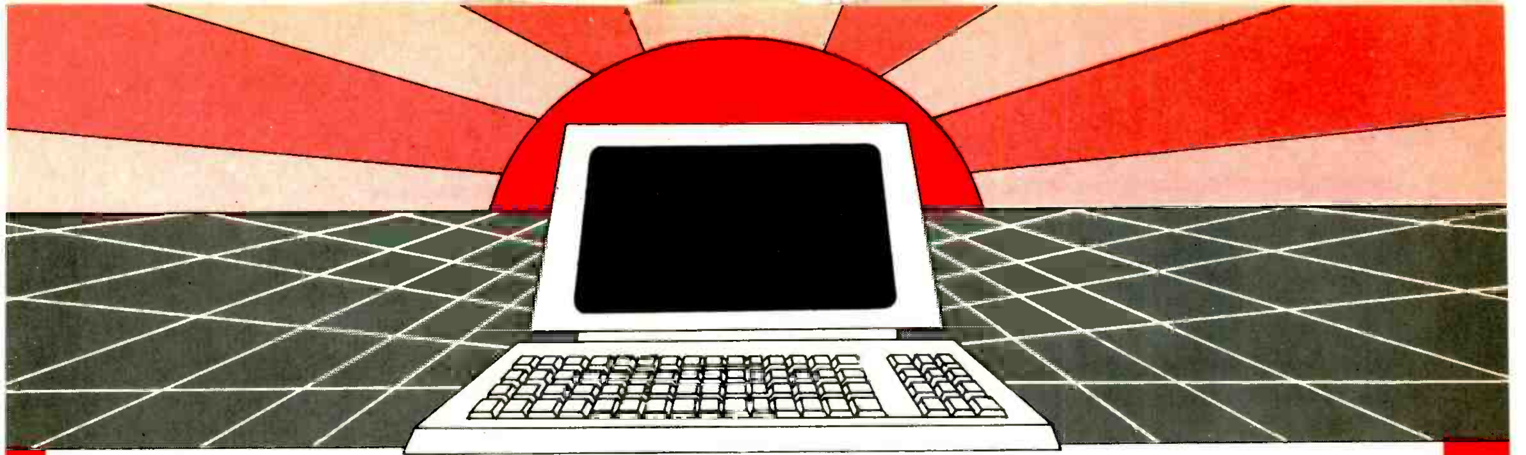
Apple IIe Business Software. Integrated business accounting programs, from State of the Art, are configured to run on the Apple IIe. Modules are available for General Ledger, Accounts Payable, Accounts Receivable, Budget, and Inventory Control. Packages are written in UCSD p-System and are transportable to any computer using a p-code interpreter. Packages can be installed in about 2-½ hours by a user who has never touched a computer. **Address:** State of the Art, 3183A Airway Ave., Costa Mesa, CA 92626 (Tel. 714-850-0111).

Commodore 64 Businessware. Southern Solutions has developed a software package called Businessware™ for the Commodore 64 using the 1541 Disk Unit, the 1525 Datasette, and 1525 Printer. It will also support the use of a larger Commodore disk unit such as the 8250 Disk Drive, which will be interfaced to the 64 later. All files in the software can be transmitted through a modem to another computer using the Mail Box package. Software consists of The Business Man (general ledger), The Bill Payer (accts. payable), The Bill Collector (accts. receivable), The Paymaster (payroll), The Record Keeper (file system), The Mail Man (electronic mail), The Time Keeper, and The Club Manager. Typical prices for the software are under $100. **Address:** Southern Solutions, PO Box P, McKinney, TX 75069 (Tel. 214-542-0278).

File Organizer. Disk-Catalog reads any single- or double-density disk directory including all popular operating systems for the TRS-80. It enables the user to list system and invisible files and to save the file names in the catalog. Disk Catalog runs on standard TRSDOS and displays a short form directory on the screen. It is capable of creating multiple catalogs and can handle 1650 files on a 34K system or 3000 files on 48K machines. Searches can be done in Partspec, Filespec, or by using Wild Card characters. $34.95. **Address:** Futura Software, One Cannon Dr., Nashua, NH 03062 (603-889-5858).

Coin Inventory. A feature of COINS (Computerized Inventory System) is the file of information on 1600 of the most common U.S. coins of all grades. Information is updated quarterly and provides for automatic re-evaluation of the collection. The system is now available for IBM-PC as well as the original TRS-80 Models I and III, for which it was designed. Minimum requirements are 64K, 2 disk drives, and a printer. Nonstandard coins can also be listed, with files maintained by the user. $95, with updates at $25 each. **Address:** Compu-Quote, 6914 Berquist Ave., Canoga Park, CA 91307 (213-348-3662).

30-Screen Color Game for IBM-PC. "Hoser" is a color graphics game featuring 15 screens at novice level and 15 for the expert. Each screen is more difficult than the last. The object is to control a thirsty hose seeking a faucet in a strange yard filled with obstacles. At any time the hose may turn against the player. Requires no joystick. $39.95. **Address:** PC Connection, Mill St., Marlow, NH 03456 (603-446-3335). ◇



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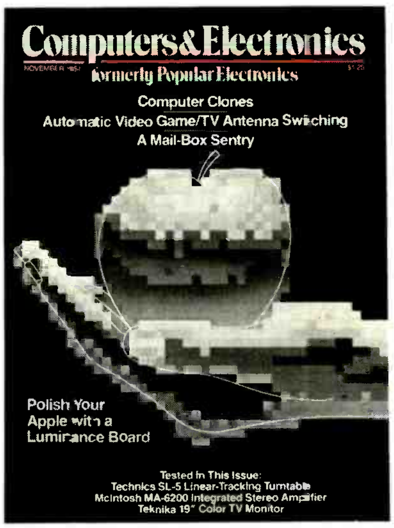

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Introducing the Varistor

By Forrest M. Mims, III

THE varistor, a nonlinear resistor that does not obey Ohm's law, is one of those wonderfully simple components whose operating principles are not yet fully understood. What is understood is that the varistor is well-suited for protecting electronic circuits from transient voltage surges.

The current through a standard resistor is directly proportional to the voltage across the resistor. The current through a varistor, however, varies according to the nth power of the voltage, where n is from 2 to 25. Figure 1 is a curve of the voltage versus current characteristics of a typical varistor.

Varistors are made from silicon carbide or metallic oxides, yet their construction more closely resembles that of a resistor than a semiconductor device. Metal oxide varistors, for example, are made from powdery grains of zinc oxide and small amounts of other metal oxides. The zinc-oxide powder is pressed and sintered to form ceramic discs. The discs are coated on opposite sides with silver to provide solderable contact regions.

The varistor's voltage and current handling capacities are determined, respectively, by the thickness and width of the disc. The size of the zinc-oxide grains also determines the varistor's voltage rating.

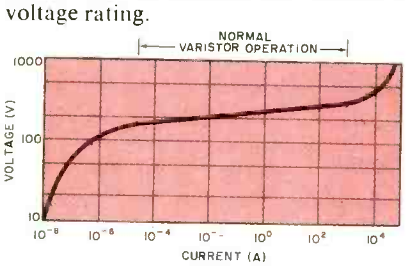

Fig. 1. Varistor V/I characteristic.

Varistors are primarily used to protect electronic circuits from transient voltage surges. They are particularly useful for protecting computers from power surges that cause memory errors or even loss of memory contents.

As shown in Fig. 1, the operation of a varistor resembles that of two back-to-back zener diodes. When the voltage across the varistor is below its rated continuous voltage, the varistor is in a high-impedance state. When the voltage exceeds the rated level, the varistor suddenly begins to conduct and its formerly very high impedance falls to a few ohms.

Voltage transients can be caused by power-line surges, lightning, switch arcing, component failures, and the sudden removal of a voltage across a transformer, inductor, or relay coil. Figure 2, for example, shows a relay coil connected through a switch to a power supply. When the switch is opened, the field in the coil collapses and induces a series of high-voltage spikes across the coil terminals. The varistor serves to short to ground the spikes having an amplitude above the varistor's voltage rating.

A New Pair of Low-Voltage Varistors. Recently General Electric added to its line of GE-MOV[R] II metal-oxide varistors two new low-voltage devices designed specifically to protect TTL integrated circuits from transient voltage spikes. Designated V8ZA1 and V8ZA2, the two varistors are rated for a continuous voltage of 5.5 V. The V8ZA1 is rated for a maximum clamping voltage of 22 V at 5 A and a peak transient current of 100 A. The V8ZA2 is rated for a maximum clamping voltage of 20 V at 5 A and a peak transient current of 250 A.

Figure 3 is a photograph of the V8AZ2 next to a 28-pin dual-in-line package IC. General Electric claims the new varistors perform better in overstress situations than competing silicon devices. Another advantage is low cost. In large quantities, the General Electric devices sell for only 35 cents each.

Incidentally, in addition to its low-voltage varistors, General Electric also manufactures an entire line of high-voltage, high-current devices. For example, the B-series device shown in Fig. 4 next to a low-voltage varistor can protect industrial electrical systems from transients with peak currents of 70,000 A and energy levels up to 10,000 joules. At 200 A, the maximum clamping voltage of this device is 7.8 kV.

For more information about metal-oxide varistors, contact a General Electric distributor or write the company

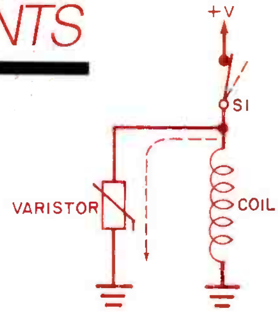

Fig. 2. Varistor voltage clamp.

(GE, Semiconductor Products Department, Auburn, NY 13021). General Electric has recently published the third edition of its excellent applications manual on varistors, "Transient Voltage Suppression" (1982). The manual is GE publication number 400.3, and it sells for $5.00. The company also offers (prices unspecified) design kits that include a low-voltage GE-MOV II varistor.

Varistor Operating Precautions. When exposed to voltage or current transients above its peak ratings, a varistor may fail. General Electric's varistor literature describes a possible consequence being ". . mechanical rupture of the package accompanied by expulsion of package material in both solid and gaseous forms." An explosion by any other name is still an explosion. For this reason, if overstress conditions are expected, it would be wise to fuse the varistor or to mechanically shield it from other components and people.

A New 12-MHz Microcomputer. The Z8 is an 8-bit, 40-pin, single-chip microcomputer designed for use as a general-purpose controller for disk drives, terminals, printers, etc. The Z8 contains a 144-byte register file. Four registers in the file are dedicated I/O ports, 16 are status and control indicators, and the remaining 124 are reserved for general-purpose, user-definable applications. The Z8 also contains a full duplex (bidirectional) UART and two programmable 8-bit counter/timers.

Traditional microprocessors include a single accumulator register, but each of the Z8's general-purpose registers

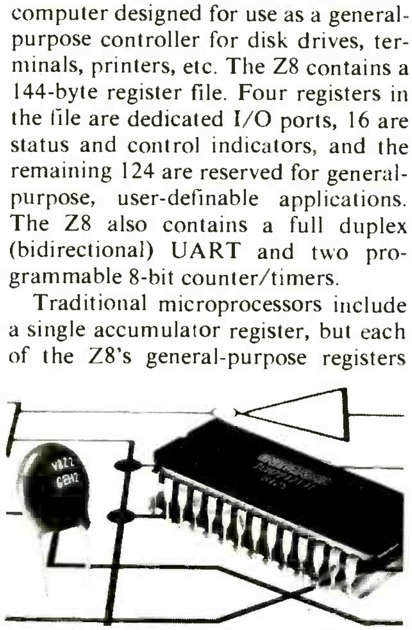

Fig. 3. GE's new varistor (left) is designed to protect TTL circuits.

can be used as an accumulator. They can also be used as address pointers, index registers, and other functions. Zilog claims this flexibility of its register oriented architecture "... permits over 30% higher code densities than primitive accumulator designs and allows appreciably reduced development time."

Until recently, the Z8 was available only in an 8-MHz version. Now, Zilog, Inc. (Components Marketing, 1315 Dell Ave., Campbell, CA 95008) has introduced a 12-MHz version of this popular single-chip microcomputer. Seven specific versions of the new computer are available. The Z8611 is the standard 40-pin computer containing 2K or 4K bytes of internal, mask-programmed ROM. The Z8613 Protopack is a 40-pin prototype development version with a self-contained 24-pin socket for direct interface to 2K or 4K bytes of erasable programmable ROM (EPROM). The Z8681 is a ROM-less version that replaces the internal ROM with alternative combinations of I/O lines and bus capabilities. The Z8671 includes on-chip Tiny BASIC.

Prices for the new 12-MHz Z8 chips are only slightly higher than the 8-MHz versions. For example, in large quantities the 8-MHz Z8611 is under $10, while the 12-MHz version of the same chip is under $12.

World's Brightest LEDs? Japan's Stanley Electric Co., Ltd. (LED Sales Section, 2-9-13, Nakameguro, Meguro-ku, Tokyo 153, Japan) has recently been running full-page ads in electronics trade magazines claiming "The World's Brightest LEDs." These new GaAlAs LEDs are claimed to emit 500 millicandelas and to be some 8 times more intense than conventional GaAsP LEDs driven at the same forward current.

Regular readers of this column will recall that GaAlAs is the ternary alloy used so successfully to make very powerful near-infrared emitters. Stanley, incidentally, also makes high-power GaAlAs near-infrared emitters.

Is a 500 millicandela LED really the world's brightest? Among the brightest conventional GaAsP red LEDs is Hewlett-Packard's 5082-4650 series (Hewlett-Packard Components, 640 Page Mill Road, Palo Alto, CA 94304). The 4655 is encapsulated in clear, diffused epoxy and at 10 mA of forward current has a luminous intensity of typically 4 millicandelas. The 4658, the same diode encapsulated in clear, *non*-diffused epoxy, has a luminous intensity of 24 millicandelas. At 20 mA, the 4658 has a luminous intensity of more than 60 millicandelas.

From Stanley's advertisement, its new diode apparently delivers 500 millicandelas when driven at 50 mA. By extrapolation, therefore, it has approximately five times more luminous intensity than the Hewlett-Packard LED when both diodes are operated at the same forward current.

GaAlAs is certainly placing a new light on both visible and near-infrared diode emitters. Several LED makers were quick to offer high-power GaAlAs near-infrared emitters when they first became available a few years ago. It is likely, therefore, that other companies will soon offer the new high-power visible-red GaAlAs diodes.

More High-Speed CMOS Chips. National Semiconductor (2900 Semiconductor Dr., Santa Clara, CA 95051) and Motorola (Box 20912, Phoenix, AZ 85036) continue to add new members to their jointly developed 54HC/74HC high-speed CMOS family. Among the latest National entries are the MM54HC139/MM74HC139 dual 2- to 4-line decoder, the MM54HC164/MM74HC164 8-bit serial-in/parallel-out shift register, and the MM54HC00/MM74HC00 quad 2-input NAND gates.

These new high-speed CMOS chips are considerably faster than conventional CMOS and easily approach or even exceed TTL speeds. For example, the 54HC164/74HC164 features a typical operating frequency of 50 MHz and a typical propagation delay (clock to Q output) of only 19 ns. Its supply voltage range is 2 to 6 V, and maximum standby current is 80 μA.

Fig. 4. The high-energy varistor at left protects against transients having peak currents of 70,000 amperes and energies of 10,000 joules.

I'm not aware of a mail order dealer that stocks these new high-speed CMOS chips, but you can be sure they will become widely available as more circuit designers learn about their excellent specifications. Their price may at first be quite a bit higher than conventional chips, however. For example, the 54HC00/74HC00 packaged in a plastic dual-in-line package now sells for 51 cents in quantities of 100 or more. Their high performance, however, more than makes up for the increased cost.

A New Fiber-Optic Record. British Telecom has established a new record for the world's longest fiber-optic telecommunications link. The system's cable links London and Birmingham and is nearly 130 miles long. The system employs second-generation LEDs that emit at 1.3 micrometers. First generation LEDs emit in the 800-900-nanometer range and are therefore subject to more attenuation when used as sources for low-loss fibers.

Thanks to the 1.3-micrometer LEDs used in this system, the cable has an attenuation of only 1.5 dB per kilometer. This increases the repeater spacing from 5 miles for a first generation system to about 6 miles.

Regular followers of fiber-optic developments should be aware that British Telecom's new system will hold the distance record for only a limited time. Developments in this field occur so rapidly that their record may be surpassed before this column is published.

Wanted: New Product Information. Information about the solid-state components and products described in this column is gleaned from news releases, phone calls to and from manufacturers, technical papers published in scholarly journals, and articles printed in electronics trade publications. If *you* work for a company, university, or research institution involved in solid-state product or component developments not yet described in this column, please ask your public relations department to place Solid-State Developments on its mailing lists. News releases, preferably accompanied by black-and-white photos, should be mailed to my attention, Solid-State Developments, COMPUTERS & ELECTRONICS, One Park Avenue, New York, NY 10016. While it will be impossible to use or acknowledge receipt of all such information, *all* news releases will be reviewed, and those having high interest to readers will be considered for inclusion in future columns. Meanwhile, thanks to all of you for your help in broadening this column's data base. ◇

Experimenting with Electronic Flash Circuits

By Forrest M. Mims, III

THE brilliant white light emitted by a xenon flash tube has many practical applications. It's used for photographic illumination, solar simulation, and laser stimulation optical (pumping of laser materials), as well as for many kinds of safety, rescue, and warning lights.

Though specially designed high-pressure xenon lamps can be operated continously if suitable cooling is provided, most xenon-filled lamps are operated in a flash mode. Such lamps can have many different configurations. A few have envelopes of metal and glass, but most are glass cylinders or bulbs containing discharge and trigger electrodes. The cylinder configuration, the most common of all, is merely a hollow glass or quartz tube with an electrode at each end.

Cylindrical xenon flash tubes can be as small as a matchstick or, in the case of very high-power glass lasers used in fusion research, as big as a fence post. The glass tubes can be straight or shaped in the form of an L, U, or spiral.

Figure 1 is a block diagram of the essential ingredients of a circuit for operating a xenon lamp in the flash mode. A high-voltage supply simultaneously charges a large energy storage capacitor and a much smaller trigger capacitor. After the main capacitor is charged, the lamp is flashed by dumping the charge on the trigger capacitor through the primary of the trigger transformer. The high-voltage spike appearing at the secondary of the transformer is coupled to a small metal strap or wire wrapped around the flash tube.

This voltage spike ionizes some of the gas within the tube and provides an electrically conductive path for the charge in the main capacitor. The capacitor then discharges through the tube and excites the xenon atoms into emitting an intense white flash.

Figure 2 is a circuit that implements the operation of the block diagram in Fig. 1. Note that *C1*, the main energy storage capacitor, is connected directly across the flash tube. No leakage of charge occurs since the xenon does not conduct unless it is first ionized by a voltage higher than that across *C1*.

After both *C1* and *C2* are charged, the flash tube is triggered by closing *S1*. This dumps *C2*'s charge through trigger transformer *T1*'s primary. Since *T1* has a very high turns ratio, several thousand volts appear across its secondary. This voltage is coupled to the flash tube's trigger electrode where it ionizes some of the xenon gas and provides a low resistance path for the energy stored in capacitor *C1*.

The discharge of *C1* through the xenon is accompanied by a brilliant flash of light. The xenon resumes its nonconductive state immediately after *C1* is discharged. As soon as *C1* and *C2* are recharged, *S1* can again be closed to obtain another flash.

The energy in joules stored in the main flash capacitor is one-half the product of the capacitance and the square of the voltage. For example, a 400-μF photoflash capacitor charged to 350 V has a stored energy of 24.5 joules.

The duration of the flash is determined by the RC time constant of the flash capacitor and the discharge path

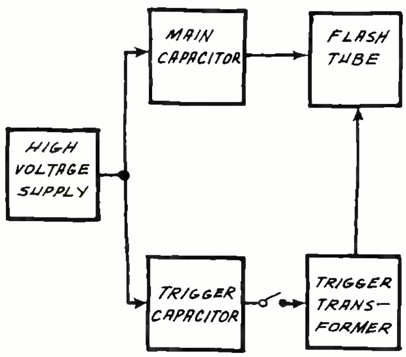

Fig. 1. Block diagram of a flash-tube trigger circuit.

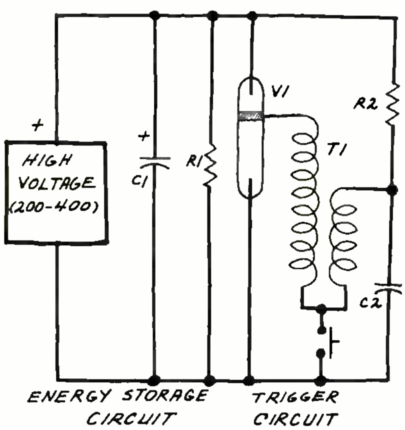

Fig. 2. Basic flash-tube circuit.

through the flash tube. Sometimes intervening networks are included to shape the discharge event into a square pulse with fast rise and fall times.

A very large C implies a long discharge time and, hence, a long flash. For short flashes it is necessary to use small values of C. To obtain equal illumination, V must then be increased. For example, to match the 24.5 joules in the preceding example, a 10-μF capacitor would have to be charged to 2.214 kV.

Alternatively, the flash can be electronically ended at almost any time by an appropriate solid-state switch. This is the method used by "computer" strobe flashes so popular with photographers. Thus, fast pulses are obtained with low energy levels. One plus is that the energy remaining in the capacitor can be used for one or more subsequent flashes, thereby extending battery life and reducing recycle time.

You may be wondering why *R1* is included in the circuit in Fig. 2 since it plays no role in the charge-discharge cycle. Its only role is to bleed the charge from *C1* should the high-voltage supply be turned off. Even if the flash tube is triggered *after* the high-voltage supply is turned off, some residual charge may remain in *C1* which will be discharged through *R1*.

The circuit will operate without *R1*, but including it is a very important safety precaution. The hazards of the high voltage required to operate xenon flash circuits are so profound that it's important to discuss them in detail before looking at some working circuits you may wish to assemble.

Important Flash Tube Precautions. Though the power supplies of some specialized xenon flash units may deliver several thousand volts, most produce from 150 to 500 V. You should, therefore, exercise considerable caution when working with such circuits. *Always* keep one hand well away from the circuit to prevent a potentially dangerous or even lethal through-the-body shock.

You can eliminate the shock hazard of a high-voltage supply simply by disconnecting the power. But this alone will *not* eliminate the hazard posed by capacitors that may have been charged by the supply. For example, in Fig. 2 the high voltage is stored in both *C1* and *C2*.

Capacitor *C2* usually has a capacity of a few tenths of a microfarad, but *C1* may have a capacity of several *hundred* microfarads. Therefore, *C1* poses far more of a hazard than *C2*. A charge of several hundred volts on a capacitor of several hundred microfarads is enough to vaporize and melt away a small crater in a steel screwdriver tip! Since considerable residual charge can be retained by such a capacitor for hours, days or even weeks, it is imperative that you treat all photoflash capacitors with the respect due a loaded gun. *Never* handle this kind of capacitor without first discharging it by bridging across its terminals the blade of an insulated screwdriver, or a power resistor with well insulated leads. Use only one hand to bridge the capacitor terminals and be sure the capacitor is *fully* discharged before handling it.

Charged photoflash capacitors are so hazardous that even taking precautions sometimes does not help. For example, ten years ago I was experimenting with a voltage divider I had assembled from a string of 10-μF, 450-V capacitors. The input to the multiplier was connected to a 350-V miniature power supply powered by a 3-V battery. The output from the multiplier was about 1000 V.

Because of the shock hazard, I followed the traditional safety practice of keeping one hand in my pocket. All went well until the springy ladder of capacitors and diodes suddenly slid from the workbench and into my lap. I grabbed one end of the multiplier with my free hand just as its high-voltage output lead touched my pants. Suddenly there was a loud pop and a puff of smoke, and a terrific jolt threw me to the floor. I was not only "shocked," but got a bad burn on my leg to boot. Suffice it to say that this unsettling experience left a lasting impression on me about the hazards of charged capacitors.

A Single-Shot Flash Circuit. Figure 3 shows a single-shot flash circuit designed around commonly available components. Transformer *T1* is a standard filament transformer. Transistors *Q1* and *Q2* form a simple oscillator. In operation, the fast-risetime pulses from the oscillator are directed through the 6.3-V winding of *T1*. When powered by a 1.5-V dry cell, the initial part of the output pulse appearing at *T1*'s 120-V winding has a peak potential of about 170-V and a duration of about 40 ms. The pulse amplitude then falls to about 100 V for the remainder of the 110-ms pulse.

The high voltage from *T1* is stored in *C2* and *C3*. Diode *D1* prevents these capacitors from discharging through *T1*. Resistor *R3* is a bleeder resistor that dis-

...EXPERIMENTER'S CORNER

charges *C2* and *C3* should the power supply be turned off.

The very high voltage required to ionize the xenon in flash tube *V1* is provided by *T2* and *C4*. Capacitor *C4* is charged through *R2* to the power-supply voltage. When *S2* is closed, *C4* is discharged through *T2*'s primary. A spike of several kilovolts then appears at *T2's* secondary and ionizes the gas in *V1*. Capacitors *C2* and *C3* are then discharged through *V1*. After *C2*, *C3* and *C4* are recharged, closing *S2* will initiate a second flash.

The only specialized components in this circuit are *T2* and *V1*, both of which can be purchased from various electronic parts suppliers. Various kinds of flash tubes and trigger transformers may have different pin orientations, so none is shown in Fig. 3. Be sure to follow any pin outlines provided with the components you purchase. The high-voltage output of *T2* is often indicated by a red dot and the primary is of heavy wire.

If you build this circuit, be sure to observe carefully all relevant safety precautions. *Never* touch any connections or leads in the boxed high-voltage section shown in Fig. 3.

An Automatic Flashing Strobe. The circuit in Fig. 4 automatically discharges a pair of capacitors through a flash tube every 1 to 2 seconds. In operation, the output from a 555 oscillator is directed through the 6.3-V winding of *T1*. When powered by a 9-V battery, a 200-V square wave appears at *T1*'s 120-V winding. Components *D1*, *D2*, *C2* and *C3* form a voltage doubler that rectifies, increases, and stores this voltage.

Resistor *R6* charges *C4* to the power-supply voltage. When the voltage reaches neon lamp *I1*'s turn-on point (80 to 100 V), *C4* begins to discharge through the primary of *T2* and *I1*. Simultaneously, *SCR1* is turned on by the voltage appearing across the lamp. *SCR1*, which should be rated for 400 or more volts, provides a very low-impedance path between *T2* and *C4*. The resulting high-voltage spike across *T2*'s secondary ionizes the gas in *V1*, thus providing a low-impedance path for discharging *C2* and *C3*. After the resulting flash, *C2*, *C3*, and *C4* begin recharging until the trigger cycle is repeated.

Because the flashes are bright enough, this simple circuit can be used as a warning light. For brighter flashes, *C2* and *C3* can both be increased. The flash rate, however, will be reduced.

If the circuit fails to flash, *I1* may be switching on at a voltage below that required to prove sufficient ionization potential across *V1*. Try another neon lamp. You may also try connecting two or more neon lamps in series to increase the ionization potential. Another cause of circuit malfunction is low-impedance leakage paths between ground and the high-voltage output from *T2*. These paths may be direct ones between exposed or poorly insulated wire leads, or may be formed by moisture and contamination on circuit boards. Even the glass surface of the flash tube itself may act as a leakage path.

Be sure to follow the safety precautions given for the previous circuit. Remember that the boxed portion of the circuit is potentially hazardous.

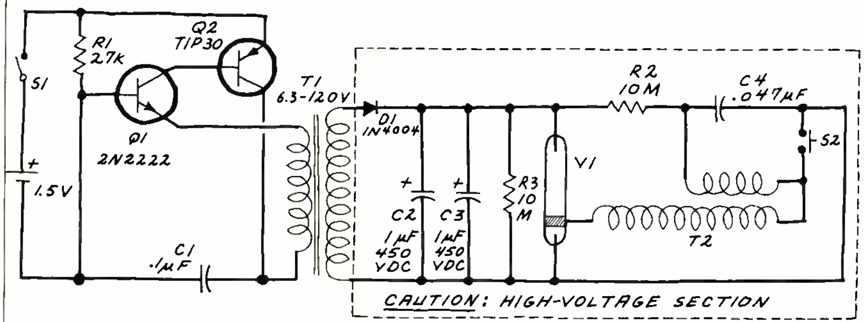

Fig. 3. Single-flash xenon strobe circuit.

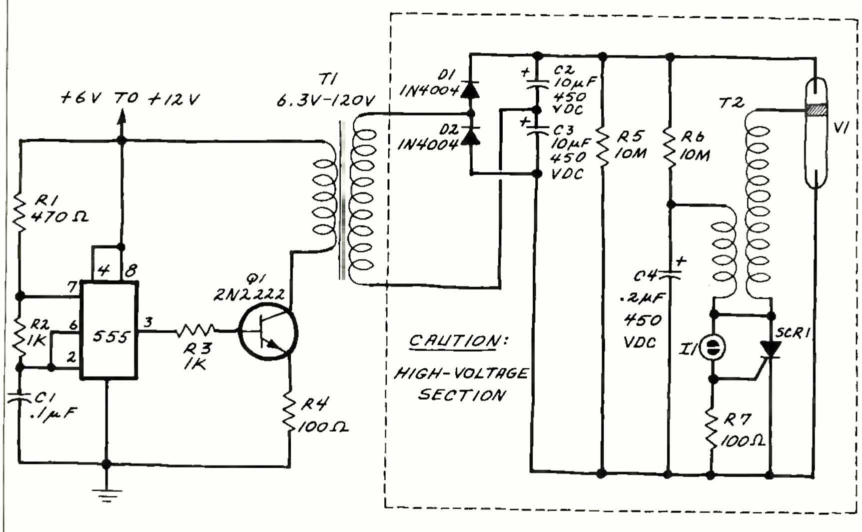

Fig. 4. Xenon strobe flasher circuit.

Going Further. After you have experimented with the basic flash circuits in Figs. 3 and 4, you may wish to replace the bulky filament transformer (*T1*) with a more compact dc-dc converter transformer like those used in photographer's strobe units. You can buy such transformers, but you can also salvage them along with flash tubes, trigger transformers, photoflash capacitors, etc. from defective or surplus flash units.

I have a stock of a dozen such flash units purchased for a few dollars each at the camera department of a discount store. Using the oscillator circuit and other components salvaged from these units, I have built half a dozen miniature automatic flashers.

A typical unit is installed in a plastic case measuring about 1" × 2" × 3". The reflector assembly and xenon lamp are protected by a yellow plastic filter. The unit's AA NiCd cells are recharged by a homemade solar battery. This unit clips on my bicycle shorts or bike packs and has accompanied me on many long distance cycling trips over the past five years.

Should you attempt to build such a flasher or work with salvaged flash units, be especially careful of the high voltage generated by these units. It is *essential* that you discharge the main capacitor *and* turn off the power before attempting to disassemble or modify such a device. Make sure the batteries are disconnected or removed before beginning work. For automatic flasher units, you will want to replace the large photoflash capacitor with one that is no more than 10 to 20 µF and rated for the proper voltage (usually 450 V). ◇

DX LISTENING

News and Notes on Shortwave Stations and Programs

By Glenn Hauser

Nicaragua. The Central American radio war grew more intense early this year with the appearance of two new stations opposing the Sandinista government: *La Voz de Nicaragua Libre,* at 0400 GMT on frequencies widely varying from night to night between 5.6 and 5.9 MHz; and *Radio Miskut,* aimed at the Atlantic Coast Indians, at 0200 on 6870-6860 kHz.

Solomon Islands. Martin Hadlow of SIBC is researching the early history of broadcasting here. Any recollections, documents, or recordings of the World War II U.S. forces stations *WVUQ* and *WVTJ* are especially wanted. Contact him c/o SIBC, P.O. Box 654, Honiara.

Sudan. We are fortunate to have an astute and experienced monitor now residing in Saudi Arabia, and a former contributing editor to this magazine, Richard E. Wood. Among the many newsworthy observations he has made from Abha is the fact that Omdurman has appeared on the new shortwave frequency of 11940 kHz, with Arabic news at 0800 GMT. Hearing it in North America will be considerably more difficult. Do not confuse with *UAE Radio,* Dubai, which also uses 11940 at times.

Surinam. The Dec. 7 coup resulted in the forced closing (and in some cases destruction of the facilities and murder of the operators) of all radio stations except the government-controlled *SRS,* on 4850 and 725 kHz. *Radio Nederland* beefed up its broadcasting to Surinam, to the displeasure of the regime, and there was talk of setting up a station devoted to liberating Surinam, in French Guiana or Venezuela.

Ukogbani. *BBC World Service* has converted its satirical review, "Two Cheers for . . ." from yearly to monthly. It alternates with other comedy programmes, usually on the first, but sometimes the last week of the month, Wednesdays at 0830 and 1430; GMT Thursdays at 0045 and 1030.

U.S.A. *Voice of America* has shaken up its program schedule in English. Here are some of the highlights: *Sundays:* "New Products U.S.A." and "New Horizons in Science" at 1105, 1505, 2105 and Monday 0105. "Issues in the News," a panel discussion, at 1130, 1830, (1930 to Africa), Monday 0230. "Critic's Choice," on the arts, 1210, 1710, Mon. 0210. "Studio One," documentaries often on topical or musical subjects, 1330, 2130, Monday 0030. "Concert Hall," 1415, 2015, Monday 0310. "Music Time in Africa," 1830 and 2230; "African Science," 2210. *Monday-Friday:* "Magazine Show," 1210, 1510, 1710, Tue-Sat 0110. "Music USA Jazz," 1415, 2015, (2210 to Africa), Tue-Sat 0310. *Saturday:* "This Week," 1110, 1510, 1710, Sunday 0110. "Press Conference USA," 1130, 1630, 1930, Sunday 0230. "Words and their Stories," 1238, 1538, 1738, Sunday 0138.

Early in the morning, *VOA* is heard on 9565 and 11715 kHz; during the day, 21840 and 15580 may be best; for African programs, 15600. In the evening, 9650, 6130, 5995.

American shortwave stations have started using the 7-MHz band, which is not allocated for broadcasting, nor is it scheduled to be under 1979 World Administrative Radio Conference agreements. First the *VOA,* appeared on 7400 kHz for Spanish between 0000 and 0300; then *WYFR* landed on 7355 kHz, for English to Europe at 0600-0800. Both these are actually in a fixed (point-to-point) band. *KGEI* began testing its new "polar beam" antenna in February, around 0300 GMT on 5975 kHz, a major *BBC* frequency to North America.

U.S.S.R. In the "USSR High Frequency Broadcast Newsletter," edited by Roger Legge, another former contributor here, we learn about shortwave sites as determined from satellite photos. Two major sites, previously unknown, are at Ulyanovsk, southeast of Moscow, and at Yevpatoriya in the Crimea. While *Radio Moscow* will specify sites on QSL cards, they seldom correspond to reality, although they may mention a large city in the general area.

Venezuela. Like Columbia, this country has a new shortwave station, *Catatumbo Internacional* on 9620 kHz. It seems to be on the air all night. Some listeners have heard *Radio Táchira,* nominally on 4830 kHz, also on 3830 and 5830 kHz. While certain receiver circuits could explain this, in this instance we believe it's a case of the transmitter mixing products, since its mediumwave outlet is on 1000 kHz. ◇

PROJECT OF THE MONTH

Constructing A Two-Way Optoisolator

By Forrest M. Mims, III

CONVENTIONAL optoisolators or optocouplers are made by installing a light source and light detector in a lighttight package. The source is electrically separated from the detector by an optically clear dielectric such as epoxy, glass or air. With this arrangement, two separate circuits or two portions of the same circuit can interact without any intervening electrical connections.

Some optoisolators use a neon glow lamp or an incandescent lamp as a light source. Most, however, use a visible or near-infrared light emitting diode. Detectors include cadmium-sulfide photoresistors, phototransistors, photodarlington transistors, photodiodes, light-activated SCRs, light-activated triacs, etc.

Conventional optoisolators are *unidirectional.* In other words, they transfer an incoming signal from the source to the detector in only one direction. It's possible, however, to make a *bidirectional* or two-way optoisolator by using components that function as both sources *and* detectors. Many LEDs and some ternary and quaternary photodiodes (such as GaAsP photodiodes made by Hamamatsu) can be used as dual-function emitter/detectors.

A Practical Two-Way Optoisolator. Figure 1 shows how to make a functional two-way optoisolator by installing two LEDs face-to-face in a short length of heat shrinkable tubing. (For very high-voltage isolation or for applications in which two circuits are some distance apart, the LEDs can be coupled to one another by means of a fiber-optic cable.)

Though many different commercial LEDs can function as both sources and detectors, GaAs, GaAs:Si, and AlGaAs:Si near-infrared emitters work better as detectors than do most visible light emitting diodes. Figure 2 shows the current transfer of a pair of TRW Optron OP-195 GaAs:Si near infrared emitters arranged in the configuration shown in Fig. 1. Data was obtained by operating the detector LED in an unbiased, photovoltaic mode. The detector LED can also be operated in a reverse-biased, photoconductive mode. If this is done, the resulting current-transfer curves are almost identical to those in Fig. 2.

The current transfer ratio (I_{out}/I_{in}) for the OP-195 LEDs which I used is only about 0.06% when the input current is 20 mA. While this is much lower than conventional LED-phototransistor optoisolators, the output current can be easily amplified. The additional circuitry needed can be justified in applications where two-way optoisolation is required.

Figure 3 shows an experimental circuit I've designed to implement, under digital control, two-way optoisolation. The circuit preserves input-output isolation by employing conventional LED phototransistor optoisolators. In operation, a low or high bit at the control input forward biases the LED in *one* of the two conventional optoisolators. For example, assume the control bit is *high.* This causes the LED in optoisolator 1 to be forward biased which, in turn, turns on its phototransistor. Any signal present at the phototransistor's collector can now forward bias *LED1* in the LED-LED (two way) optoisolator. In this case, *LED2* functions as a detector. It cannot receive any signal present at the collector of the phototransistor in optoisolator 2 since that phototransistor is turned off. When the control bit is changed from high to low, the operating mode is reversed and the LED-LED optoisolator transmits in the opposite direction. ◇

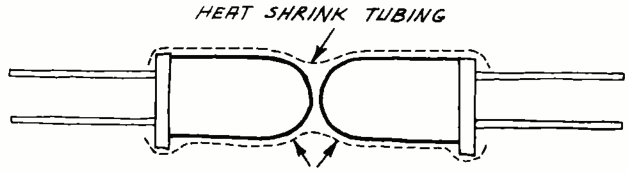

Fig. 1. How to assemble a LED/LED optoisolator.

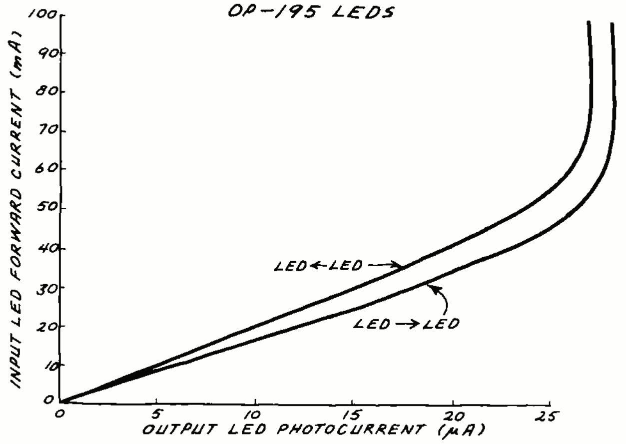

Fig. 2. LED/LED optoisolator current transfer.

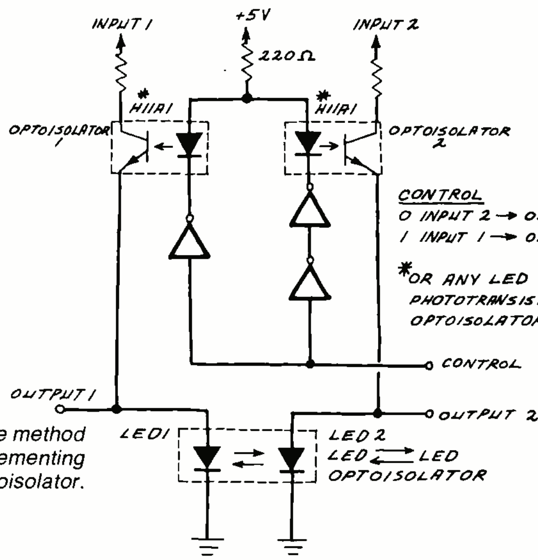

Fig. 3. One method for implementing two-way optoisolator.

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by Mark Charlton

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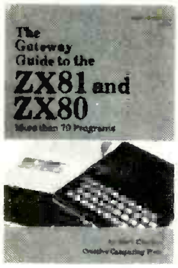

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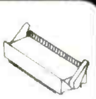

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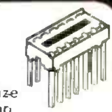

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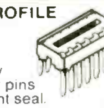

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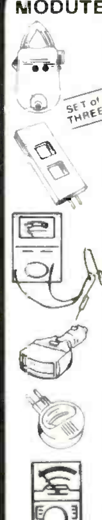

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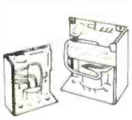

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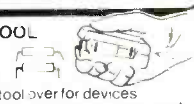
13803	SOLV15-12	12	1.5A	4-7/16x4x2	Fixed included	39.95
13804	SOLV15-15	15	1.2A	4-7/16x4x2	Fixed included	39.95
13806	SOLV15-24	24	0.75A	4-7/16x4x2	Fixed included	39.95
13808	SOLV30-5	5	6.0A	5-5/8x4-7/8x3-3/16	OVP-4	59.95
13809	SOLV30-12	12	4.0A	5-5/8x4-7/8x3-3/16	OVP-4	59.95
13810	SOLV30-15	15	3.3A	5-5/8x4-7/8x3-3/16	OVP-4	59.95
13812	SOLV30-24	24	2.0A	5-5/8x4-7/8x3-3/16	OVP-4	59.95
13802-1	Data Sheet for SOLV Series					.25

PIN FORMING TOOL



puts IC's on their true row to row spacing. One side is for .300 centers. Flip tool over for devices on .600 centers. Put device in tool and squeeze.

NEW! Stock No. 10200 $14.95 (ANTI-STATIC MODEL)

ONE TOOL DOES 8 thru 40 PINS!

Stock No. 11059 $12.95

OK MACHINE AND TOOL

IC INSERTION/EXTRACTION KIT

Includes DIP IC extractors and inserters to accommodate all ICs from 14 to 40 pins. Tools that engage conductive surfaces are CMOS safe and include grounding lugs. Stock No. 13309 **$37.74**

SOCKET WRAP ID

DIP socket sized plastic panels with numbered holes in pin locations. Slip onto socket before wire wrapping to identify pins. Also write on them for location, IC part number, function, etc. Simplifies initial wire wrapping, troubleshooting and repair.

13295	14 pin
13296	16 pin
13297	18 pin
13298	20 pin
13299	22 pin
13300	24 pin
13301	28 pin
13302	40 pin
13303	96 pin

$1.82 per pack

IC EXTRACTOR

One-piece, spring steel construction. Will extract all LSI, MSI and SSL devices with 8 to 24 pins. Stock No. 13313 **$2.10**

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CIRCLE NO. 36 ON FREE INFORMATION CARD

2732 32K EPROM $4.95

2764 64K EPROM $9.95

CAPACITORS

TANTALUM

	6V	10V	15V	20V	25V	35V	50V
.22uf						.40	
.27						.40	
.33						.40	.45
.47				.35			.50
.68						.45	.50
1.0			.40	.40	.45	.45	
1.5				.45		.50	.60
1.8							.75
2.2		.35	.40	.45		.65	.85
2.7		.40	.45				.90
3.3		.45	.50	.55	.60	.65	.90
3.9		.45					
4.7	.45	.55		.60	.65	.85	.90
6.0			.60				
6.8			.70		.75		
8.2							1.00
10	.55	.65	.80	.85	.90	1.00	
12	.65		.85	.90			
15	.75	.85	.90				
18			1.25				
22		1.00	1.35				
27			2.25				
39		1.50					
47	1.35						
56	1.75						
100		3.25					
270	3.75						

DISC

10pf	50V	.05	470	50V	.05
22	50V	.05	560	50V	.05
25	50V	.05	680	50V	.05
27	50V	.05	820	50V	.05
33	50V	.05	.001uf	50V	.05
47	50V	.05	.0015	50V	.05
56	50V	.05	.0022	50V	.05
68	50V	.05	.005	50V	.05
82	50V	.05	.01	50V	.07
100	50V	.05	.02	50V	.07
220	50V	.05	.05	50V	.07
330	50V	.05	.1	12V	.10
			.1	50V	.12

MONOLITHIC

1uf-mono 50V .18 .47uf-mono 50V .25

ELECTROLYTIC

RADIAL			AXIAL		
47uf	50V	.14	1uf	50V	.14
1	25V	.14	4.7	16V	.14
2.2	35V	.15	10	16V	.14
4.7	50V	.15	10	50V	.16
10	50V	.15	22	16V	.14
47	35V	.18	47	50V	.20
100	16V	.18	100	15V	.20
220	35V	.20	100	35V	.25
470	25V	.30	150	25V	.25
2200	16V	.60	220	25V	.30
			330	16V	.40
			500	16V	.42
			1000	16V	.60
			1500	16V	.70
			6000	16V	.85

COMPUTER GRADE

26,000uf 30V 3.95

WIREWRAP CARDS

FR-4 Epoxy Glass Laminate
With Gold-Plated Contact Fingers

S-100 BUSS

P100-1	Bare — No Foil Pads	15.95
P100-2	Horizontal BUSS	22.95
P100-3	Vertical BUSS	22.95
P100-4	Single Foil Pads Per Hole	23.95

APPLE

P500-1	Bare — No Foil Pads	15.95
P500-3	Horizontal BUSS	22.95
P500-4	Single Foil Pads Per Hole	23.95

IBM

IBM-PR	BUSS Lines + Pads	55.00

GENERAL PURPOSE

22/44 PIN (.156" SPACING)

P441-3	Vertical BUSS, 4.5" x 6"	13.95
P442-3	Vertical BUSS, 4.5" x 9"	14.95

36/72 PIN (.1" SPACING)

P721-3	Vertical BUSS, 4.5" x 6"	13.95
P722-3	Vertical BUSS, 4.5" x 9"	14.95

IF YOU CAN FIND A PRICE LOWER ELSEWHERE, LET US KNOW AND WE WILL MEET OR BEAT THEIR PRICE! (SEE TERMS BELOW)

OPTO-ISOLATORS

4N26	1.00	MCA-7	1.50
4N27	1.10	MCA-255	1.75
4N28	.69	IL-1	1.25
4N33	1.75	ILA-30	1.25
4N35	1.25	ILQ-74	2.75
4N37	1.25	H11C5	1.25
MCT-2	1.00	TIL-111	1.00
MCT-6	1.50	TIL-113	1.75

DIODES

1N751	5.1 volt zener	.25
1N759	12.0 volt zener	.25
1N4148	(1N914) switching	25/1.00
1N4004	400PIV rectifier	10/1.00
KBP02	200PIV 1.5amp bridge	.45
KBP04	400PIV 1.5amp bridge	.55

MUFFIN FANS NEW UN-USED

4.68 Square	14.95
3.125 Square	14.95

SWITCHES

SPDT mini-toggle	1.25
DPDT mini-toggle	1.50
SPDT push-button	1.49

TRANSISTORS

2N918	.50	MPS3706	.15
MPS918	.25	2N3772	1.85
2N2102	.50	2N3903	.25
2N2218	.50	2N3904	.10
2N2218A	.50	2N3906	.10
2N2219	.50	2N4122	.25
2N2219A	.50	2N4123	.25
2N2222	.25	2N4249	.25
PN2222	.10	2N4304	.75
MPS2369	.25	2N4401	.25
2N2484	.25	2N4402	.25
2N2905	.50	2N4403	.25
2N2907	.25	2N4857	1.00
PN2907	.125	PN4916	.25
2N3055	.79	2N5086	.25
3055T	.69	PN5129	.25
2N3393	.30	PN5139	.25
2N3414	.25	2N5209	.25
2N3563	.40	2N6028	.35
2N3565	.40	2N6043	1.75
PN3565	.25	2N6045	1.75
MPS3638	.25	MPS-A05	.25
MPS3640	.25	MPS-A06	.25
PN3643	.25	MPS-A55	.25
PN3644	.25	TIP29	.65
MPS3704	.15	TIP31	.75
		TIP32	.79

HEAT-SINKS

TO-3 style	.95
TO-220 style	.35

IC SOCKETS

	1-99	100
8 pin ST	.13	.11
14 pin ST	.15	.12
16 pin ST	.17	.08
18 pin ST	.20	.18
20 pin ST	.29	.27
22 pin ST	.30	.27
24 pin ST	.30	.27
28 pin ST	.40	.32
40 pin ST	.49	.39
64 pin ST	4.25	call
ST = SOLDERTAIL		
8 pin WW	.59	.49
14 pin WW	.69	.52
16 pin WW	.49	.49
18 pin WW	.99	.90
20 pin WW	1.09	.98
22 pin WW	1.39	1.28
24 pin WW	1.49	1.35
28 pin WW	1.69	1.49
40 pin WW	1.99	1.80
WW = WIREWRAP		
16 pin ZIF	6.75	call
24 pin ZIF	9.95	call
28 pin ZIF	10.95	call
ZIF = TEXTOOL (Zero Insertion Force)		

DIP SWITCHES

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

MasterCard

VISA

LED LAMPS

	1-99	100-up
Jumbo Red	.10	.09
Jumbo Green	.18	.15
Jumbo Yellow	.18	.15

LED DISPLAYS

HP 5082-7760	.6"	CC	1.29
MAN 72	.3"	CA	.99
MAN 74	.3"	CC	.99
FND-357 (359)	.375"	CC	1.25
FND-500 (503)	.5"	CC	1.49
FND-507 (510)	.5"	CA	1.49

BYPASS CAPS

.01 UF DISC	100/6.00
.1 UF DISC	100/8.00
.1 UF MONOLITHIC	100/15.00

RESISTORS

¼ WATT 5% CARBON FILM ALL STANDARD VALUES FROM 1 OHM TO 10 MEG OHM

50 PCS. SAME VALUE	.025
100 PCS. SAME VALUE	.02
1000 PCS. SAME VALUE	.015

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

2716 16K EPROM $3.95 TMS2532 32K EPROM $5.95

MICROCOMPUTER HARDWARE HANDBOOK

FROM ELCOMP — $14.95

Over 800 pages of manufacturers data sheets on most commonly used IC's

Includes

- TTL — 74/74LS and 74F
- CMOS
- Voltage Regulators
- Memory — RAM, ROM, EPROM
- CPU's — 6800, 6500, Z80, 8080, 8085, 8086/8
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BEST SELLING BOOKS

OSBORNE/MC GRAW-HILL

Apple II User's Guide	16.95
CRT Controller's Handbook	9.95
68000 Assembly Language Programming	16.99
CBASIC User Guide	15.00

SYBEX

Your First Computer	8.95
The CP/M Handbook	14.95
The PASCAL Handbook	18.95
Microprocessor Interfacing Techniques	17.95

TRANSFORMERS

FRAME STYLE

12.6VAC	2amp	4.95
12.6VAC CT	2amp	5.95
12.6VAC CT	4amp	7.95
12.6VAC CT	8amp	10.95
25.2VAC CT	2amp	7.95

PLUG CASE STYLE

12VAC	250ma	3.95
12VAC	500ma	4.95
12VAC	1amp	5.95
12VAC	2amp	6.95

DC ADAPATER

6, 9, 12 VDC selectable with universal adapter 8.95

NOTE: Please include sufficient amount for shipping on above items.

DISK DRIVES

TANDON

TM100-1 5¼" (FOR IBM) SS/DD 229.00
TM100-2 5¼" (FOR IBM) DS/DD 295.00

SHUGART

SA 400L 5¼" (40 TRACK) SS/DD 199.95
SA 400 5¼" (35 TRACK) SS/DD 189.95

SIEMENS

FD100-8 8" SS/DD (801 REPLACEMENT) 259.00

PERTEC

FD-200 5¼" SS/DD 179.95
FD-250 5¼" DS/DD 199.95

MPI

MP-52 5¼" (FOR IBM) DS/DD 295.00

NOTE: Please include sufficient amount for shipping on above items.

CABINETS FOR 5¼" DISK DRIVES

CABINET #1 $29.95

- ★ DIMENSIONS 8⅝ x 5 15/16 x 3 15/16"
- ★ COLOR MATCHES APPLE
- ★ FITS STANDARD 5¼" DRIVES, INCL. SHUGART
- ★ INCLUDES MOUNTING HARDWARE AND FEET

CABINET #2 $79.00

- ★ COMPLETE WITH POWER SUPPLY, SWITCH, LINE CORD, FUSE & STANDARD POWER CONNECTOR
- ★ DIMENSIONS: 11½ x 5¾ x 3 15/16"
- ★ +5V @ 1 AMP, +12V @ 1.5 AMP
- ★ FITS STANDARD 5¼" DRIVES
- ★ PLEASE SPECIFY GRAY OR TAN

NOTE: Please include sufficient amount for shipping on above items.

JDR SPRING SPECIALS

SA400 $189.95

- ★ 35 TRACKS
- ★ REPEAT OF A SELLOUT
- ★ LIMITED SUPPLY (AGAIN)
- ★ MODIFY FOR USE IN APPLE (EXPERIENCED TECHNICIANS)
- ★ USE WITH CABINET #1 TO MAKE A BEAUTIFUL APPLE COMPATIBLE DRIVE

MODIFICATION INSTRUCTIONS $1.00

34 PIN EDGE CARD CONNECTOR MATES TO RIBBON CABLE $3.25

MEMORY SALE

2114 450NS (TMS4045)	8/9.95	100 FOR .99 ea.
2114 250NS (TMS4045)	8/10.95	100 FOR 1.99 ea.
2102L-4 LOW POWER 450NS	.55 ea.	100 FOR .49 ea.

4164 200NS	5.95	Z80A-CPU 4MHZ	4.95
HM6116-4 200NS	4.75	8080 2MHZ	3.95
TMM2016 200NS	4.15	8085 3MHZ	5.95
2732 450NS	4.95	8086 5MHZ	29.95
TMS2532 450NS	5.95	6800 1MHZ	3.95
2764 450NS	9.95	68000 8MHZ	59.95

COMPONENTS

LM1488 or LM1489 .69 ea. 7805T or 7812T .75 ea.
16 PIN LOW PROFILE ST IC SOCKETS 100/8.00
16 PIN TOOLED WIRE WRAP IC SOCKETS .49 EA.

SPRING SPECIALS ARE GOOD ONLY UNTIL MAY 31, 1983

POWER SUPPLY

MODEL 2 $39.95

MOUNTED ON PC BOARD
MANUFACTURED BY CONVER

+5 VOLT 4 AMP
±12 VOLT 1 AMP

NOTE: Please include sufficient amount for shipping on above items.

CONNECTORS

RS232 MALE	2.50
RS232 FEMALE	3.25
RS232 FEMALE RIGHT ANGLE	5.25
RS232 HOOD	1.25
S-100 ST	3.95
S-100 WW	4.95
44 pin ST	2.95
44 pin WW	4.95
72 pin ST	6.95
72 pin WW	7.95

RIBBON CABLE

CONTACTS	SINGLE COLOR 1'	SINGLE COLOR 10'	COLOR CODED 1'	COLOR CODED 10'
10	.50	4.40	.83	7.30
20	.65	5.70	1.25	11.00
26	.75	6.60	1.32	11.60
34	.98	8.60	1.65	14.50
40	1.32	11.60	1.92	16.80
50	1.38	12.10	2.50	22.00

D-SUBMINIATURE

DESCRIPTION	SOLDER		RIGHT ANGLE SOLDER		RIBBON CABLE		HOODS	
	MALE	FEMALE	MALE	FEMALE	MALE	FEMALE	BLACK	GREY
ORDER BY	DBxxP	DBxxS	DBxxPR	DBxxSR	IDBxxP	IDBxxS	HOOD-B	HOOD
CONTACTS 9	2.08	2.66	1.65	2.18	3.37	3.69	---	1.60
15	2.69	3.63	2.20	3.03	4.70	5.13	---	1.60
25	2.50	3.25	3.00	4.42	6.23	6.84	1.25	1.25
37	4.80	7.11	4.83	6.19	9.22	10.08	---	2.95
50	6.06	9.24	---	---	---	---	---	3.50

For order instructions see "IDC Connectors" below.

IDC CONNECTORS

DESCRIPTION	SOLDER HEADER	RIGHT ANGLE SOLDER HEADER	WW HEADER	RIGHT ANGLE WW HEADER	RIBBON HEADER SOCKET	RIBBON HEADER	RIBBON EDGE CARD
ORDER BY	IDHxxS	IDHxxSR	IDHxxW	IDHxxWR	IDSxx	IDMxx	IDExx
CONTACTS 10	.82	.85	1.86	2.05	1.15	---	2.25
20	1.29	1.35	2.98	3.28	1.86	5.50	2.36
26	1.68	1.76	3.84	4.22	2.43	6.25	2.65
34	2.20	2.31	4.50	4.45	3.15	7.00	3.25
40	2.58	2.72	5.28	4.80	3.73	7.50	3.80
50	3.24	3.39	6.63	7.30	4.65	8.50	4.74

ORDERING INSTRUCTIONS: Insert the number of contacts in the position marked "**xx**" of the "order by" part number listed. **Example:** A 10 pin right angle solder style header would be IDH10SR.

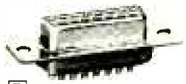
CIRCLE NO. 22 ON FREE INFORMATION CARD

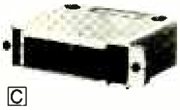
BEGIN YOUR SPRING PROJECT AT THE SHACK®

Quality Parts! Huge Selection! No Minimum Order!

New! 9-Position D-Sub Connectors


A


B


C

Low As **1.99**

The BEST for less! Fit joystick ports of many video games and micros. Perfect for making joystick extension cords or chassis mounting.

A **9-Conductor Plug.** 276-1537 ...... 1.99
B **Socket for above.** 276-1538 ...... 2.49
C **Hood.** Fits both. 276-1539 ...... 2.19

Low-Voltage Indicator


TO-72 Case

3.59

ICM7201. Triggers an LED (not incl.) when voltage falls below preset 2.9V level. Easy way to add low-battery warning to power packs—ideal for nickel-cadmiums! 276-2333 .... 3.59

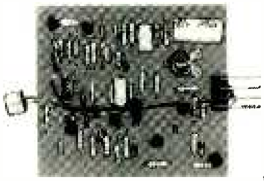
Compressor/Expander For Audio Use


16-Pin With Data

6.99

NE572. Dual-channel device can compress or expand dynamic range. Ideal for stereo noise reduction systems. 6 to 22VDC, single supply. 276-1781 .. 6.99

Sound Switch Module



Only **1.99**

Whistle Activated!

- *With User Notes*
- *Up to 25 ft. Range*

Whistle once for on, again for off! Use it to control a relay, appliances, lights, TV sound, more. 6 to 9VDC. 277-1011 .... 1.99

Sale! EMI/RFI Filter

Save $3.07

8.88 Reg. 11.95

- ***U.L./CSA Approved***
- ***Protect Your Computer & Data***

Keeps power line transients out! Rated 5A at 120VAC. 273-100 .. Sale, 8.88

Single-Supply UART

Full-Duplex Universal Transceiver


40-Pin With Specs & Data **5.95**

AY-3-1015. Accepts asynchronous serial binary characters, converts to parallel format, and vice versa. Multi-logic compatible inputs. Fully buffered outputs. Low power. 4.75-5.25VDC. 276-1794 .... 5.95

Tantalum Capacitors

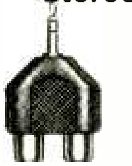
NEW!

16 WVDC Minimum

Premium capacitors for critical bypass, blocking, decoupling and filtering applications. Provide high capacity in a very small package.

µF	Cat. No.	Each
0.1	272-1432	.49
0.47	272-1433	.49
1.0	272-1434	.49
2.2	272-1435	.59
10.0	272-1436	.69
22.0	272-1437	.79

Stereo Y-Adapter



NEW! 1.99

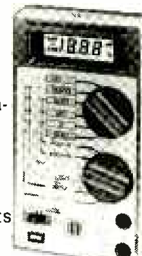
Adapts two phono plugs to 1/8" stereo mini jack. Color-coded. 274-369 ...... 1.99

Handy Digital Logic Probe

Diagnose Any Digital Circuit

LEDs indicate high, low, or pulsed (to 10 MHz) logic states. Minimum detectable pulse: 50 ns. Overload and polarity protected. 34" leads obtain power from circuit under test. 22-301 ...... 19.95

Deluxe, 21-Range LCD Multimeter



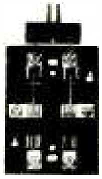
Time-saving audible continuity and range-change indicator. Measures AC and DC voltage, AC and DC current, and resistance to 20 megs. Tests forward conduction of diodes and transistors. Overload protected. Requires two "AA" batteries. With spare fuse, test leads, instructions. 22-191 .... 79.95

Colored Mini Lamps

69¢ NEW!

Long-life incandescents are great for model trains, panels, projects. 60 mA.
6V. 272-1098 .... 3/69¢
12V. 272-1099 .... 3/69¢

DPDT Knife Switch



99¢

Great for projects, antenna switching, model railroads and more. 0.5A at 250VAC. Screw terminals. 275-1537 .... 99¢

100 Disc Capacitors

Builder's Bargain **1.98** Set of 100

Includes NPOs, N-750s, Mylar and ceramics from 2 pF to 0.1 µF, WVDC up to 1 kV. 272-801 ... Set, 1.98

16K RAMs—25% Off!

Reg. 3.95 **2.95**

4116 Dynamic RAM. Under 450 ns access. Manufacturer's prime. Stock up now! 276-2505 .... Sale, 2.95

UHF Adapters and Connectors

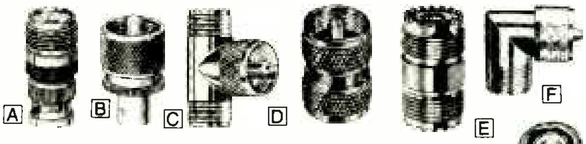
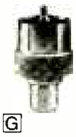
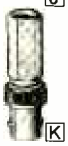

A B C D E F

Fig.	Type	Adapts	To Fit	Cat. No.	Each
A	UG-255/U	Female BNC	PL-259	278-120	2.99
B	UG-273/U	Male BNC	SO-239	278-121	2.99
C	M-358 "T"	SO-239	(2) PL-259	278-198	2.59
D	—	SO-239	SO-239	278-192	1.89
E	PL-258	PL-259	PL-259	278-1369	1.59
F	M-359	Right-Angle	Adapter	278-199	2.09


G


H


J


K

G **Solderless Push-On PL-259.** For RG58/59. **278-190** 1.59
H **1094 Female BNC.** Mounts in 5/8" hole. **278-105** 1.59
J **UG-88 Male BNC.** Solderless. For RG58. **278-103** 2.29
J **UG-88 Male BNC.** Above, for RG59/RG62. **278-104** 2.29
K **Inline Female BNC.** For RG58 cable. **278-113** 2.49
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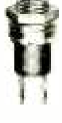

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SN7403N	14	.25	SN7475N	16	.45	SN74161N	16	.69
SN7404N	14	.25	SN7476N	16	.35	SN74162N	16	.69
SN7405N	14	.25	SN7479N	14	4.95	SN74163N	16	.69
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SN7409N	14	.25	SN7485N	16	.59	SN74167N	16	2.79
SN7410N	14	.25	SN7486N	14	.35	SN74170N	16	1.29
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SN7416N	14	.25	SN7493N	14	.39	SN74176N	14	.69
SN7417N	14	.25	SN7494N	14	.69	SN74177N	14	.69
SN7420N	14	.19	SN7495N	14	.49	SN74179N	16	1.49
SN7421N	14	.35	SN7496N	16	.49	SN74180N	14	.69
SN7422N	14	.45	SN7497N	16	2.75	SN74181N	24	1.95
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SN7426N	14	.29	SN74105N	14	.89	SN74185N	16	1.95
SN7427N	14	.25	**SN74107N**	14	.29	SN74190N	16	.69
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SN7432N	14	.29	SN74121N	14	.39	SN74193N	16	.69
SN7437N	14	.25	SN74122N	14	.55	SN74194N	16	.69
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SN7439N	14	.59	SN74125N	14	.45	SN74196N	14	.89
SN7440N	14	.19	SN74126N	14	.45	SN74197N	14	.89
SN7441N	16	.89	SN74132N	14	.49	SN74198N	24	1.19
SN7442N	16	.45	SN74136N	14	.49	SN74199N	24	1.19
SN7443N	16	.99	SN74141N	16	.69	SN74221N	16	1.19
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SN7453N	14	.19	SN74151N	16	.59	SN74366N	16	.55
SN7454N	14	.19	SN74152N	14	.59	SN74367N	16	.55
SN7459A	14	.25	SN74153N	16	.59	SN74368N	16	.55
SN7460N	14	.19	SN74154N	24	1.25	SN74390N	16	1.49
SN7470N	14	.29	SN74155N	16	.59	SN74393N	14	1.49

74LS

74LS00	14	.25				74LS192	16	.79
74LS01	14	.25				74LS193	16	.79
74LS02	14	.25	74LS92	14	.55	74LS194	16	.69
74LS03	14	.25	74LS93	14	.55	74LS195	16	.69
74LS04	14	.29	74LS95	14	.79	74LS197	14	.79
74LS05	14	.29	74LS96	16	.89	74LS221	16	.89
74LS08	14	.29	74LS107	14	.39	74LS240	20	1.09
74LS09	14	.29	74LS109	16	.39	74LS241	20	1.09
74LS10	14	.29	74LS112	16	.39	74LS242	14	1.09
74LS11	14	.35	74LS113	14	.39	74LS243	14	1.09
74LS12	14	.35	74LS114	14	.39	74LS244	20	1.09
74LS13	14	.39	74LS122	14	.49	74LS245	20	1.49
74LS14	14	.59	74LS123	16	.79	74LS247	16	1.09
74LS15	14	.35	74LS125	14	.49	74LS248	16	1.09
74LS20	14	.29	74LS126	14	.49	74LS249	16	1.09
74LS21	14	.29	74LS132	14	.59	74LS251	16	.59
74LS22	14	.29	74LS133	16	.59	74LS253	16	.59
74LS26	14	.29	74LS136	14	.39	74LS257	16	.59
74LS27	14	.29	74LS138	16	.59	74LS258	16	.59
74LS28	14	.35	74LS139	16	.59	74LS260	14	.59
74LS30	14	.29	74LS151	16	.59	74LS266	14	.69
74LS32	14	.35	74LS153	16	.59	74LS273	20	1.49
74LS33	14	.55	74LS154	24	.99	74LS279	16	.49
74LS37	14	.35	74LS155	16	.69	74LS283	16	.69
74LS38	14	.35	74LS156	16	.69	74LS290	14	.89
74LS40	14	.29	74LS157	16	.69	74LS293	14	.79
74LS42	16	.55	74LS158	16	.59	74LS298	16	.89
74LS47	16	.75	74LS160	16	.69	74LS352	16	1.29
74LS48	16	.75	74LS161	16	.69	74LS353	16	1.29
74LS49	14	.75	74LS162	16	.69	74LS365	16	.49
74LS51	14	.25	74LS163	16	.69	74LS366	16	.49
74LS54	14	.25	74LS164	14	.69	74LS367	16	.49
74LS55	14	.29	74LS165	16	1.19	74LS368	16	.49
74LS73	14	.39	74LS168	16	1.19	74LS373	20	1.29
74LS74	14	.39	74LS169	16	1.19	74LS374	20	1.29
74LS75	16	.39	74LS170	16	1.49	74LS375	16	.69
74LS76	16	.39	74LS173	16	.69	74LS386	14	.45
74LS78	14	.39	74LS174	16	.59	74LS393	14	1.19
74LS83	16	.65	74LS175	16	.59	74LS399	16	1.49
74LS85	16	.69	74LS181	24	2.49	74LS670	16	1.49
74LS86	14	.39	74LS190	16	.89	81LS95	20	1.49
74LS90	14	.55	74LS191	16	.89	81LS97	20	1.49

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74S03	14	.35	74S124	16	2.95	74S251	16	1.19
74S04	14	.45	74S133	16	.45	74S253	16	1.19
74S05	14	.45	74S134	16	.50	74S257	16	1.19
74S08	14	.39	74S135	16	.69	74S258	16	1.19
74S09	14	.39	74S136	14	1.39	74S260	14	.79
74S10	14	.35	74S138	16	.89	74S280	14	1.95
74S11	14	.35	74S139	16	.89	74S287*	16	1.95
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74S74	14	.55	74S195	16	1.49	74S571*	16	2.95
74S86	14	.55	74S196	14	1.49	74S572*	18	4.95
74S112	16	.55	74S240	20	2.25	74S573*	18	4.95
74S113	14	.55	74S241	20	2.25	74S940	20	2.49
74S114	14	.55	74S242	14	2.49	74S941	20	2.49

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CA3039H		1.35	CA3082N	16	1.49	CA3160H		1.95
CA3046N	14	.89	CA3083N	16	1.49	CA3401N	14	.59
CA3059N	14	3.25	CA3086N	14	.69	CA3600N	14	3.95

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CD4010	16	.39	CD4046	16	.89	CD4514	24	1.79
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CD4013	14	.39	**CD4049**	16	.39	CD4518	16	.99
CD4014	16	.79	CD4050	16	.39	CD4519	16	.39
CD4015	16	.39	CD4051	16	.79	CD4520	16	.79
CD4016	14	.39	CD4052	16	.79	CD4526	16	1.19
CD4017	16	.75	CD4053	16	.79	CD4528	16	1.19
CD4018	16	.79	CD4056	16	2.95	CD4529	16	1.19
CD4019	16	.39	CD4059	24	7.95	CD4543	16	1.19
CD4020	16	.75	CD4060	16	.89	CD4562	14	6.95
CD4021	16	.79	CD4066	14	.39	CD4566	16	1.39
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CD4023	14	.29	CD4069	14	.29	CD4584	14	.59
CD4024	14	.69	CD4070	14	.39	CD4723	16	1.19
CD4025	14	.23	CD4071	14	.29	CD4724	16	1.19
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M-CDP1802	User Manual	7.50
M-2650	User Manual	5.00
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MM5290-3	16	16,384x1	(200ns)	1.69 - 8/12.95
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21L02	16	1024x1	(450ns) L.P.	1.49
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2114-2	18	1024x4	(200ns)	2.25 - 8/15.95
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2147	18	4096x1	(70ns)	4.95
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TMS4045	18	1024x4	(450ns)	3.95
5101	22	256x4	(450ns) CMOS	4.95
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HM6116P-3	24	2048x8	(150ns) CMOS	7.95
HM6116-4	24	2048x8	(200ns) CMOS	6.95
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7489	16	16x4	(50ns) 3101	2.25
74C920	22	256x4	(250ns) CMOS (6551)	3.95
74C921	18	256x4	(250ns) CMOS	3.95
74C929	16	1024x1	(250ns) CMOS (6501)	3.95
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74S206	16	256x1	(60ns) 93411	3.95
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82S10	16	1024x1	(50ns) O.C. (93415)	3.95
82S25	16	16x4	(50ns) O.C. (74S289)	2.25

EPROMS

1702A	24	256x8	(1us)	4.95
2708	24	1024x8	(450ns)	3.95
2708-5	24	1024x8	(550ns) SM00246	2.95
TMS2516	24	2048x8	(450ns) 2716	6.95
TMS2532	24	4096x8	(450ns) NMC2532	9.95
TMS2564	28	8192x8	(450ns)	19.95
TMS2716	24	2048x8	(450ns) 3 voltage	7.95
2716	24	2048x8	(450ns)	4.95
2716-1	24	2048x8	(350ns)	6.95
2732	24	4096x8	(450ns)	9.95
27580	24	1024x8	(450ns) single +5V	2.95
MM2764	28	8192x8	(450ns)	16.95
MM2764-3	28	8192x8	(300ns)	19.95

PROMS

74S188	16	32x8	PROM O.C. (6330-1)	1.49
74S287	16	256x4	PROM T.S. (6301-1)	1.95
74S288	16	32x8	PROM T.S. (6331-1)	1.95
74S387	16	256x4	PROM O.C. (6300-1)	1.95
74S471	20	256x8	PROM T.S. (6309-1)	5.95
74S472	20	512x8	PROM T.S. (6349-1)	4.95
74S473	20	512x8	PROM O.C. (6348)	4.95
74S474	24	512x8	PROM T.S. (DM87S296N)	4.95
74S475	24	512x8	PROM O.C. (6340)	4.95
74S478	24	1024x8	PROM T.S. (TBP28S86)	8.95
74S570	16	512x4	PROM O.C. (6305)	2.95
74S571	16	512x4	PROM T.S. (6306)	2.95
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74S573	18	1024x4	PROM T.S. (82S137)	4.95
82S23	16	32x8	PROM O.C. (27S18)	2.95
82S115	24	512x8	PROM T.S. (27S15)	9.95
82S123	16	32x8	PROM T.S. (27S19)	2.95
82S126	16	256x4	PROM O.C. (27S20)	3.95
82S129	16	256x4	PROM T.S. (27S21)	3.95
82S130	16	512x4	PROM O.C. (27S12)	5.95
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DM87S180N	24	1024x8	PROM O.C. (82S180)	9.95
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DA15S	15 Pin Socket	2.95
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DB25S	**25 Pin Socket (Meets RS232)**	**3.25**
DB25P-831	25 Pin Right Angle Plug	4.95
DB25S-831	25 Pin Right Angle Socket	5.25
DC37P	37 Pin Plug	4.95
DC37S	37 Pin Socket	5.95
DD50P	50 Pin Plug	5.95
DD50S	50 Pin Socket	6.95

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DE-9H	Hood for DE-9 Series Connectors	$1.19
DA-15H	Hood for DA-15 Series Connectors	1.29
DB25H	Hood for DB25 Series Connectors	1.25
DC37H	Hood for DC37 Series Connectors	1.39
DD50H	Hood for DD50 Series Connectors	1.49
D20418-2	2 screws for mtg. connectors to a panel	.79

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Part No.	Cnts.	Sp.	Description	Price
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22/44PC	22/44	.156	PC type (no mtg. ears)	.99
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22/44WW	22/44	.156	Wire Wrap - Level 3	4.95
67031-5	22/44	.156	WW (Pins .0625x.03x.75)	3.95
R-681-1	50/100	.125	Wire Wrap - Level 3	7.95
R-681-2	50/100	.125	Wire Wrap - Level 1	6.95

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PL258	UHF Straight Adapter	.89
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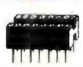
UG88/U	BNC Plug	1.49
UG89/U	BNC Jack	1.69
UG306/U	BNC Angle Adapter	2.49
UG260/U	BNC Plug	1.49
UG1094/U	BNC Bulkhead Receptacle	.89



IC SOCKETS

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

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16 pin LP	.19	.17	.16
18 pin LP	.26	.24	.23
20 pin LP	.30	.27	.25
22 pin LP	.31	.28	.27
24 pin LP	.33	.30	.28
28 pin LP	.40	.37	.35
36 pin LP	.46	.42	.39
40 pin LP	.49	.46	.43

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14 pin WW	.65	.62	.59
16 pin WW	.69	.65	.61
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20 pin WW	1.09	1.05	.99
22 pin WW	1.25	1.19	1.15
24 pin WW	1.29	1.23	1.18
28 pin WW	1.59	1.50	1.45
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The DT1050 consists of a Speech Processor Chip, MM54104 (40-pin) and two (2) Speech ROMs MM52164SSR1 and MM52164SSR2 (24-pin) along with a Master Word list and a recommended schematic diagram on the application sheet.

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DT1057 — Expands the DT1050 vocabulary from 137 to over 260 words. Incl. 2 ROMs and specs.

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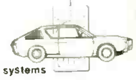

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7206CEV/Kit*	16	Tone Generator Chip, XTL	7.95
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7216DIPI	28	8 Digit Freq. Counter C.C.	19.95
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7217AIPI	28	4 Digit LED Up/Down Counter C.C.	11.95
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74C14	14	.59	74C154	24	3.49	74C901	14	.59
74C20	14	.35	74C157	16	2.25	74C903	14	.59
74C30	14	.35	74C160	16	1.19	74C906	14	.59
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74C85	16	1.95	74C174	16	1.19	74C923	20	4.95
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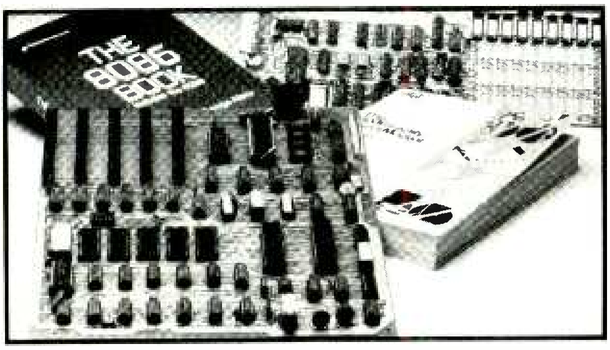

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☐ Extra 62-pin connectors @ 4.25 ea. + 1.00 p&i

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The EXPLORER 88-PC can be expanded at any pace you decide. Invest and learn at a pace that is comfortable for you. Netronics is dedicated to supplying the finest hardware and software to make this a meaningful learning experience. Hard disks, built-in modem board, eprom burner, print buffer system plus more will be available shortly. The following items are available now:

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JAWS MEMORY BOARD. Features the INTEL 8202 for invisible refresh. Designed to be used with 8080, 8085 and Z80 CPU's. Works in all well designed S-100 computers, 10 day refund (or exchange wired unit for a Kit) on wired units.

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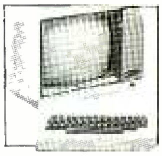
Use 90 preprogrammed words or generate your own words using phonems. Perfect for any project that needs speech or for speech development system. Connects to any RS 232 serial or 8 bit parrallel port or can be used in a stand alone mode. ☐ Speak-easy (board only) 159.95 + 3.00 p&i. ☐ Cabinet and power transformer 25.00 + 2.00 p&i.

TRS 80 ELECTRIC MOUTH. Plugs into the expansion slot on the TRS 80 models 1 or 3 (specify type) ☐ with 143 word set 119.95 + 3.00 p&i. Includes separate power supply, ☐ second word set 39.95 + 1.00 p&i, same specs as S-100 model

APPLE ELECTRIC MOUTH. Same as above except this board plugs into any of the Apple expansion slots ☐ with 143 word set 99.95 + 3.00 p&i. ☐ second word set 39.95 + 1.00 p&i. Accepts 3 word sets or custom word ROMs.

TERMINALS & VIDEO

FASTERM 64 ☐ 199.95 + 3.00 p&i. Display format: 64 or 32 char/16 lines...96 ASCII characters (u/l case)...8 baud rates, 150 to 19,200...line output: RS 232-C or 20 ma loop...video output: 1V P/P...cursor modes: home & clear screen, erase to end of line, erase cursor line, cursor up and down, auto carriage return/line feed at ends of line and auto scrolling...reverse video...blinking cursor...parity: off, even, or odd...stop bits: 1, 1.5, 2...data bits per character: 5, 6, 7 or 8...printer output: prints all incoming data...1k on-board RAM...2k on-board ROM...complete with power supply, cabinet & 56-key ASCII encoded keyboard. ☐ Optional graphics mode: includes 34 Greek & math plus 30 special graphic characters. 19.95 prepaid.



☐ **FASTERM VIDEO BOARD:** 99.95 + 3.00 p&i.

SMARTERM 80 ☐ 299.95 + 3.00 p&i. Display format: specify either 80 by 24 or 40 by 16...128 ASCII characters (u&l case)...8 baud rates: 110 to 19,200...line output: RS232/C or 20 ma current loop...video output: 1V P/P...editing features: insert/delete line, insert/delete character, forward/back tab...line or page transmit...page print function...cursor positioning: up, down, right, left, plus absolute cursor positioning with read back...visual attributes: underline, blink, reverse video, half intensity & blank...graphics: 12,000 pixel resolution block plus line graphics...on-screen parity indicator...parity: off, even or odd...stop bits: 110 baud 2, all others 1...printer output...60 or 50 Hz vertical refresh...blinking block cursor...2k on-board RAM...ASCII encoded keyboard: 56 keys, 128 characters...4k on-board ROM...complete with power supply & cabinet.

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5101	256 x 4 (450ns) (cmos)	3.95
2102-1	1024 x 1 (450ns)	.89
2102L-4	1024 x 1 (450ns) (LP)	.99
2102L-2	1024 x 1 (250ns) (LP)	1.49
2111	256 x 4 (450ns)	2.49
2112	256 x 4 (450ns)	2.99
2114	1024 x 4 (450ns)	8/9.95
2114L-4	1024 x 4 (450ns) (LP)	8/12.95
2114L-3	1024 x 4 (300ns) (LP)	8/13.45
2114L-2	1024 x 4 (200ns) (LP)	8/13.95
2147	4096 x 1 (55ns)	4.95
TMS4044-4	4096 x 1 (450ns)	3.49
TMS4044-3	4096 x 1 (300ns)	3.99
TMS4044-2	4096 x 1 (200ns)	4.49
MK4118	1024 x 8 (250ns)	9.95
TMM2016-200	2048 x 8 (200ns)	4.15
TMM2016-150	2048 x 8 (150ns)	4.95
TMM2016-100	2048 x 8 (100ns)	6.15
HM6116-4	2048 x 8 (200ns) (cmos)	4.75
HM6116-3	2048 x 8 (150ns) (cmos)	4.95
HM6116-2	2048 x 8 (120ns) (cmos)	8.95
HM6116LP-4	2048 x 8 (200ns) (cmos)(LP)	5.95
HM6116LP-3	2048 x 8 (150ns) (cmos)(LP)	6.95
HM6116LP-2	2048 x 8 (120ns) (cmos)(LP)	10.95
Z-6132	4096 x 8 (300ns) (Qstat)	34.95

LP = Low Power   Qstat = Quasi-Static

DYNAMIC RAMS

TMS4027	4096 x 1 (250ns)	1.99
UPD411	4096 x 1 (300ns)	3.00
MM5280	4096 x 1 (300ns)	3.00
MK4108	8192 x 1 (200ns)	1.95
MM5298	8192 x 1 (250ns)	1.85
4116-300	16384 x 1 (300ns)	8/11.75
4116-250	16384 x 1 (250ns)	8/11.95
4116-200	16384 x 1 (200ns)	8/12.95
4116-150	16384 x 1 (150ns)	8/14.95
4116-120	16384 x 1 (120ns)	8/29.95
2118	16384 x 1 (150ns) (5v)	4.95
4164-200	65536 x 1 (200ns) (5v)	5.95
4164-150	65536 x 1 (150ns) (5v)	6.95

5V = single 5 volt supply

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1702	256 x 8 (1us)	4.50
2708	1024 x 8 (450ns)	3.95
2758	1024 x 8 (450ns) (5v)	5.95
2716	2048 x 8 (450ns) (5v)	3.95
2716-1	2048 x 8 (350ns) (5v)	5.95
TMS2516	2048 x 8 (450ns) (5v)	5.50
TMS2716	2048 x 8 (450ns)	7.95
TMS2532	4096 x 8 (450ns) (5v)	5.95
2732	4096 x 8 (450ns) (5v)	4.95
2732-250	4096 x 8 (250ns) (5v)	8.95
2732-200	4096 x 8 (200ns) (5v)	11.95
2764	8192 x 8 (450ns) (5v)	9.95
2764-250	8192 x 8 (250ns) (5v)	14.95
2764-200	8192 x 8 (200ns) (5v)	24.95
TMS2564	8192 x 8 (450ns) (5v)	17.95
MC68764	8192 x 8 (450ns) (5v)(24 pin)	39.95

5v = Single 5 Volt Supply

EPROM ERASERS

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

Z-80

2.5 Mhz	
Z80-CPU	3.95
Z80-CTC	4.49
Z80-DART	10.95
Z80-DMA	14.95
Z80-PIO	4.49
Z80-SIO/0	16.95
Z80-SIO/1	16.95
Z80-SIO/2	16.95
Z80-SIO/9	16.95
4.0 Mhz	
Z80A-CPU	4.95
Z80A-CTC	4.95
Z80A-DART	11.95
Z80A-DMA	16.95
Z80A-PIO	4.95
Z80A-SIO/0	16.95
Z80A-SIO/1	16.95
Z80A-SIO/2	16.95
Z80A-SIO/9	16.95
6.0 Mhz	
Z80B-CPU	11.95
Z80B-CTC	13.95
Z80B-PIO	13.95
Z80B-DART	19.95
ZILOG	
Z6132	34.95
Z8671	39.95

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32.768 khz	1.95
1.0 mhz	4.95
1.8432	4.95
2.0	3.95
2.097152	3.95
2.4576	3.95
3.2768	3.95
3.579535	3.95
4.0	3.95
5.0	3.95
5.0688	3.95
5.185	3.95
5.7143	3.95
6.0	3.95
6.144	3.95
6.5536	3.95
8.0	3.95
10.738635	3.95
14.31818	3.95
15.0	3.95
16.0	3.95
17.430	3.95
18.0	3.95
18.432	3.95
20.0	3.95
22.1184	3.95
32.0	3.95

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6845	14.95
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HD46505SP	15.95
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MC1372	6.95
68047	24.95
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8085	5.95
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8086	29.95
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8155	6.95
8155-2	7.95
8156	6.95
8185	29.95
8185-2	39.95
8741	39.95
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8755	24.95

8200

8202	24.95
8203	39.95
8205	3.50
8212	1.80
8214	3.85
8216	1.75
8224	2.25
8226	1.80
8228	3.49
8231	call
8237	19.95
8237-5	21.95
8238	4.49
8243	4.45
8250	10.95
8251	4.49
8253	6.95
8253-5	7.95
8255	4.49
8255-5	5.25
8257	7.95
8257-5	8.95
8259	6.90
8259-5	7.50
8271	39.95
8272	39.95
8275	29.95
8279	8.95
8279-5	10.00
8282	6.50
8283	6.50
8284	5.50
8286	6.50
8287	6.50
8288	25.00
8289	49.95

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1771	16.95
1791	24.95
1793	26.95
1795	49.95
1797	49.95
2791	54.95
2793	54.95
2795	59.95
2797	59.95
6843	34.95
8272	39.95
UPD765	39.95
1691	17.95
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RS232 FEMALE	3.25
RS232 HOOD	1.25
S-100 ST	3.95

6800

68000	59.95
6800	3.95
6802	7.95
6808	13.90
6809E	19.95
6809	11.95
6810	2.95
6820	4.35
6821	3.25
6828	14.95
6840	12.95
6843	34.95
6844	25.95
6845	14.95
6847	11.95
6850	3.25
6852	5.75
6860	9.95
6862	11.95
6875	6.95
6880	2.25
6883	22.95
68047	24.95
68488	19.95
6800 = 1MHZ	
68B00	10.95
68B02	22.25
68B09E	29.95
68B09	29.95
68B10	6.95
68B21	6.95
68B45	19.95
68B50	5.95
68B00 = 2 MHZ	

6500

1 MHZ	
6502	4.95
6504	6.95
6505	8.95
6507	9.95
6520	4.35
6522	7.95
6532	9.95
6545	22.50
6551	11.85
2 MHZ	
6502A	6.95
6522A	9.95
6532A	11.95
6545A	27.95
6551A	11.95
3 MHZ	
6502B	14.95

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AY3-1014	6.95
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XR2206	3.75
8038	3.95

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74LS00	.24	74LS173	.69
74LS01	.25	74LS174	.55
74LS02	.25	74LS175	.55
74LS03	.25	74LS181	2.15
74LS04	.24	74LS189	8.95
74LS05	.25	74LS190	.89
74LS08	.28	74LS191	.89
74LS09	.29	74LS192	.79
74LS10	.25	74LS193	.79
74LS11	.35	74LS194	.69
74LS12	.35	74LS195	.69
74LS13	.45	74LS196	.79
74LS14	.59	74LS197	.79
74LS15	.35	74LS221	.89
74LS20	.25	74LS240	.95
74LS21	.29	74LS241	.99
74LS22	.25	74LS242	.99
74LS26	.29	74LS243	.99
74LS27	.29	74LS244	.99
74LS28	.35	74LS245	1.49
74LS30	.25	74LS247	.75
74LS32	.29	74LS248	.99
74LS33	.55	74LS249	.99
74LS37	.35	74LS251	.59
74LS38	.35	74LS253	.59
74LS40	.25	74LS257	.59
74LS42	.49	74LS258	.59
74LS47	.75	74LS259	2.75
74LS48	.75	74LS260	.59
74LS49	.75	74LS266	.55
74LS51	.25	74LS273	1.49
74LS54	.29	74LS275	3.35
74LS55	.29	74LS279	.49
74LS63	1.25	74LS280	1.98
74LS73	.39	74LS283	.69
74LS74	.35	74LS290	.89
74LS75	.39	74LS293	.89
74LS76	.39	74LS295	.99
74LS78	.49	74LS298	.89
74LS83	.60	74LS299	1.75
74LS85	.69	74LS323	3.50
74LS86	.39	74LS324	1.75
74LS90	.55	74LS352	1.29
74LS91	.89	74LS353	1.29
74LS92	.55	74LS363	1.35
74LS93	.55	74LS364	1.95
74LS95	.75	74LS365	.49
74LS96	.89	74LS366	.49
74LS107	.39	74LS367	.45
74LS109	.39	74LS368	.45
74LS112	.39	74LS373	.99
74LS113	.39	74LS374	.99
74LS114	.39	74LS377	1.39
74LS122	.45	74LS378	1.18
74LS123	.79	74LS379	1.35
74LS124	2.90	74LS385	1.90
74LS125	.49	74LS386	.45
74LS126	.49	74LS390	1.19
74LS132	.59	74LS393	1.19
74LS133	.59	74LS395	1.19
74LS136	.39	74LS399	1.49
74LS137	.99	74LS424	2.95
74LS138	.55	74LS447	.37
74LS139	.55	74LS490	1.95
74LS145	1.20	74LS624	3.99
74LS147	2.49	74LS640	2.20
74LS148	1.35	74LS645	2.20
74LS151	.55	74LS668	1.69
74LS153	.55	74LS669	1.89
74LS154	1.90	74LS670	1.49
74LS155	.69	74LS674	9.65
74LS156	.69	74LS682	3.20
74LS157	.65	74LS683	3.20
74LS158	.59	74LS684	3.20
74LS160	.69	74LS685	3.20
74LS161	.65	74LS688	2.40
74LS162	.69	74LS689	3.20
74LS163	.65	74LS783	24.95
74LS164	.69	81LS95	1.49
74LS165	.95	81LS96	1.49
74LS166	1.95	81LS97	1.49
74LS168	1.75	81LS98	1.49
74LS169	1.75	25LS2521	2.80
74LS170	1.49	25LS2569	4.25

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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	74190	1.15
7453	.23	74191	1.15
7454	.23	74192	.79
7460	.23	74193	.79
7470	.35	74194	.85
7472	.29	74195	.85
7473	.34	74196	.79
7474	.33	74197	.75
7475	.45	74198	1.35
7476	.35	74199	1.35
7480	.59	74221	1.35
7481	1.10	74246	1.35
7482	.95	74247	1.25
7483	.50	74248	1.85
7485	.59	74249	1.95
7486	.35	74251	.75
7489	2.15	74259	2.25
7490	.35	74265	1.35
7491	.40	74273	1.95
7492	.50	74276	1.25
7493	.35	74279	.75
7494	.65	74283	2.00
7495	.55	74284	3.75
7496	.70	74285	3.75
7497	2.75	74290	.95
74100	1.75	74293	.75
74107	.30	74298	.85
74109	.45	74351	2.25
74110	.45	74365	.65
74111	.55	74366	.65
74116	1.55	74367	.65
74120	1.20	74368	.65
74121	.29	74376	2.20
74122	.45	74390	1.75
74123	.49	74393	1.35
74125	.45	74425	3.15
74126	.45	74426	.85
74128	.55	74490	2.55

LINEAR

LM301	.34	LM340 (see 7800)		LM566	1.49	LM1800	2.37
LM301H	.79	LM348	.99	LM567	.89	LM1812	8.25
LM307	.45	LM350K	4.95	NE570	3.95	LM1830	3.50
LM308	.69	LM350T	4.60	NE571	2.95	LM1871	5.49
LM308H	1.15	LM358	.69	NE592	2.75	LM1872	5.49
LM309H	1.95	LM359	1.79	LM709	.59	LM1877	3.25
LM309K	1.25	LM376	3.75	LM710	.75	LM1889	1.95
LM310	1.75	LM377	1.95	LM711	.79	LM1896	1.75
LM311	.64	LM378	2.50	LM723	.49	ULN2003	2.49
LM311H	.89	LM379	4.50	LM723H	.55	LM2877	2.05
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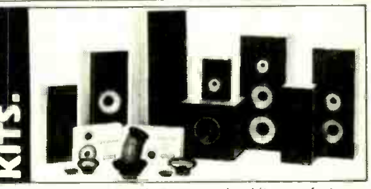

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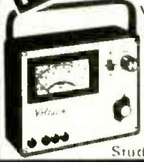

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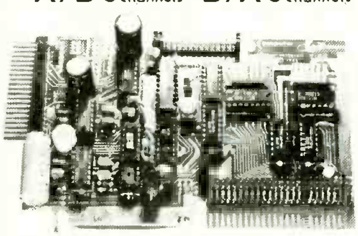

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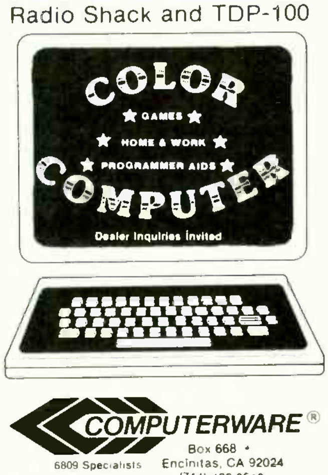

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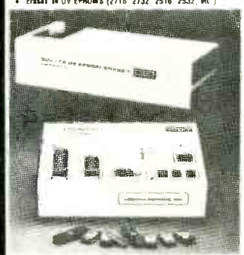

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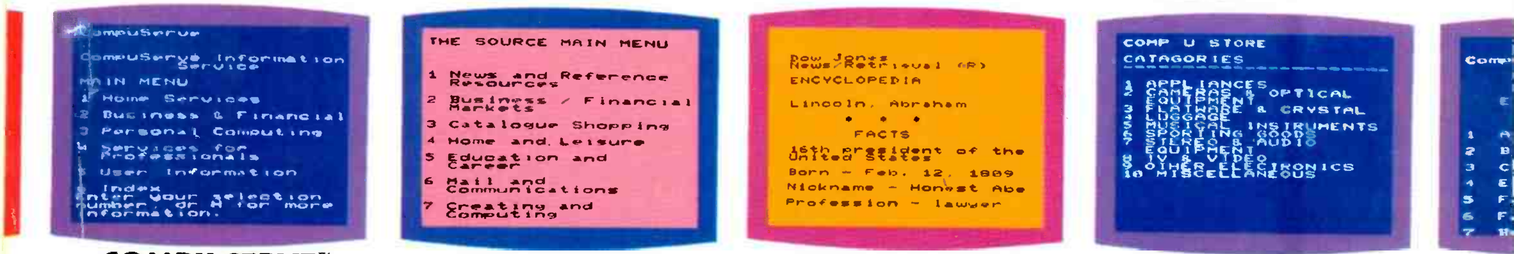

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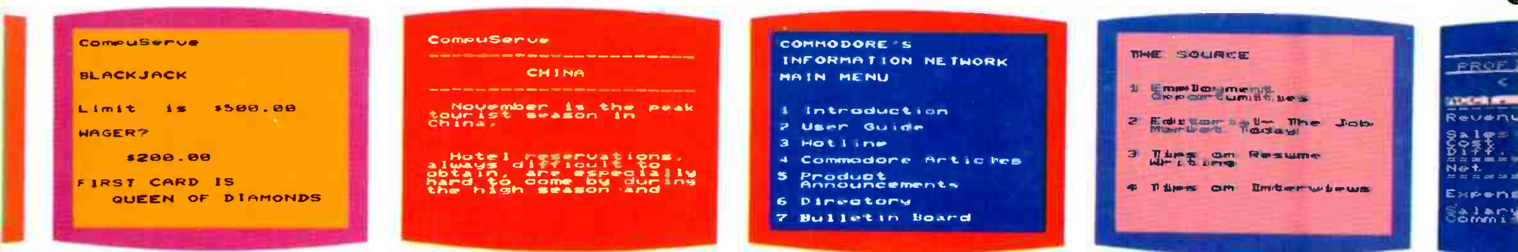

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