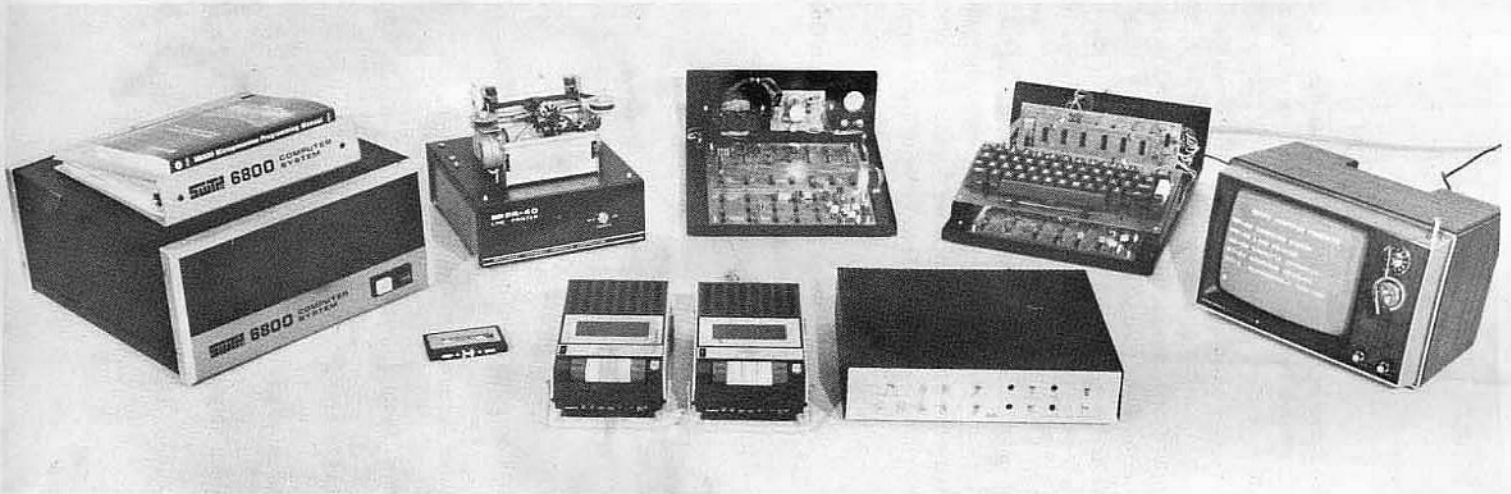
SWTPC COMPUTER PRODUCTS



SOUTHWEST TECHNICAL PRODUCTS CORP., 219 W. RHAPSODY, SAN ANTONIO, TEXAS 78216 CP-01

INTRODUCTION

This brochure contains a comprehensive description of each of the SWTPC Computer Product Kits. Included are details on the SWTPC 6800 Computer System, Computer System Software, CT-64 Terminal System, AC-30 Audio Cassette Interface, PR-40 Alphanumeric Printer GT-61 Graphics Terminal and Potentiometer Digitizer. You might note that all of our peripheral products have been designed to be "universally" compatible with almost any computer system including our own SWTPC 6800 Computer. This gives you the user maximum flexibility when configuring and upgrading your processing system throughout the coming years.

SWTPC also sells many other electronic kits besides computer products. For example, we offer power amplifiers, preamplifiers, reverbs, equalizers, strobes, power supplies, function generators and digital test equipment just to mention a few. Write us for a copy of our general catalog.

Southwest Technical Products Corporation
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San Antonio, Texas 78216

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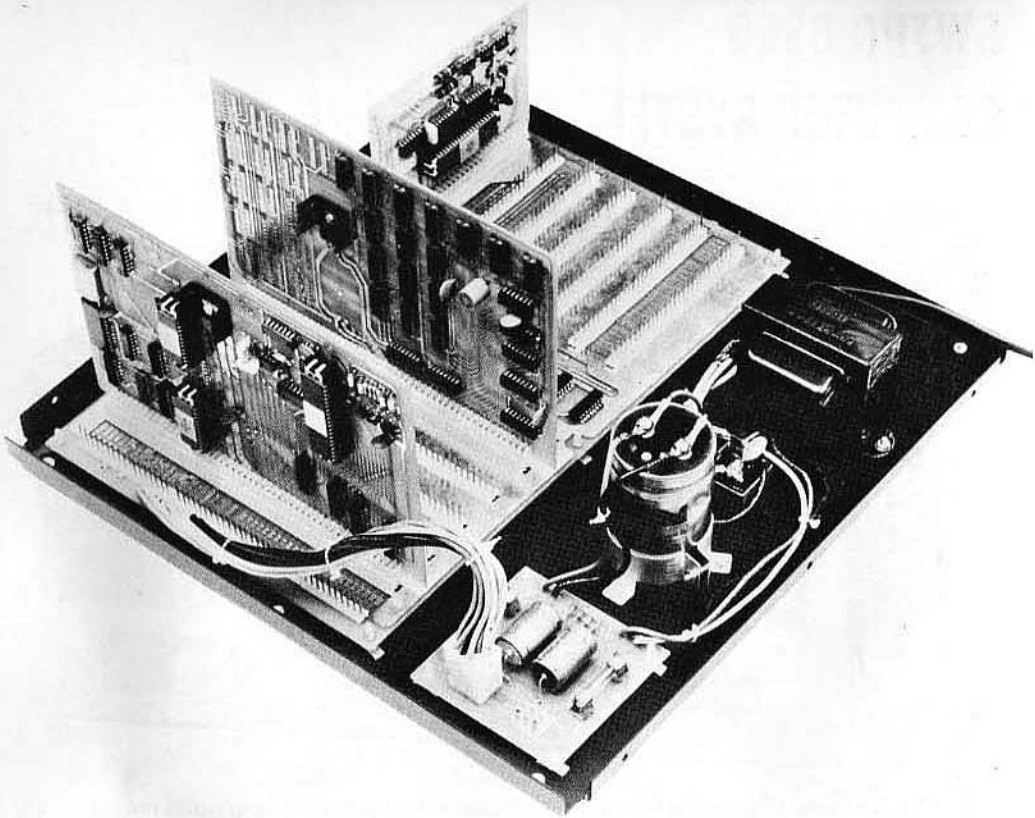
SWTPC 6800 COMPUTER SYSTEM



The Southwest Technical Products 6800 computer system is based upon the Motorola MC6800 microprocessor unit (MPU) and its matching support devices. The 6800 system was chosen for our computer because this set of parts is currently, in our opinion, the "Benchmark Family" for microprocessor computer systems. It makes it possible for us to provide you with an outstanding computer system having a minimum of parts, but with outstanding versatility and ease of use. In addition to the outstanding hardware system, the Motorola 6800 has without question the most complete set of documentation yet made available for a microprocessor system. The 714 page Motorola Applications Manual (not included with the kit), for example, contains material on programming techniques, system organization, input/output techniques, hardware characteristics, peripheral control techniques, and more. The Motorola Programmers Manual which is supplied with our kit details the various types of software available for the system and instructions for programming and using the unique interface system that is part of the 6800 system. The M6800 family of parts minimizes the number of required components and support parts, provides extremely simple interfacing to external devices and has outstanding documentation.

The MC6800 is an eight-bit parallel microprocessor with addressing capability of up to 65,536 words (BYTES) of data. The system is TTL compatible requiring only a single five-volt power supply. All devices and memory in the 6800 computer family are connected to an 8-bit bi-directional data bus. In addition to this a 16-bit address bus is provided to specify memory location. This later bus is also used as a tool to specify the particular input/output device to be selected when the 6800 family interface devices are used.

System timing is provided by the crystal oscillator portion of an MC14411 driving a two phase clock system. The circuit also includes dividers to provide bit rate signals for the interface circuits. This makes it possible to independently connect the serial interfaces in the system for 110, 150, 300, 600, or 1200 baud operation with crystal controlled accuracy.



The SWTPC 6800 computer consists of the following major parts:

MC6800	Microprocessing Unit (MPU)
MCM6830	Read Only Memory (ROM)
MC6820	Peripheral Interface Adaptor (PIA)
MCM6810	Random Access Memory (RAM)

These parts combined with an appropriate power supply, memory, interface and bus drivers make up our computer system. For those not familiar with computer systems this may not mean much, but a system made up of these parts offers some outstanding advantages to the user, or programmer of the computer.

Let's assume you have purchased something other than a SWTPC 6800 computer system, and are ready to connect it to a teletype or terminal; just connect some wires together, right? Wrong! You will probably find that you need to purchase an interface plug-in for your computer that is compatible with the terminal you plan to use. This will cost you anywhere from seventy-five to a hundred and twenty-five dollars depending upon the interface involved. The SWTPC 6800 computer system includes the control interface as part of the basic package, not an an extra cost option.

Now at last you have connected the terminal to the computer, turned the power on and you're ready to type in your first program, right? Wrong! Unless you have a control program stored in memory giving the terminal, system control, the terminal will do absolutely

nothing. How do you get this control program into memory? Well, you can load it from tape, that is if you have a tape reader and the patience to enter the tape loader routine from the programmer's console; or if your system does not have a tape reader you can load the entire control program from the programmer's console. The problem here is that such control programs are typically 500 bytes in length and that's a lot of data to load from the programmer's console especially when you consider that the entire sequence must be repeated every time you power up or its allocated area of memory is accidentally overwritten by a wayward user program. Another problem is that most of the micro-computer manufacturers do not supply a listing of such a control program with their systems. Their routines providing terminal control over system operation are built into high level language software packages that must be loaded from some kind of tape reader. This is unfortunate for the individual who can't afford a tape reader for his system or doesn't have the memory space required by such packages. Besides, this still doesn't help the individual who wants to enter his program in machine language. His only means of getting a program into the computer is by entering it byte by byte from the programmer's console. Even if there is a terminal connected to the system, it cannot be used to load a program into memory.

The SWTPC 6800 computer system does not have a programmer's console. This is because all information that the machine needs to communicate with a terminal at start up is contained in a ROM in our system. This component is a permanently programmed memory that contains the necessary information to configure the machine for use with a terminal. You actually have a mini-operating system for system control, in that it is possible to display and change data located in memory, to print out or punch a tape (if applicable) of selected memory contents, to load a user program from tape (if applicable), to display and/or change the contents of the MPU registers, to jump to and execute a user written program loaded into memory. In addition to these functions a debug routine is provided for debugging user programs. These operating system functions are all initiated and monitored through a serial terminal, either 20 ma TTY current loop or RS-232 at 110 or 300 baud. Together the two provide those functions normally handled through the programmer's console as well as many others that are not. All data input and output is in convenient hexadecimal (base 16) notation rather than binary. This means you can type in a command to load address location $A000_{16}$ with $9E_{16}$ instead of setting twenty four console switches to an address of 1010 0000 0000 0000 with data of 1001 1110 as must be done with the conventional programmer's console. Take note also that since this operating system is stored in ROM, it is always at your finger tips and since it has its own RAM memory, it does not use any user program memory space. It cannot be accidently over-written or lost when powering down and simply depressing the "RESET" switch on the front panel will always load the system. When computer control is turned over to the user's program via the operating system, the terminal is totally available for user program input/output communciation.

Now you have at last gotten your computer connected to an input device and loaded the memory so it will accept instructions from your terminal. Now at last you can run programs and enjoy your computer. Well you can provided you don't have a very long program. Most of the inexpensive computers and computer kits now being offered come with only 256 words of memory. This is not much. It might be enough to do a few simple problems similar to those you can do on a regular pocket calculator, but nothing really elaborate. Programming in machine language is a real pain too if you have very much programming to do. An editor/assembler package greatly simplifies programming but unfortunately consumes a great deal of memory (8K words). The solution to both of these drawbacks is the same—more memory. We are offering about ten times the amount offered in most other low cost computer systems. The SWTPC 6800 provides you with 4,096 words of memory which we consider a practical minimum. If you want more memory it can be easily added.

We also have a low cost cassette tape data storage system described within another seciton of this brochure which utilizes the operating system features and communicates thru the same control interface as does the terminal. It can be used to store user data or programs

and it is a medium through which we supply a resident editor and assembler as well as other software. The editor and assembler are great time savers when it comes to writing and modifying programs especially if those programs are long. We also have a growing library of software which includes game programs and even Basic interpreters with more to come, all of which are either free or available on a "cost of documentation" basis.

So you can see that with our computer you can actually use the system as it stands without having to buy a series of expensive interface and memory modules. As an added bonus we offer a user contributed software exchange newsletter compiled and distributed by us to our customers providing a means through which our users can share their programming efforts with the other users while compiling a software library at the lowest possible cost.

So there you have it—the SWTPC 6800. An affordable and also usable computer system with no hidden tricks. You get everything you need to operate your own small computer system without additional expense. If you have already purchased a Motorola 6800 chip set and would like to use our boards, they are available. We are offering the maximum possible flexibility to allow you the maximum possible savings in building your system. Check our prices on the following page I think you will agree that you can't complain about deals like these.

OK—I Like It—What Do I Order?

First of all, our computer requires a terminal to operate the system. The terminal is required for system control and is also used for data input/output after control is transfered to the user program. The terminal must be an ASCII terminal, communicating serially via either a 20 ma TTY current loop or RS-232 and capable of operating at either 110 baud (10 cps) or 300 baud (30 cps). Baudot, or IBM EBCDIC coded terminals will not work. If you do not already have a terminal that meets these requirements, our CT-64 terminal system is a terminal ideally suited for this computer system.

Another thing I would like to make clear is that our computer systems and terminal systems are sold in kit form only. We do not offer them in assembled form. Our instructions have been written for the individual who has built up electronic projects before, knows how to recognize the various components, and is experienced at printed circuit board soldering. Although the instructions include step-by-step assembly details, schematics, pictorials, wiring diagrams, and a theory of operation, they have not been written for the beginner. The various modules within each of the kits simply plug together keeping the wiring to a minimum.

We have a very comprehensive documentation package available with the computer system, which goes into great detail on both the hardware and software for the system. Much of the material is official Motorola written literature which is some of the best we've seen. Most of it is written on the assumption the reader has an understanding of machine language operation/assembler programming so if you're not up to par here you might want to get ahead and patronize your local library to read some books on computer operation at the machine language level.

The following is a detailed description of each of the items presently available for the SWTPC 6800 Computer System.

SWTPC 6800 Computer System Price List

MP-68	Complete 6800 computer system kit. Consisting of kits, MP-A, MP-B, MP-C, MP-D, MP-F, MP-M, MP-MX and MP-P listed below	$395.00
MP-A	Microprocessor system board kit—with MC6800 microprocessor MCM 6830 read only memory, MCM6810 random access memory, clock oscillator, clock driver and data bus buffers.	$145.00
MP-B	Mother Board—with interface address decoders	$ 40.00
MP-C	Control Interface (serial) for TTY current loop or RS232 terminal interface	$ 40.00
MP-D	System documentation, test programs plus copy of Motorola Programming Manual for M6800	$ 35.00
MP-F	Chassis and cover—aluminum with black finish	$ 37.50
MP-M	Memory board with 2,048 words of static memory devices. Expandable to 4,096 words with MP-MX kit below	$ 65.00
MP-MX	2,048 words of static memory devices and regulator.	$ 35.00
MP-8M	8,192 words of static memory devices with regulators	$250.00
MP-P	Power Supply—7.0 Volts DC filtered unregulated, ±12 Volts DC filtered unregulated. Powers complete set of memory boards and as many as eight interfaces	$ 42.50
MP-S	Serial Interface—using MC6850 ACIA	$ 35.00
MP-L	Parallel Interface—using MC6820 PIA	$ 35.00
MP-T	Interrupt timer option	$ 39.95

Circuit Boards*

MP-Ab	Processor circuit Board	$14.50
MP-Mb—MP-8b	Memory circuit Boards	$14.50
MP-Bb	Mother Board	$30.00
MP-Cb, MP-Sb, or MP-Lb or MP-T	Interface circuit boards	$ 9.50
Connector Set	Male and matching Female connectors for processor or memory boards	$ 2.50
Connector Set	Male and matching Female connectors for interface circuit boards (Specify serial or parallel type)	$ 2.00

*All boards are fibreglass G-10/FR4 with plated through holes.

MP-A Microprocessor/System Board

The MP-A board is the primary logic board for the system. It is a 5½" x 9" double sided plated thru hole circuit board containing the 6800 microprocessor chip, the 6830 ROM which stores the Mini-Operating system and the 6810 128 byte scratch pad memory for the ROM. There is a crystal controlled processor clock driver and baud rate generator providing serial interface baud rates of 110, 150, 300, 600 and 1200 baud for all but the control interface which is operable at 110 or 300 baud. The board also contains a power up/manual reset circuit which loads the ROM stored operating system when activated. Full I/O buffering is

provided for the 16 address lines and 8 bi-directional data lines with these and other interconnections made to the rest of the system thru a fifty pin connector to the mother board (MP-B). +5 volt power for the board is supplied by an on board +5 volt regulator with heatsink at a total current consumption of 0.8 A typical.

The 6800 Microprocessor chip itself is a 40 pin eight bit parallel processor with sixteen memory/peripheral address lines and an eight bit bi-directional data bus. There is a full compliment of 72 basic instructions with five possible addressing modes (direct, relative, immediate, indexed and extended). There are six internal registers (program counter, stack pointer, index register, accumulator A, accumulator B and condition code register). Since the pushdown stack is located within user memory, it is easily accessable and space limited only by the programmer and the amount of RAM memory available. The processor has both maskable and non-maskable interrupts which are executed as jumps to specific memory locations. Restart is also executed as a jump, but in this system the restart jump transfers system control over to terminal control via the mini-operating system ROM. The ROM itself gives the user the ability to:

1. load user programs or data into memory from either the keyboard or tape (where applicable)
2. execute user programs
3. list user programs or data within specified memory locations on the terminal or tape (where applicable)
4. print the data contents within the internal CPU registers
5. change the data in specified memory locations or the CPU registers.

MP-M Memory Board

The MP-M Memory Board is a 5½" x 9" double sided plated thru hole board with a total storage capability of 4,096 words of 8 bit random access memory. The kit, however, is supplied with only half (2,048 words) of its memory capacity. To bring the board to maximum capacity, you must purchase the MP-MX memory expansion kit. The circuitry on the board provides all of the address decoding and data line buffering to handle a total of 32 (1K bit x 1 bit) 2102 type static random access memories. All interconnections to the system are made via a 50 pin connector to the Mother Board (MP-B). +5 volt power for the board is supplied by a on board regulator with heatsink for each 2,048 words of memory. Current consumption is approximately 0.75 A for every 2,048 words of memory.

MP-MX Memory Expansion Kit

The MP-MX Memory Expansion kit contains 16 2102 type static random access memories plus the 5V voltage regulator necessary to expand the MP-M Memory Board to a full 4,096 words.

MP-8M Memory Board

The MP-8M Memory Board is a 5½" x 9" double sided plated thru hole board with a total storage capability of 8,192 words of 8 bit random access memory. The circuitry on the board provides all of the address decoding and data line buffering to handle a total of 16 (4K bit x 1 bit) static random access memories. All interconnections to the system are made via a 50 pin connector to the Mother Board (MP-B). +5 volt power for the board is supplied by two on board regulators with heatsinks. Current consumption is approximately 1A for the entire 8K of memory. Up to 32K of memory may be implemented on the SWTPC 6800 Computer System.

MP-B Mother Board

The MP-B mother board is 9" x 14" double sided plated thru hole board onto which all of the various processor boards are plugged. Provisions have been made for one MP-A Microprocessor/System board, up to four memory boards plus two unused slots. This gives the user the ability to handle up to 32,768 words of memory.

The mother board also provides the line buffering and address decoding for up to eight interface boards. Although one of the eight must be the control interface (serial), MP-C, the other seven may be any combination of serial (MP-S) and parallel (MP-L) interfaces the user may choose to have. For those demanding even more interfaces the 50 line processor buss may be paralleled onto another MP-B Mother Board with power supply expanding the interfacing to one control interface (serial), MP-C, plus any combination of up to fifteen serial (MP-S) and parallel (MP-L) interfaces.

MP-C Control Interface (Serial)

The MP-C Control Interface is a 5¼" x 3½" double sided, plated thru hole board which is meant to interface a serial terminal to the Microprocessor System for both system control and when selected, user program input/output. It may be jumper configured to operate serially at either 110 baud (10 characters/second) or 300 baud (30 characters/second) with an upper case ASCII terminal RS-232C or 20 ma TTY compatible. Baudot coded teletypes are not compatible with this interface, they must be ASCII coded. Our CT-64 terminal system kit, however, is compatible. All terminal input/output data is made thru a ten pin connector installed along the top edge of the board. Power for the board is supplied by a +5V voltage regulator and has a current consumption of approximately 0.2A.

MP-P Power Supply

The MP-P Power Supply is the supply designed to power the Mother Board (MP-B) and its complement of plug-on boards including the MP-A Microprocessor/System Board, up to four MP-M full 4,096 word memory boards and eight interface boards. It includes the power transformer, bridge rectifier, filter capacitor and power interconnect board. The Power Interconnect Board is a 3½" square circuit board supporting the protection fuses, ±12 volt rectifier with filter, and the MP-B Mother Board and front panel wiring connectors. These connectors greatly aid in interconnecting and servicing the unit.

MP-F Chassis and Cover

The MP-F includes a 15 1/8" wide x 7" high x 15 1/4" deep chassis with perforated cover all done in black anodized aluminum with silver trim. The front panel contains the power ON/OFF switch, power indicator and reset switch. The chassis houses the Mother Board (MP-B) along with its complement of boards, the power transformer, bridge rectifier, filter capacitor and power interconnect board (MP-P).

MP-D Documentation Package

The MP-D Documentation package is loose-leaf notebook containing comprehensive information on 6800 system hardware and software. Much of the material is official Motorola documentation so you can be sure of getting the most accurate and informative information available. In addition the package includes the Motorola written 6800 Microprocessor Programming Manual which give the complete assembler/machine language instruction set as well as various programming examples.

MP-S Serial Interface

The MP-S Serial Interface is a 5¼" x 3½" double sided, plated thru hole board which interfaces a serial device to the Microprocessor system. It may be jumper configured to operate serially at 110, 150, 300, 600, or 1200 baud and is RS 232C and 20 ma TTY compatible. Baudot coded teletypes are not compatible with this interface. Complete interrupt control of the interface is under software control thru the user's program. All data input/output is made thru a ten pin connector installed along the top edge of the board. Power for the board is supplied by a +5V voltage regulator and has a current consumption of approximately 0.2A.

MP-L Parallel Interface Board

The MP-L Parallel Interface is a 5¼" x 3½" double sided, plated thru hole board implemented with the 6820 peripherial interface adaptor integrated circuit which is used to interface a parallel data device to the computer. The board is provided with two separate connectors along the top edge of the board. One has 8 fully buffered high current data outputs along with one buffered "data ready" output line and one "data accepted" input line for complete handshake control. The other has 8 fully buffered data inputs along with one "data ready" input line and one buffered "data accepted" output line for complete handshake control. The interface is completely software programmable by the user with interrupt control as well as polarity control of the handshake lines. Power for the board is supplied by a +5V voltage regulator and has a current consumption of approximately 0.3A.

MP-T Interrupt Timer Interface

The MP-T Interrupt Timer is a 5¼" x 3½" double sided, plated thru hole circuit board implemented with the Mostek 5009 programmable counter/divider and 6820 peripheral interface adapter integrated circuits. The board provides software selectable interrupts of 1 usec, 10 usec, 100 usec, 1 msec, 10 msec, 20 msec, 100 msec, 1 sec, 10 sec, 100 sec, 1 min, 10 min or 1 hour. Since only half of the 6820 peripheral interface adaptor is used for the interrupt timer the other half has been fully buffered to provide a general purpose eight bit input port along with one buffered "data ready" input line and one buffered "data accepted" output line for complete handshake control. The interface is completely software programmable by the user with interrupt control as well as polarity control of the input port handshake lines. Power for the board is supplied by a +5 volt regulator with a current consumption of approximately 0.3A. Approximately 15 ma. is drawn from the -12 VDC interface power buss to supply minus voltage to the 5009 integrated circuit.

6800 SOFTWARE

4K and 8K BASIC (c)

Southwest Technical Products Corporation offers both 4K and 8K Basic (c) software for the SWTPC 6800 Computer System. Both feature fixed and floating point math with a full 1.0E-99 to 9.99999999E+99 number range. In addition to the line number mode a direct (no line number) mode of execution is provided on most statements to create a calculator like mode of entry for short programs. Provisions have been made in both packages for saving and loading BASIC programs to and from either cassette or paper tape. A USER function is even provided for jumping to machine language subroutines.

COMMANDS	STATEMENTS			FUNCTIONS		
LIST	REM	END		ABS	†VAL	†SIN
RUN	DIM	GOTO*	STOP	INT	†EXT$	†COS
NEW	DATA	ON. . .GOTO*	GOSUB*	RND	†LEN$	†TAN
SAVE	READ	ON. . .GOSUB*	PATCH*	SGN	†LEFT$	†EXP
LOAD	RESTORE	IF. . .THEN*	RETURN	CHR	†MID$	†LOG
PATCH	LET*	INPUT	†DEF	USER	†RIGHT$	†SQR
	FOR	PRINT*	†PEEK	TAB		
		NEXT	†POKE			

** Direct mode statements*
† 8K Version only

MATH OPERATORS	RELATIONAL OPERATORS
- (unary) Negate	= Equal
* Multiplication	( ) Not Equal
/ Division	(Less Than
+ Addition	) Greater Than
— Subtraction	(= Less Than or Equal
† ↑ Exponent	) = Greater Than or Equal

SWTPC Cassette Tape Program Library

The following programs are available from SWTPC on AC-30 (Kansas City) formatted audio cassette tape:

MP-EC Editor/Assembler package with manual. Runs in 8K, but requires at least a 12K system for assembling medium size programs. . . . . $14.95 ppd. in U.S.

BAS4C 4K BASIC VER. 2.0 (c) with manual. Requires minimum of 6K, 8K preferred. Floating point math, but no string or trig. . . . . $4.95 ppd. in U.S.

BAS8C 8K BASIC VER 1.01 (c) with manual. Requires 8K, 12K preferred. Includes strings, trig, and optional interface driver routines. . . . . $9.95 ppd in in U.S.

GAMI TIC-TAC-TOE and BLACKJACK as listed in notebook and newsletter. Requires 6K of memory. . . . . $4.95 ppd. in U.S.

ANIM Animals programs. A children's learning game. Requires 2K of memory. . . . . $4.95 ppd. in U.S.

RACE Designed for use with a GT-6144 graphics terminal and PPG-J joystick. Object of the game is to maneuver a space ship from the bottom of the screen to the top without being crunched by asteroids. Requires 4K of memory. . $4.95 ppd. in U.S.

SWTPC Paper Tape

The following is available on 8 level paper tape:

BAS4P 4K BASIC VER. 2.0 (c) with manual. Requires 6K, 8K preferred . . . . . $10.00 ppd. in U.S.

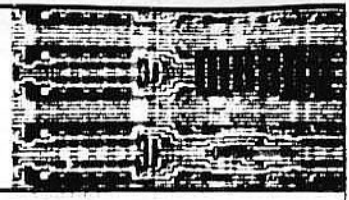
BAS8P 8K BASIC VER 1.01 (c) with manual. Requires 8K, 12K preferred . . . . . $20.00 ppd. in U.S.

MP-EP Editor/Assembler package, as above, on paper tape. . . . . $14.95 ppd. in U.S.

Notice to SWTPC Software Users

Because of the prices being charged for software, and/or agreements made with authors of the various programs, SWTPC is unable to supply source listings. Also we are unable to modify the available software to run on computers made by other manufacturers.

Language of the M6800 Microprocessor



Instruction Set

ABA	Add Accumulators
ADC	Add with Carry
ADD	Add
AND	Logical And
ASL	Arithmetic Shift Left
ASR	Arithmetic Shift Right
BCC	Branch if Carry Clear
BCS	Branch if Carry Set
BEQ	Branch if Equal to Zero
BGE	Branch if Greater or Equal Zero
BGT	Branch if Greater than Zero
BHI	Branch if Higher
BIT	Bit Test
BLE	Branch if Less or Equal
BLS	Branch if Lower or Same
BLT	Branch if Less than Zero
BMI	Branch if Minus
BNE	Branch if Not Equal to Zero
BPL	Branch if Plus
BRA	Branch Always
BSR	Branch to Subroutine
BVC	Branch if Overflow Clear
BVS	Branch if Overflow Set
CBA	Compare Accumulators
CLC	Clear Carry
CLI	Clear Interrupt Mask
CLR	Clear
CLV	Clear Overflow
CMP	Compare
COM	Complement
CPX	Compare Index Register
DAA	Decimal Adjust
DEC	Decrement
DES	Decrement Stack Pointer
DEX	Decrement Index Register
EOR	Exclusive OR
INC	Increment
INS	Increment Stack Pointer
INX	Increment Index Register
JMP	Jump
JSR	Jump to Subroutine
LDA	Load Accumulator
LDS	Load Stack Pointer
LDX	Load Index Register
LSR	Logical Shift Right
NEG	Negate
NOP	No Operation
ORA	Inclusive OR Accumulator
PSH	Push Data
PUL	Pull Data
ROL	Rotate Left
ROR	Rotate Right
RTI	Return from Interrupt
RTS	Return from Subroutine
SBA	Subtract Accumulators
SBC	Subtract with Carry
SEC	Set Carry
SEI	Set Interrupt Mask
SEV	Set Overflow
STA	Store Accumulator
STS	Store Stack Register
STX	Store Index Register
SUB	Subtract
SWI	Software Interrupt
TAB	Transfer Accumulators
TAP	Transfer Accumulators to Condition Code Reg.
TBA	Transfer Accumulators
TPA	Transfer Condition Code Reg. to Accumulator
TST	Test
TSX	Transfer Stack Pointer to Index Register
TXS	Transfer Index Register to Stack Pointer
WAI	Wait for Interrupt

Instruction Execution Time

(in microseconds assuming a 1 MHz clock)

	(Dual Operand)	ACCX	Immediate	Direct	Extended	Indexed	Implied	Relative
ABA		•	•	•	•	•	2	•
ADC	x	•	2	3	4	5	•	•
ADD	x	•	2	3	4	5	•	•
AND	x	•	2	3	4	5	•	•
ASL		2	•	•	6	7	•	•
ASR		2	•	•	6	7	•	•
BCC		•	•	•	•	•	•	4
BCS		•	•	•	•	•	•	4
BEQ		•	•	•	•	•	•	4
BGE		•	•	•	•	•	•	4
BGT		•	•	•	•	•	•	4
BHI		•	•	•	•	•	•	4
BIT	x	•	2	3	4	5	•	•
BLE		•	•	•	•	•	•	4
BLS		•	•	•	•	•	•	4
BLT		•	•	•	•	•	•	4
BMI		•	•	•	•	•	•	4
BNE		•	•	•	•	•	•	4
BPL		•	•	•	•	•	•	4
BRA		•	•	•	•	•	•	4
BSR		•	•	•	•	•	•	8
BVC		•	•	•	•	•	•	4
BVS		•	•	•	•	•	•	4
CBA		•	•	•	•	•	2	•
CLC		•	•	•	•	•	2	•
CLI		•	•	•	•	•	2	•
CLR		2	•	•	6	7	•	•
CLV		•	•	•	•	•	2	•
CMP	x	•	2	3	4	5	•	•
COM		2	•	•	6	7	•	•
CPX		•	3	4	5	6	•	•
DAA		•	•	•	•	•	2	•
DEC		2	•	•	6	7	•	•
DES		•	•	•	•	•	4	•
DEX		•	•	•	•	•	4	•
EOR	x	•	2	3	4	5	•	•
INC		2	•	•	6	7	•	•
INS		•	•	•	•	•	4	•
INX		•	•	•	•	•	4	•
JMP		•	•	•	3	4	•	•
JSR		•	•	•	9	8	•	•
LDA	x	•	2	3	4	5	•	•
LDS		•	3	4	5	6	•	•
LDX		•	3	4	5	6	•	•
LSR		2	•	•	6	7	•	•
NEG		2	•	•	6	7	•	•
NOP		•	•	•	•	•	2	•
ORA	x	•	2	3	4	5	•	•
PSH		•	•	•	•	•	4	•
PUL		•	•	•	•	•	4	•
ROL		2	•	•	6	7	•	•
ROR		2	•	•	6	7	•	•
RTI		•	•	•	•	•	10	•
RTS		•	•	•	•	•	5	•
SBA		•	•	•	•	•	2	•
SBC	x	•	2	3	4	5	•	•
SEC		•	•	•	•	•	2	•
SEI		•	•	•	•	•	2	•
SEV		•	•	•	•	•	2	•
STA	x	•	•	4	5	6	•	•
STS		•	•	5	6	7	•	•
STX		•	•	5	6	7	•	•
SUB	x	•	2	3	4	5	•	•
SWI		•	•	•	•	•	12	•
TAB		•	•	•	•	•	2	•
TAP		•	•	•	•	•	2	•
TBA		•	•	•	•	•	2	•
TPA		•	•	•	•	•	2	•
TST		2	•	•	6	7	•	•
TSX		•	•	•	•	•	4	•
TXS		•	•	•	•	•	4	•
WAI		•	•	•	•	•	9	•

Instruction Addressing Modes

ACCX (accumulator only) Addressing

In accumulator only addressing, either accumulator A or accumulator B is specified. These are one-byte instructions.

Immediate Addressing

In immediate addressing, the operand is contained in the second byte of the instruction. No further addressing of memory is required. The MPU addresses this location when it fetches the immediate instruction for execution. These are two/three-byte instructions.

Direct Addressing

In direct addressing, the address of the operand is contained in the second byte of the instruction. Direct addressing allows the user to directly address the lowest 256 bytes in the machine; i.e., locations zero through 255. That part of the memory should be used for temporary data storage and intermediate results. In most configurations, it should be a random access memory. These are two-byte instructions.

Extended Addressing

In extended addressing, the value contained in the second byte of the instruction is used as the higher eight-bits of the address of the operand. The third byte of the instruction is used as the lower eight-bits of the address of the operand. This gives one a 16-bit address for the operand. This is an absolute address in memory. These are three-byte instructions.

Indexed Addressing

In indexed addressing, the value contained in the second byte of the instruction is added to the index register lower eight-bits in the MPU. The carry is then added to the higher order eight-bits of the index register. This result is then used to address memory. The modified address is held in a temporary address register so there is no change to the index register. These are two-byte instructions.

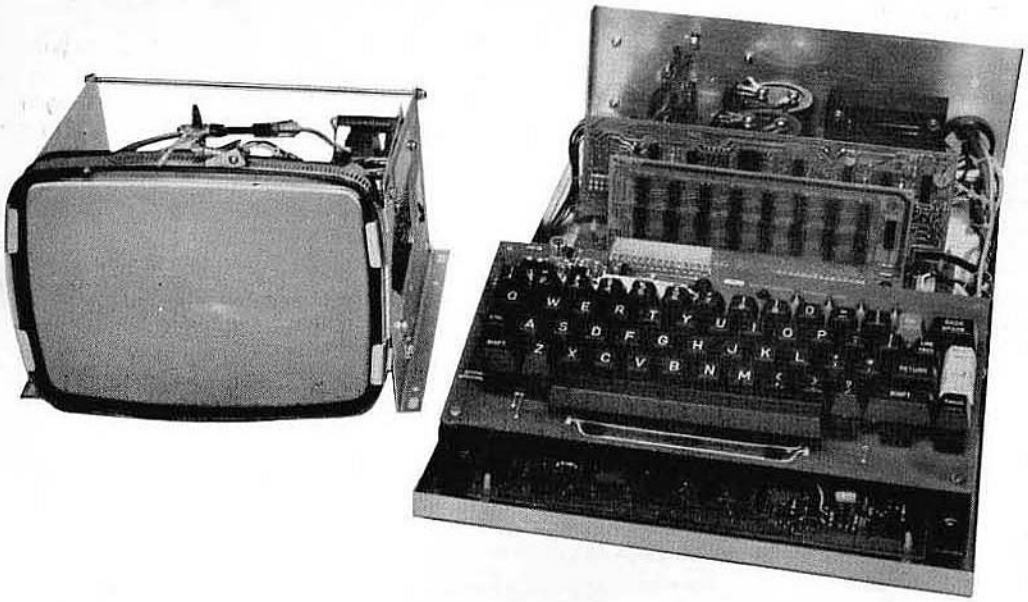
Implied Addressing

In the implied addressing mode the instruction gives the address (i.e., stack pointer, index register, etc.). These are one-byte instructions.

Relative Addressing

In relative addressing, the value contained in the second byte of the instruction is added to the program counters lowest eight-bits plus two. The carry or borrow is then added to the high eight-bits. This allows the user to address data within a range of −125 to +129 bytes of the present instruction. These are two-byte instructions.

CT-64 TERMINAL SYSTEM KIT



The CT-64 Terminal System kit is a low cost, ASCII stand alone computer terminal for use with either resident or remote computer systems. The display format of the CT-64 is 32 or 64 characters/line, 16 lines per page, 2 pages of storage and either page or scrolling operation with upper and lower case characters.

The CT-64 has been designed to be as universal a computer terminal as possible with a number of jumper selectable options. The CT-64 will operate in either a page or scrolling mode. When in the page mode after the last position of the last line of data has been filled the cursor will move to the first position of the first line on either the same or alternate page, jumper selectable. When in the scrolling mode after the first page is filled, the top line of the display will be removed and all other lines will move up one position. The cursor will remain on the 16th line which will be brought up erased after the top line is "scrolled off". The scrolling mode is the method most used in computer terminal systems. When the CT-64 is initially powered up it will come up with a blinking cursor in the top left of the screen. The CT-64 can be brought up in either the page or scrolling mode, jumper selectable. If desired the page/scrolling selection circuitry can be connected to the CT-64's control character decoding to allow software control over the selection of page and scrolling modes.

The CT-64 will display 16 lines of either 32 or 64 characters/line, jumper selectable. Changing this figure for either more or less would entail complete redesign and is thus not recommended. When operating at 32 char./line a modified television can be used as a display device, but at 64 char./line we highly recommend that a video monitor with a bandwidth of at least 10MHz be used. Our CT-VM described later meets the requirements of the CT-64. Some modified televisions will work marginally at 64 char./line while others give very poor quality. The output of the CT-64 is composite video and is meant to be connected directly to the video input of a monitor. The CT-64 cannot be connected directly to the antenna terminals of a television and we do not sell a device to allow this.

The CT-64 will display the full 128 character ASCII set including upper and lower case letters, numbers and their shfited characters (!, #, etc.). The CT-64 can also be jumpered to print control characters on the screen if desired (a null will show as ^{N}U, for example). The characters are displayed in a 7 X 9 dot matrix.

The CT-64 comes standard with full 32 character control character decoding to allow software control of external devices (punch on, etc.). A separate decoder board is not needed. The output of the decoders are low going TTL compatible pulses approximately 1 usec. in length. Standard ASCII backspace (Ø8), horizontal tab (Ø9), line feed (ØA), vertical tab (ØB) and carriage return (ØD) are hardwired in the terminal to provide, respectively, cursor left, cursor right, line feed, cursor up and carriage returns. Decoded READ ON, READ OFF, PUNCH ON and PUNCH OFF commands have been provided at a convenient connector on the board to connect to a cassette tape interface such as our AC-30. The terminal's UART CLOCK IN and CLOCK OUT lines have also been run to this connector.

Various special functions are provided on the CT-64 which can be triggered through either hardware or through the available decoded software commands. These features include screen reversal (for black characters on a white background), selection of either scrolling or page mode, cursor on/off switching, solid or blinking cursor selection and page selection. The CT-64 also has a beeper which beeps whenever 16 lines have been displayed or whenever a CTRL.G is encountered.

The CT-64 is a full 8 bit terminal which allows for the highlighting of individual characters and words. Highlighting is accomplished by sending the CT-64 the appropriate letter or number with BIT 8 =1. Highlighting results in reversing the field on the highlighted character. (black on white background instead of white on black background or vice-versa.)

The circuitry on the terminal is designed to operate on a 60 Hz power line frequency and U.S. standard 525 line monitors. The CT-64 can be jumper programmed for 50 Hz 625 line European systems. The power supply will accept input of either 120 or 240 volts AC.

Although the CT-64 has been designed primarily as a computer terminal it can be used for just displaying messages on a monitor screen. The CT-64 is not adaptable, however, to being fed from external sync sources which eliminates its use in superimposed video titling applications.

Communications to a computer system are made via a serial interface board. The UART (Universal Asynchronous Receiver/Transmitter) on the serial board breaks up the parallel data on the terminal into serialized pulses to go to a computer or modem via a three wire system. Data transmission through the interface can be at 110, 150, 300, 600 or 1200 baud, switch selectable. There is provision for "ECHO OFF" (full duplex) where the data is transmitted to the computer, but is not displayed on the screen until echoed by the computer, or "ECHO ON" (half duplex) where the data is simultaneously transmitted to the computer and displayed on the screen.

The input/output connections to the interface are RS-232 compatible and will attach directly to most computers and acoustic couplers. However, to record on, or play back from, magnetic tape, a cassette tape interface such as our AC-30 is needed. The RS-232 pin connections include transmitted data, received data, terminal ready, and ground. The serial interface board is plugged onto the main board's interface connector vertical just behind the terminal's memory board.

The CT-64 comes complete with a matching chassis and cover, keyboard and power supply. The chassis is designed to accommodate one CT-64 terminal, memory, serial interface, KBD-5 keyboard and P-200 power supply. The chassis is made from aluminum and the cover is sturdy, molded plastic.

The CT-64 is sold in kit form only. All terminal boards are double sided plated-thru hole types. The main board is 10" X 13", the memory is 3 1/8" X 7 5/8" and the serial interface is 3 3/8" X 9 1/2". Note the CT-64 is sold only as a complete terminal. Approximate dimensions for the complete unit (less monitor) are 13" X 21" X 5".

Although the CT-64 is basically similar to our earlier CT-1024 terminal, the CT-1024 can not be modified into this later version. All of the CT-1024's plug in options (serial interface, screen read, parallel interface, etc.) are not compatible with the CT-64 with the exception of the keyboard. At this time we do not offer a screen read board or a parallel interface for the CT-64.

The KBD-5, included with the CT-64 kit, is a 56 key upper/lower case keyboard kit with switch de-bounce, N key lockout, 2 key rollover and ASCII encoding. The new key switches are firm contact, full typewriter travel, gold plated contact switches with dark grey double shot molded keytops. The keyswitches have been positioned on the 11 5/8" X 6 1/8" reinforced epoxy fibreglass circuit board so as to form an 11" wide array of keyswitches with straight blocked sides for ease of mounting. The spacebar is 6" in length and fully pressure equalized.

The complement of keys includes upper and lower case characters and numbers, brackets and parenthesis, two shift keys, carriage return, line feed, escape, two typewriter type user defined keys and two push on/push off user defined keys for locked ON control functions such as "Echo" ON/OFF and "Receive-Transmit" ON/OFF on the CT-64 terminal system. Because the encoder circuit uses a scanning type MOS integrated circuit, switches may be wired to generate ASCII data not already output by the unit. This makes it ideal for use in systems where uncommon ASCII characters are used.

The keyboard also features a unique repeat circuit. If you hold any of the keys down more than a second or so, that character will automatically repeat itself several times a second until the key is released. It even works when generating control functions which is almost impossible to do using a conventional keyboard with a separate repeat key.

The CT-64 kit includes the main board, memory, serial interface, power supply, keyboard, chassis and cover, all parts and assembly instructions (less video monitor):
CT-64 Terminal System Kit . . . . . $325.00 ppd. in U.S.

CT-VM Video Monitor

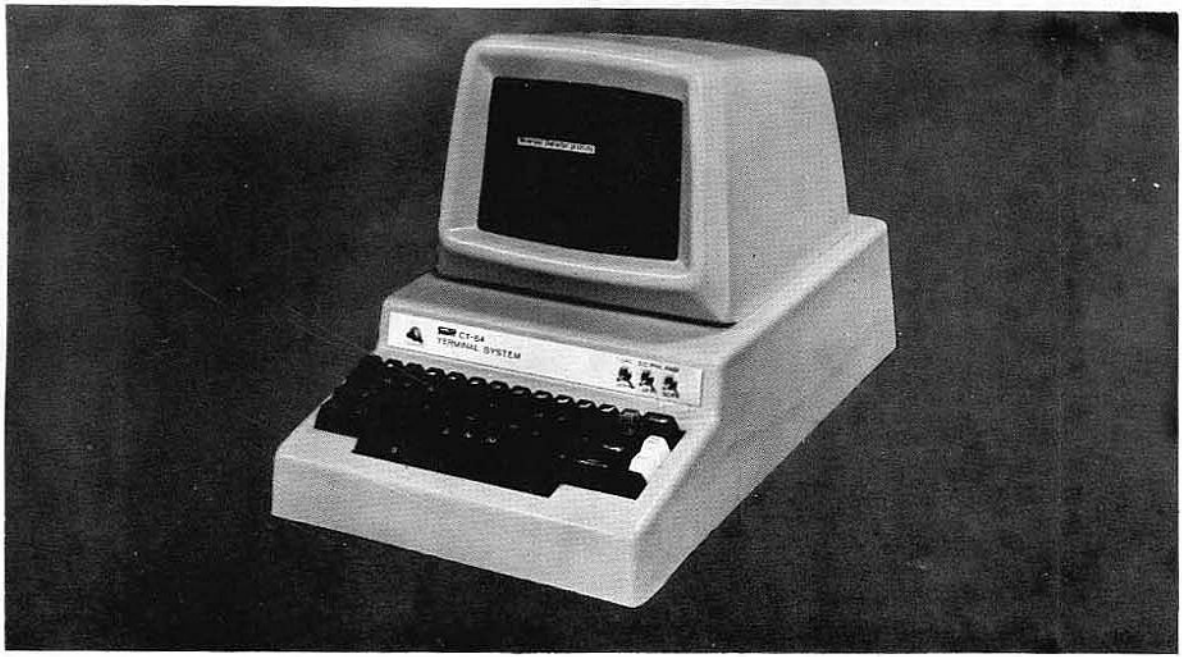
The CT-VM is a 9 inch (diagonal) compact video monitor ideally suited for data entry type terminals. The monitor is completely solid state, with the exception of the P4 phosphor picture tube. Video bandwidth is 12 MHz allowing excellent performance with high charac- density computer terminals.

Input to the monitor can be either composite video (0.5 to 2.5 v composite P-P, sync negative, input impedance 75 ohm terminated, 12K ohm unterminated) or TTL separate horizontal, vertical and video (2.5 v to 5.0 v P-P, sync positive at input.)

Power required by the monitor is +12 VDC (regulated) @ approximately 900 mA. When used in conjucntion with a CT-64 terminal system, the P-200 provides the necessary power for the monitor. The monitor will operate on either 525 line US or 625 line European standards.

The CT-VM comes completely assembled along with a case matching the CT-64 cover. The only assembly required is mounting the actual monitor in the chassis.
CT-VM . . . . . $175.00 ppd. in U.S.

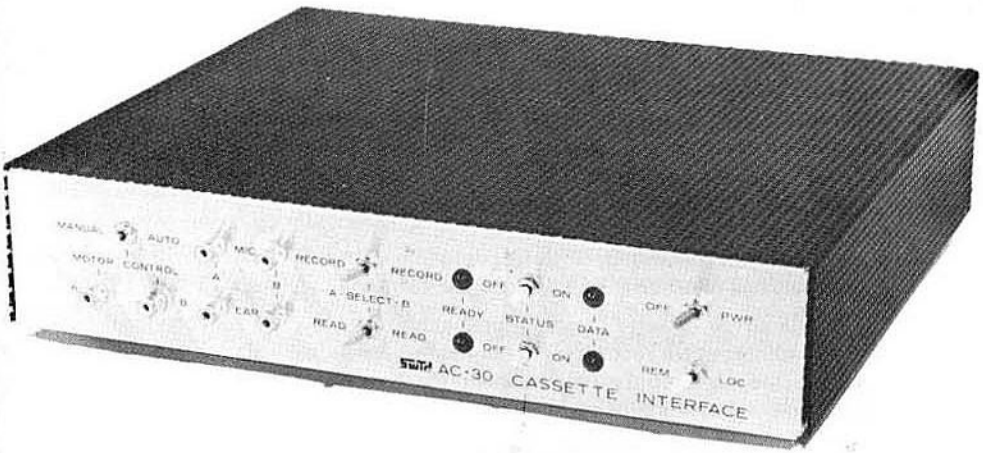
CT-64 TERMINAL SYSTEM



- * 64 OR 32 CHARACTERS PER LINE
- * UPPER AND lower case LETTERS
- * FULL 8 BIT MEMORY
- * 128 CHARACTER ASCII SET
- * 110/220 Volt 50-60 Hz POWER SUPPLY
- * SCROLLING OR PAGE MODE OPERATION
- * CONTROL CHARACTER DECODING–32 COMBINATION
- * PRINTS CONTROL CHARACTERS
- * USABLE WITH ANY 8 BIT ASCII COMPUTER
- * REVERSED BACKGROUND – HIGHLIGHTING

COMPLETE WITH – Chassis and cover, cursor control, 110-1200 Baud serial interface and keyboard. Optional monitor show in photo available.

SWTPC AC-30
AUDIO CASSETTE INTERFACE



Cassette tape is one of the most flexible and least expensive means of mass data storage for computer systems. When compared to paper tape readers and punches, you'll find that although the paper tape readers can be made rather inexpensively, the punches cannot. Paper tape systems are typically slower and the punched tapes cannot of course be repunched and used over and over again, as you can with cassettes. Disk systems on the other hand offer significant advantages over cassettes but are still too expensive for many applications, and for most hobbyists. Even those lucky enough to have a disk system still need a more universal medium for exchanging programs.

Although there are several commercial digital cassette tape decks on the market today, recording techniques vary and they are of course much more expensive than the average audio cassette unit. As could be expected most hobbyist computer system mass data storage designs have been based on the audio cassette recorder. The use of inconsistent recording techniques among the various manufacturers makes it impossible for example to record a program, or data tape on a SWTPC 6800 Computer System and play it back on a MITS 680 Computer System. In order to coordinate manufacturer design efforts, and exploit the most effective recording technique, BYTE Magazine of Peterborough, New Hampshire 03458 held a symposium in the Fall of 1975 in Kansas City in an attempt to establish a recording standard for the storage of digital data on audio cassette recorders. The standard which was adopted has been tested and fully supported by Southwest Technical Products Corporation. It appears to be the best compromise between economy and reliability. Although complete details are contained in the Feb., 1976 issue of BYTE Magazine, the recording philosophy is to record data serially using the standard UART format at 300 baud (30 characters/second). Marks or logic ones are represented by recording a 2400 Hz sine wave on the tape while spaces or logic zeroes are represented by recording a 1200 Hz sine wave. With the proper circuitry this recorded data can then be read off the tape and transposed into a self clocking UART based tape system which will tolerate audio recorder speed variations of approximately ±30%. This figure is far better than that of most other modulation techniques and is a real

advantage when you consider the degree of worst case speed variation between inexpensive audio recorders; in addition to which we have speed variations due to line voltage, battery voltage, wow and flutter, mechanism wear, etc. Thus evolved the "Kansas City" standard. It should be noted that the standard does not specify how the data is to be organized on the tape, so there can, and probably will be some incompatibility among various manufacturer's units. This is however more of a software problem than a hardware problem and thus a little easier to resolve.

Since the creation of the "Kansas City" standard, there have been several articles printed on circuits conforming to the standard but there has yet to be a true audio cassette interface "system". When considering an audio cassette tape interface system, the potential user should ask himself the following:

1) Can the cassette interface be added to the computer system in such a way as to take full advantage of the computer system's already resident tape load and dump routines?

2) Can the cassette unit be interfaced to the computer system without requiring the use of an additional interface on the computer system?

3) Can the single cassette interface unit simultaneously or independently operate two audio cassette recorders? (One reading while the other is recording) and if so can the user simply switch select the function of each recorder instead of swapping a multitude of patch cords?

4) Will the cassette interface provide manual or computer control (switch selectable) over either cassette recorder's motor operation in both read and record modes?

5) Does the interface have status indicators to show read and record states as well as valid data flow?

6) Can the cassette interface unit simultaneously operate with a computer and/or a 300 baud terminal, switch selectable allowing you to use your terminal in a stand alone mode to record or visually examine data on tapes before loading them into your computer?

7) Can the unit be tied to a 300 baud terminal like the TV typewriter II so as to respond to Reader ON, Reader OFF, Record ON and Record OFF control commands just like a teletypewriter with automatic reader/punch features?

8) Is the cassette interface unit complete with chassis, cover and 120/240 VAC, 50 to 60 Hz internal power supply?

Well, the SWTPC AC-30 Audio Cassette Interface meets all of these requirements when incorporated into most computer and/or terminal systems. Although it has been used extensively with the SWTPC 6800 Computer System and SWTPC CT Series Terminal Systems, it has been designed to be as universal and flexible a system as possible. If your computer's control terminal is interfaced to the computer thru 300 baud, RS-232 compatible serial interfaces with accessible UART type 16 X baud rate clocks on both computer and terminal, the SWTPC AC-30 Cassette Interface Unit is simply plugged between the computer and terminal interfaces. This is the ideal mode of operation since the cassette unit can take full advantage of computer resident tape load and dump routines and requires no additional interfaces. Switching the cassette unit to the LOCAL mode directly interconnects the terminal and cassette unit for terminal "only" cassette tape operation just like the LOCAL mode of operation on teletypewriters. While operating in the REMOTE mode the computer communicates with both the terminal and cassette unit, here again, just like the REMOTE mode of operation on teletypewriters. Those customers using the SWTPC CT Series Terminal Systems or any terminal system with accessible control character decoders may

even pick Reader ON (Control Q), Reader OFF (Control S), Record ON (Control R), and Record OFF (Control T) control commands right off the control character decoder circuitry on their terminal system giving the computer system program control over cassette recorder data flow and even motor operation. Those not having access to decoded control commands may still have cassette control by driving the cassette interface with control lines from a separate parallel interface option located on the attached computer system.

Those users not operating their control terminal RS-232 serial at 300 baud or not having access to their terminal's 16 X UART clock may still use the cassette interface, but must attach it to the computer system thru a separate RS-232 serial 300 baud interface with accessible 16 X clocks located on the computer system. This however eliminates the ability to use the computer resident control terminal tape load and dump routines as well as the LOCAL/REMOTE feature described previously.

The cassette interface circuitry is constructed on a 7 3/4" x 7 1/2" doubled sided, plated thru hole fibreglass circuit board with all electrical connections made to the board thru one of the five edge connectors. The three connectors along the back edge of the circuit board are for connections to the computer, control decoder and terminal while the two along the front edge are for connections to the cassette interface's control panel. The PC board in turn is mounted inside a 12 3/4" wide x 3" high x 11" deep aluminum chassis with a silver dress panel and black anodized perforated cover. The complement of front panel switches, indicators and jacks includes the following:

MIC, EAR and REMOTE jacks for recorder A: These jacks should be connected thru patch cords to the cassette recorder's respective jacks. It is often times necessary to patch the MIC output of the cassette interface to the AUX input rather than the MIC input of the recorder to be used. Some experimentation may be necessary here. Be sure the cassette recorder(s) you select have a REMOTE jack on them. This is necessary in order to have cassette recorder motor control.

MIC, EAR and REMOTE jacks for recorder B: These jacks may be used for feeding a second cassette recorder often required when using Editor/Assembler software packages. Their functional description is identical to that provided for recorder A.

RECORD SELECT A/B: When this two position switch is in the A position, the cassette interface will output all record data to cassette recorder A. When in the B position it will output all record data to cassette recorder B.

READ SELECT A/B: When this two position switch is in the A position, the cassette interface will input all read data from cassette recorder A. When in the B position it will input all read data from cassette recorder B.

RECORD STATUS ON/OFF: This three position switch is normally left in the center position allowing computer program generated control commands to to set the state of the record latch. Momentarily flipping the switch to the ON or OFF position will manually update the status of the record latch. Leaving the switch in either the ON or OFF position will override computer program control entirely. A convenient LED status indicator just to the left of this switch always shows the state of the record latch. The operation of the cassette interface as a function of the state of the record latch is dependent upon the setting of the motor control switch which is described in detail later.

READ STATUS ON/OFF: This three position switch is normally left in the center position allowing computer program generated control commands to set the state of the read latch. Momentarily flipping the switch to the ON or OFF position will manually update the status of the read latch. Leaving the switch in either the ON or OFF position will override computer program control entirely.

A convenient LED status indicator just to the left of the switch always shows the state of the read latch. The operation of the cassette interface as a function of the state of the read latch is dependent upon the setting of the motor control switch which is described in detail later.

RECORD DATA INDICATOR: This LED indicator shows the transmission of valid record data out of the cassette interface. It lights only when the record latch is on and logic zeros or spaces are being transmitted. This allows the operator to confirm that a tape dump is in progress when lit since the null data marking output does not light the indicator.

READ DATA INDICATOR: This LED indicator shows the receipt of valid read read data into the cassette interface. It lights only when the read latch is on, valid FSK data is detected on the tape and logic zeros or spaces are being received. This allows the operator to confirm that a tape load is in progress when lit since the null data marking input or a loss of audio tones does not light the indicator.

MOTOR CONTROL–MANUAL/AUTO: The position of the motor control switch actually determines the function of the record and read status latches. In the MANUAL position both the record and read cassette recorder motors are always activated thru their respective REMOTE jacks. If the record latch is off, the interface's selected recorder MIC jack will output a constant marking carrier; even if there is data flowing back and forth between the computer and terminal. As soon as the record latch is turned on either by the computer or manual control all data transmitted from the computer to the terminal is simultaneously transmitted out thru this same MIC jack. Data flow out of the MIC jack ceases as soon as the record latch is again reset by either manual or computer control.

If the read latch is off the interface will ignor all data incoming thru its selected EAR jack and yet pass data back and forth between the terminal and computer. If the read latch is turned ON either by manual or computer control and valid audio tones are sensed from the selected EAR jack, read data is stored from the cassette unit to the computer. This same data is simultaneously displayed on the attached terminal system only if the computer is programmed to echo the incoming cassette data. Data flow from the cassette to the computer system ceases either upon resetting the read latch or loss of audio on the tape.

Operation in the Auto position is quite different. If both the record and read latches are reset, cassette recorder motor operation is inhibited thru the respective REMOTE jacks on both the record and read recorders. The interface's selected record MIC jack will output no audio data, even if there is data flowing back and forth between the computer and terminal. As soon as the record latch is turned ON, the recording recorder's motor is turned on thru the respective REMOTE jack and a variable delay timer is fired which delays the output of audio marking data to allow this same cassette recorder's tape to come up to normal tape speed. This hardware delay circuit must be supplemented with a software delay loop written into your program to guarantee that you don't start outputting record data until after this hardware delay timer on the cassette interface has already timed out. When the record latch is again turned off, the interface will cease to output audio data and the selected recorder's motor is turned off. Here again it is wise to include a software delay loop in your programs to give the recorder time to come to a complete stop. This guarantees a sufficient gap between multiple recorded segments to allow one to do either incremental (start-stop) or continuous reads from the same tape.

When the read latch is turned on the read recorder's motor is started. The interface inhibits all read recorder data until valid audio tones are detected, at which time all incoming cassette data is stored to the computer and simultaneously displayed on the terminal only if the computer's echo is enabled. Reads may be either continuous or incremental (start-stop). Since incremental tapes have blank gaps between recorded segments, the cassette interface's audio tone sensing circuitry has been designed to ignor all but the valid data segments stored on the tape.

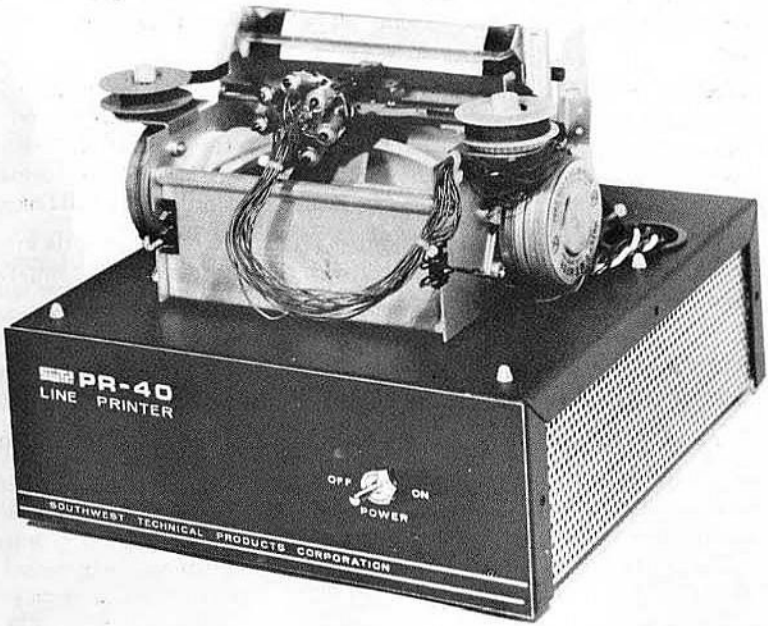
LOCAL/REMOTE: The LOCAL/REMOTE switch on this cassette interface is analogous to that on standard teletypewriters. In the LOCAL mode there is a direct data link between the terminal and cassette recorder(s). The computer is electrically eliminated from the system. In the REMOTE or normal mode of operation, the computer, terminal and cassette recorder(s) are all linked together.

POWER ON/OFF: This switch controls AC power to the cassette interface unit. It must be powered up consistently with the interconnected computer and terminal system even if cassette operation is not desired.

The AC-30 Audio Cassette Interface System is available in kit form only and includes the circuit board, components, chassis, cover, power supply and assembly instructions:

AC-30 Audio Cassette Interface Kit . . . . . $79.50 ppd. in U.S.

SWTPC PR-40 ALPHANUMERIC PRINTER



Ever since the microcomputer's introduction, computer hobbyists everywhere have been searching for a low cost alphanumeric printer. Well, the search is over because here it is! The unit presented here is a 5 X 7 dot matrix impact printer similar in operation to the well known Centronics printers. It prints the 64 character upper case ASCII set with 40 characters/line at a rate of 75 lines/minute on standard 3 7/8" wide rolls of adding machine paper. One complete line is printed at a time from an internal forty character line buffer memory. Printing takes place either on receipt of a carriage return or automatically whenever the line buffer memory is filled.

The printer can accept character data as fast as one character per micro-second or as slow as you wish to send it. The printer's seven parallel data lines are TTL compatible and may be enabled by a single "data ready" control line or by separate "data ready" and "data accepted" handshake control lines. This universal approach makes the printer compatible with all computer and terminal systems having an eight bit parallel interface; including of course the MITS 8800 and SWTPC 6800 computer systems just to mention a few.

The printer mechanism is attached to a black anodized aluminum chassis with front trim panel which houses the unit's circuitry including its own 120/240 VAC 50 to 60 Hz power supply making the printer's overall dimentions 9 5/8" wide X 10 1/2" deep X 8 3/4" high.

The Mechanics

The entire design is based on a remarkably simple and hence more reliable print mechanism. The printed characters are formed by moving the print head horizontally across the paper while selectively energizing solenoid driven print wires on the head which strike an inked ribbon and imprint dots on standard adding machine paper. All seven of these solenoid

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* SWTPC PR-40 ALPHANUMERIC PRINTER *

* 40 CHARACTERS / LINE
* 5 X 7 DOT MATRIX IMPACT PRINT
* USES STANDARD 3 7/8" CALCULATOR PAPER
* 75 LINE / MINUTE PRINT RATE
* AUTOMATIC RIBBON REVERSE
* 64 CHARACTER ASCII CHARACTER SET
* 40 CHARACTER LINE MEMORY
* TTL, SWTPC 6800, MITS COMPATIBLE
```

driven print wires converge at the tip of the print head in a vertical line which is perpendicular to the horizontal direction of movement of the print head. By selectively firing the print wires, 5 dot wide X 7 dot high characters are printed as the print head moves across the paper. A one dot time spacing is left for separation between the printed characters.

This method of printing characters is not new but the method of moving this wire impact print head is unique. Rather than using dual motors, clutches timing bars and the other hardware often associated in operating this type of print head, this printer rotates a long cylinder just beneath the print head. The length of the cylinder itself is a little longer than the head's printing width on the paper. The cylinder has a uniform single cyclic zig-zag track formed on its outer circumference, running from the left side of the cylinder to the right side and then back to the left again. A small projection on the bottom of the print head rides in this track so that as the cylinder rotates, the print head moves back and forth from left to right. This technique moves the print head across the paper at a constant velocity excluding operation at the extreme ends of course, where nothing is printed anyway.This approach greatly simplifies the electronics needed to drive the printer since no head positioning circuitry is necessary. The cylinder itself is turned by an AC motor on the lower right hand side of the print mechanism. A small ribbed nylon belt interconnecting the two rides on gear teeth of both the motor and cylinder. Also attached to the right side of the cylinder is a cam that actuates a roller arm micro-switch riding on the cam. This is how the printer's electronic circuitry senses the "start of line" position of the print head. On the left side of the cylinder is an eccentric driven pawl arm that advances the paper one line for each revolution of the cylinder which is the same as one cycle of the print head.

Let's go thru a cyclic operation of a printed line where we will first assume the head is in rest position just left of center. When a line print command is initiated by the control circuitry, the motor starts and the head begins to move from the center position toward the far left side of the printer where the head reverses direction. This non-print dead zone gives the motor, cylinder, and print head time to attain full speed. As the head begins its movement from left to right, the cam actuated micro-switch opens telling the electronic circuitry to start outputting character forming solenoid driving pulses. Somewhere before the print head reaches the far right hand edge of the paper the solenoid pulses will cease while the head continues to move. When the head reaches the right end of its travel, it will reverse direction and begin to move back toward the center of the printer. During this return movement, the pawl arm will rotate the platen one line for the line feed. The motor is then turned off just to the left of center where it started originally. Character data is not accepted by the printer's circuitry during an actual print cycle, however feeding continual print data from a computer to the printer may take place so fast that the print motor may never appear to stop between repeatedly printed lines although it actually does.

The operation of printing ribbon used on the unit is also amazingly simple. A ratchet technique not only advances the ribbon incrementally for each cycle of the print head but automatically reverses it when it reaches the end of one of the two spools. This means you need only change the ribbon when the printing becomes too light for easy legibility.

The Electronics

The electronic circuitry driving the forementioned print mechanism can vary from nothing but motor and solenoid drivers constantly serviced by the microcomputer to a fully self-contained hardware control unit with memory needing only 7 bit parallel ASCII data and a "data ready" strobe control line from the computer. This printer system fits into the latter catagory. The printer has it's own 40 character FIFO (first in—first out) memory allowing the computer to send character data at whatever speed it wishes. The entire line is printed upon receipt of a carriage return ($\emptyset D_{16}$) or automatically whenever the 40 character line buffer has been filled. All control characters with the exception of a carriage return are ignored by the printer. They are not stored in the FIFO line memory since they cannot be printed anyway. Repeated line feeds are initiated by sending repeated carriage return control commands. Since the printer prints upper case ASCII characters only, all lower case characters sent to the printer are transposed to their upper case equivalent before printing. The printer's line buffer memory is automatically cleared by a hardware power-up reset circuit when printer power is first applied. The printer's motor is triac controlled and is powered by a 120 VAC secondary on the power supply's power transformer. This not only provides power line isolation but allows the entire unit to be run on either 120 VAC or European 240 VAC power systems since the power transformer has two primary windings which may be either parallel or series connected.

The seven ASCII parallel data input lines and "data ready" and "data accepted" control lines are all TTL compatible. The inputs represent a maximum of two standard TTL loads while the "data accepted" output will drive ten standard TTL loads. Data is presented to the printer by storing the selected ASCII data on the seven data input lines and strobing the normally high (logic 1) "data ready" input line low. This line should go low (logic 0) for at least 1 microsecond and when it does the normally high "data accepted" will also go low. The character is not actually loaded until the "data ready" input is returned to its normally high stage. The "data accepted" line will then normally return high as well, indicating that the character has been loaded. However, when loading the 40th character on a print line or a carriage return command, this "data accepted" line will not return high until the character data has been printed and the printer memory is ready for more data. The printer will ignor all data sent to it while the "data accepted" line is low. So you will usually want to make sure the "data accepted" output line is high before sending the printer data to be printed.

If you are careful not to output data faster than one character per microsecond and allow a minimum one second delay before sending data after sending a carriage return or the 40th character of each line then you may avoid using the "data accepted" line altogether. However, using the "data accepted" line will give your system the fastest possible print speed.

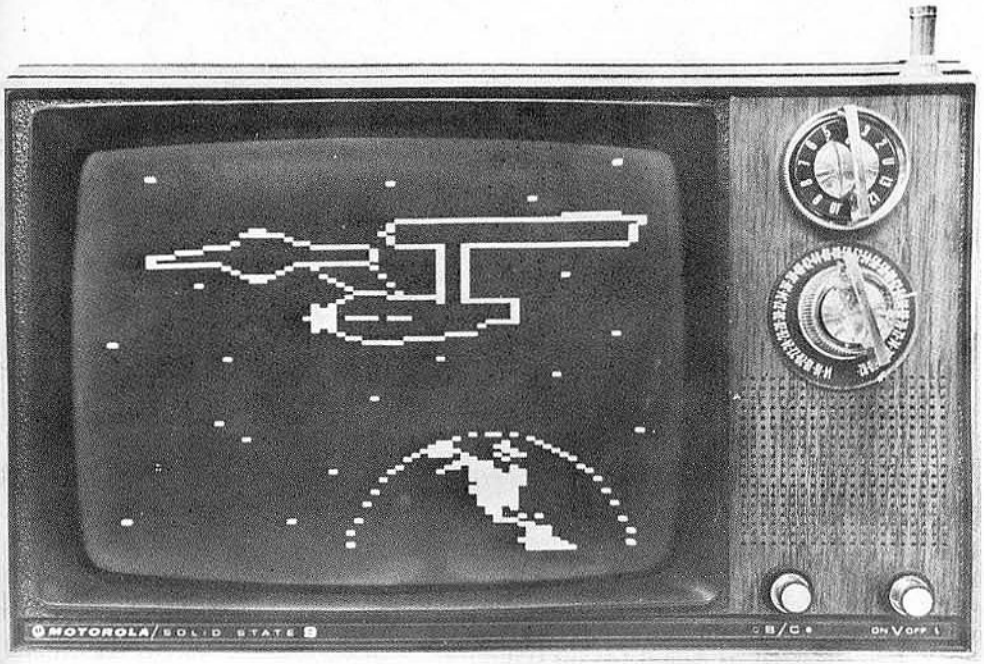
The PR-40 Alphanumeric Printer is available in kit form only and includes the print mechanism, chassis, circuit boards, components, power supply, assembly instructions, one ribbon and one roll of paper:

# PR-40	Alphanumeric Printer Kit	.$250.00 ppd in U.S.
# PR-4R	extra ribbon for above printer.	.$ 5.00 ppd in U.S.

Those customers using the PR-40 printer with the SWTPC 6800 Computer System will need one of the computer's MP-L parallel interface option boards to drive it.

# MP-L	SWTPC 6800 Parallel Interface Option Kit	.$ 35.00 ppd in U.S.

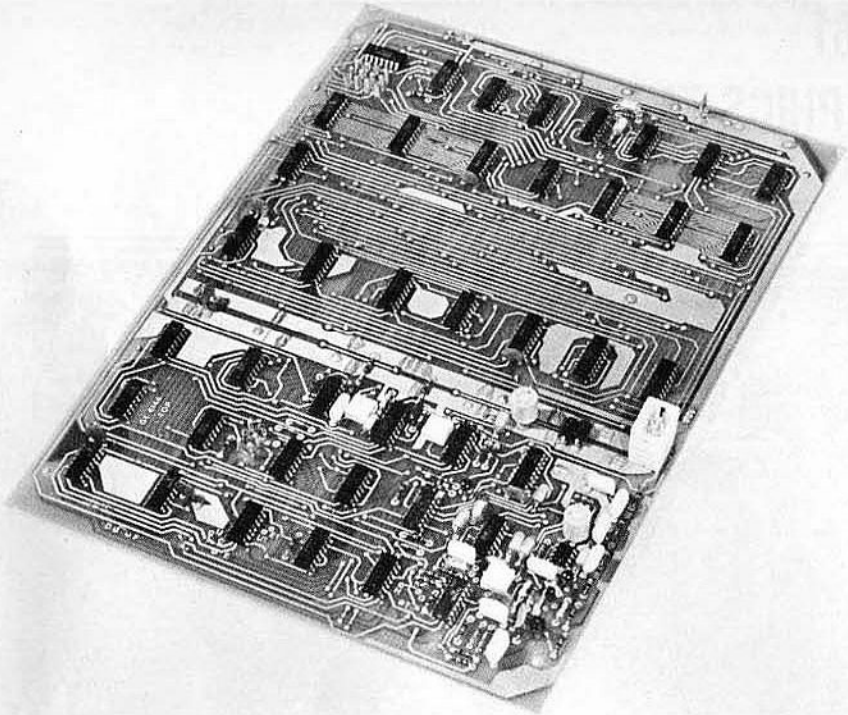
GT-61
GRAPHICS TERMINAL



Many people find games one of the most interesting applications of a computer system. These range from simple games such as tic-tac-toe, blackjack and ping-pong to very complicated games such as spacewar. All of these have one thing in common; they are much more fun when played on a video terminal with a graphic display. With such terminals you can provide instant response and provide a pictorial playing area that cannot be duplicated on any type printing terminal. Can you imagine attempting to play an elaborate game on a teletype machine? Unfortunately, graphic terminals normally cost thousands of dollars and are completely beyond the budget of the average person.

The GT-6144 is our answer to this dilemma. By settling for a bit less resolution than is available in expensive graphic terminals we can generate graphic displays on any monitor, or standard TV set to which a video input has been added.

The display screen is divided into an array of cells 64 wide X 96 high. Each cell is individually addressable and may be selectively turned ON or OFF by programmed commands from the computer. With a little imaginative progamming fixed or moving images may be displayed on the screen for added enhancement to game programs. The photograph shows Startrek's starship the "USS Enterprise" generated using the graphics terminal with the SWTPC 6800 Computer System. Memory cell data can be loaded in less than 2 microseconds; much faster than most microcomputers can generate the information. The system features a power-up screen blanking circuit which in addition may be enabled, or disabled at any time thru program commands from the computer system or hardwired switches. In addition, a unique image reverse feature allows you to select between white on black or black on white



images by a simple one word command generated by your computer's program or through switches. The system will operate on either 50 Hz or 60 Hz power lines with American standard 525 line or European standard 625 line television sets or video monitors.

The terminal has its own 6,144 bit static RAM memory which eliminates the requirement that it be used with a specific computer system. The terminal will operate with any computer system whose parallel interface outputs an 8 bit data word and "data ready" strobe. This includes 8800 and SWTPC 6800 Computer Systems.

The unit is available as a kit which is complete less the chassis and does not include the required video monitor or modified television set. Instructions for the addition of a video input jack to the television are included with the kit and a switch installed on the back of the TV set will allow one to select between terminal and normal television operation. You may use the same television set or video monitor used by the SWTPC CT series terminal system. In fact, control commands from your computer allow you to display graphic, alphanumeric, or even a combination of the two, all on the same display device. The mixing of graphic and alphanumeric video applies only when using a SWTPC CT series terminal. The video from other alphanumeric terminals cannot be mixed with the GT-6144 since the unit is not designed to accept sync sources other than those from a CT series. Power requirements for the terminal are 5.0 VDC @1A, -12 VDC @20 Ma and 6 VAC @20 Ma. The solder plated, double sided plated thru hole circuit board is 9 1/2" X 13".

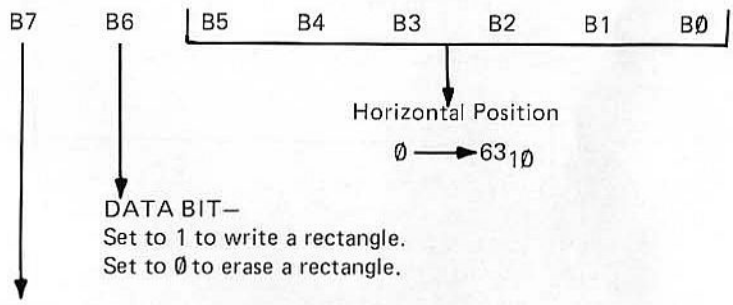
Programming

The display of the GT-6144 graphics terminal consists of 6144 small rectangles formatted 64 across and 96 down that can be turned on or off at will. In order for the GT-6144 to do a particular function the data fed to it must be formatted correctly. The coordinate of a particular location is referenced from the top left corner of the screen with the first square residing at location (Ø, Ø). When inputting data to the GT-6144, the first byte (8 bits) sent to the terminal must be the horizontal position. The actual position is determined in bits

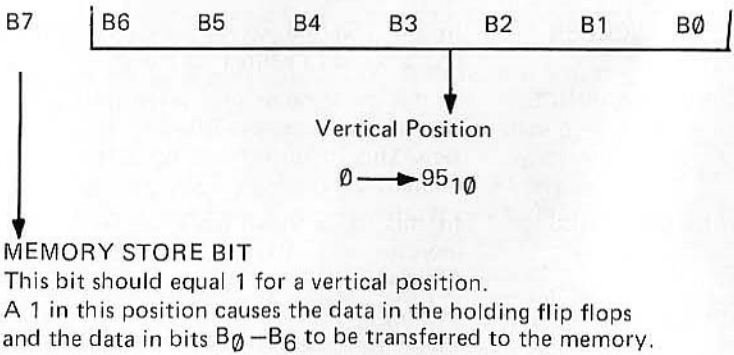
$B_\emptyset - B_5$ and is in binary. When bit 6 = Ø a rectangle will be removed at the desired coordinates, when bit 6 = 1 a white rectangle will be generated. Bit 7 must always equal Ø for the terminal to know that a HORIZONTAL position is being loaded. A Ø in the bit 7 position causes the data holding flip flops in the terminal to store the present data.

The second byte from the computer contains the vertical coordinate. The location is contained in binary in bits $B_\emptyset - B_6$ of this second byte while bit 7 must equal a 1.

FIRST BYTE FROM COMPUTER–HORIZONTAL POSITION



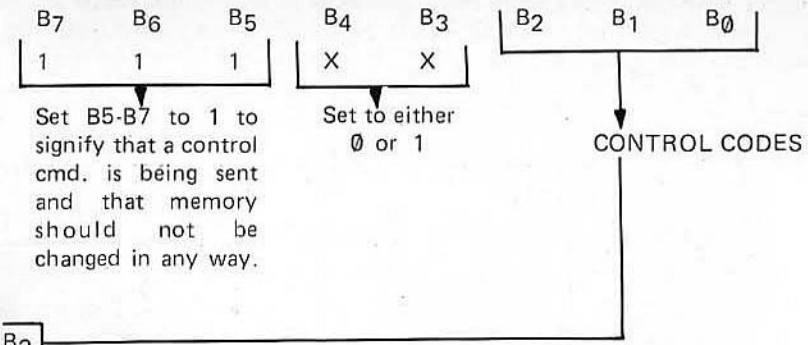
SECOND BYTE FROM COMPUTER–VERTICAL POSITION



When programming an image to appear on the screen there are two ways the characters can be loaded–the method you use depends on how your software is organized. One method is to just send out successive coordinates (H_1, V_1); (H_2, V2) etc. until all H, V locations are specified. With this method two bytes must be sent out for each character.

Another method can be used that will result in saving time and memory space. In this method the HORIZONTAL position of a particular column is loaded only once into the terminal. The VERTICAL coordinate of all other characters that have this same HORIZONTAL coordinate can then be loaded by themself since the HORIZONTAL position is latched in the terminal's holding flip-flops.

Since there are 96 characters to be accessed in the vertical direction at least seven address lines must be used. Seven lines give the possibility of addressing 2^7 ($128_{1\emptyset}$) locations giving us $32_{1\emptyset}$ extra undefined locations. These extras can be used as control commands for controlling BLANKING ON/OFF, REVERSE SCREEN, etc. The correct format for control commands for the GT-6144 terminal is as follows:



$B_Ø$	B_1	B_2	
0	0	0	INVERTED SCREEN
0	0	1	NORMAL SCREEN
0	1	0	DISABLE CT-1024
0	1	1	ENABLE CT-1024
1	0	0	ENABLE GRAPHICS
1	0	1	BLANKED GRAPHICS
1	1	0	NOT USED
1	1	1	NOT USED

NORMAL SCREEN — In the normal screen mode white characters appear on a black background. This applies both to graphics and mixed alphanumeric data.

INVERTED SCREEN — In the inverted screen mode all characters appear as black characters on a white background.

BLANKED GRAPHICS — In this mode no graphic video from the GT-6144 is transferred to the video monitor. This gives an "all rectangles off" condition. This condition does not affect the status of mixed alphanumeric data.

ENABLE GRAPHICS — In this mode video from the GT-6144 is transferred to the monitor and mixed with alphanumeric data if this data is enabled.

ENABLE CT TERMINAL — In this mode video data from the terminal is mixed with video from the GT-6144. If the 6144 is disabled, only alphanumeric data will appear on the screen.

DISABLE CT TERMINAL — No CT data is mixed with the GT-6144 video data.

When writing input-output programs care should be taken to optimize them for speed and memory conservation. All of the above functions can also be under hardware control by using SPST pushbutton switches.

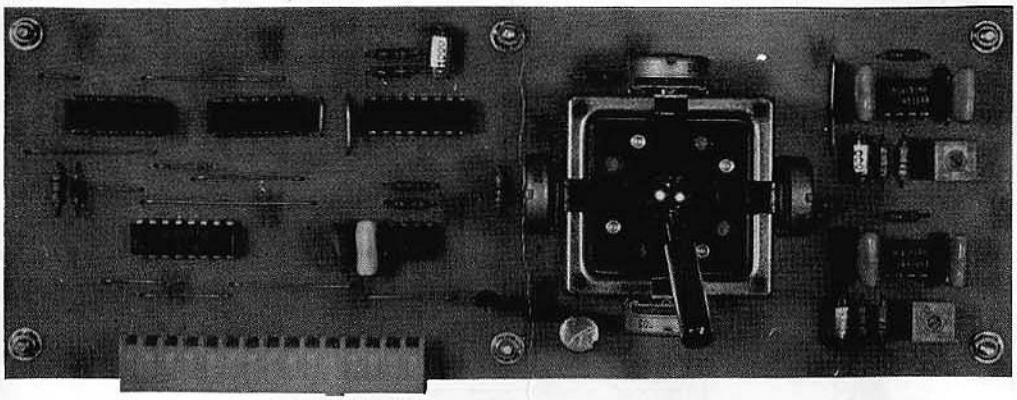
The GT-6144 Graphics Terminal is available in kit form only and includes the circuit board, components and assembly instructions. The kit does not include the optional power supply or the chassis, cover and video display which are not available from us.

GT-61 Graphics Terminal Kit . . . . . $98.50 ppd in U.S.
CT-P Power Supply for the above kit . . . . . $15.50 ppd in U.S.

Those customers using the GT-61 graphics terminal with the SWTPC 6800 Computer System will need one of the computer's MP-L parallel interface option boards to drive it.

MP-L SWTPC 6800 Parallel Interface Option Kit . . . . . $35.00 ppd in U.S.

POTENTIOMETER DIGITIZER (JOYSTICK)



With the rash of graphic terminal designs and ktis available to the microcomputer hobbyist, such as our GT-61, it only makes sense that there should be a low cost joystick and linear control digitizer kit to make these graphic terminals more useful and entertaining. Just imagine being able to play TANK OR BIPLANE on your own graphic terminal instead of having to sacrifice all of those quarters in the commercial units at the local quarter arcade. Remember also that the commercial units are limited to a specific game while the programability of the computer and graphics terminal lets you play as many different games as you have programs for. You can even use the digitizer's controls to help you create or change images or pictures on the graphic terminal screen.

The circuit was designed to accommodate either two linear slide potentiometers or a low cost joystick designed for use in four channel sound systems. A joystick, for those not familiar with the term, is simply a vertically positioned handle resembling the type of maneuvering control used in helicopters and some other aircraft. It can be moved forward, backward, left or right, or any degree of any two directions. The joystick has an unrestricted 360^{o} movement. On this particular joystick, the handle is interconnected to two potentiometers such that the resistance of one control changes with respect to left-right movement while the resistance of one control changes with respect to forward-backward movement. The digitizer's circuitry then alternately converts each potentiometer's resistance into a seven bit binary count that is fed to your microcomputer thru the input side of a standard eight bit parallel interface. An updated value of each potentiometer's position is generated by the circuitry approximately fifty times a second.

The eighth bit generated by the digitizer tells the computer which potentiometer's data is being presented. A "DATA READY" strobe and its compliment are generated by the circuitry making the board usable in either polling or interrupt driven computer systems.

The linear slide control version of the board works the same way except that instead of having a joystick, there are two linear slide controls in its place. These controls might be used for speed, positioning, skill factor, or whatever you wish. You can of course replace the slide potentiometers with conventional circular potentiometers if the application is more suited to using them.

This product as with all other Southwest Technical Products Corp. peripherals was designed to be as universal and as software independent as possible. All of the counting, timing and latching is done by hardware on the circuit board rather than software in the com-

puter system. This not only makes the digitizer easier to use but saves computer time in an application where the computer needs all the time it can get just to update the graphics display. Interfacing can often be done thru the input side of the same interface that feeds the graphic terminal. That is if the graphic terminal is interfaced thru an eight bit parallel interface as is the SWTPC GT-61. Some applications will require the use of both the joystick and linear controls. In this case it will be necessary to use two separate digitizers with separate interfaces.

The entire unit is constructed on a 3" X 8" single sided circuit board. Since the voltage requirements for the board are a mere +12 to 18 VDC @ 20 ma., power for the board may be drawn from the computer system to which it is interfaced.

The potentiometer digitizer is sold in kit form only and is available in two versions. The PPG-J kit is the joystick version and includes the circuit board, joystick, components and assembly instructions. The PPG-S kit is the slide control version and includes the circuit board, slide controls, components and assembly instructions. A chassis is not offered for either kit.

PPG-J Joystick/Potentiometer Digitizer kit . . . . . $39.95 ppd. in U.S.
PPG-S Slide Control/Potentiometer Digitizer kit . . . . . $35.95 ppd. in U.S.

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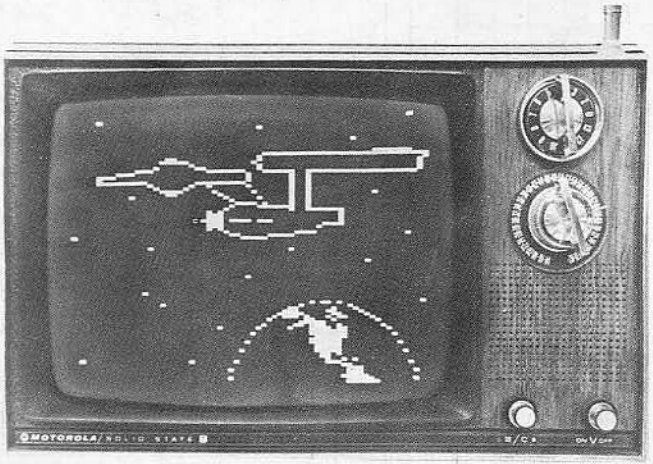
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