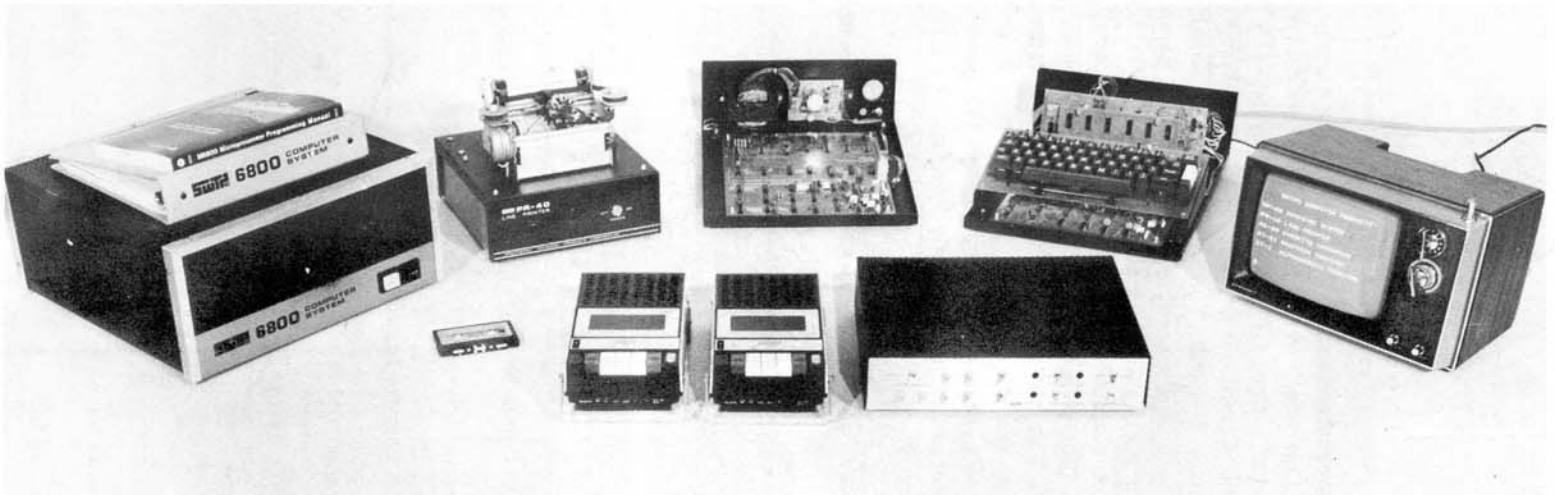
SWTPC COMPUTER PRODUCTS



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, CT-1024 Terminal System (TV Typewriter II), AC-30 Audio Cassette Interface, PR-40 Alphanumeric Printer and GT-61 Graphics Terminal. 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
219 W. Rhapsody
San Antonio, Texas 78216

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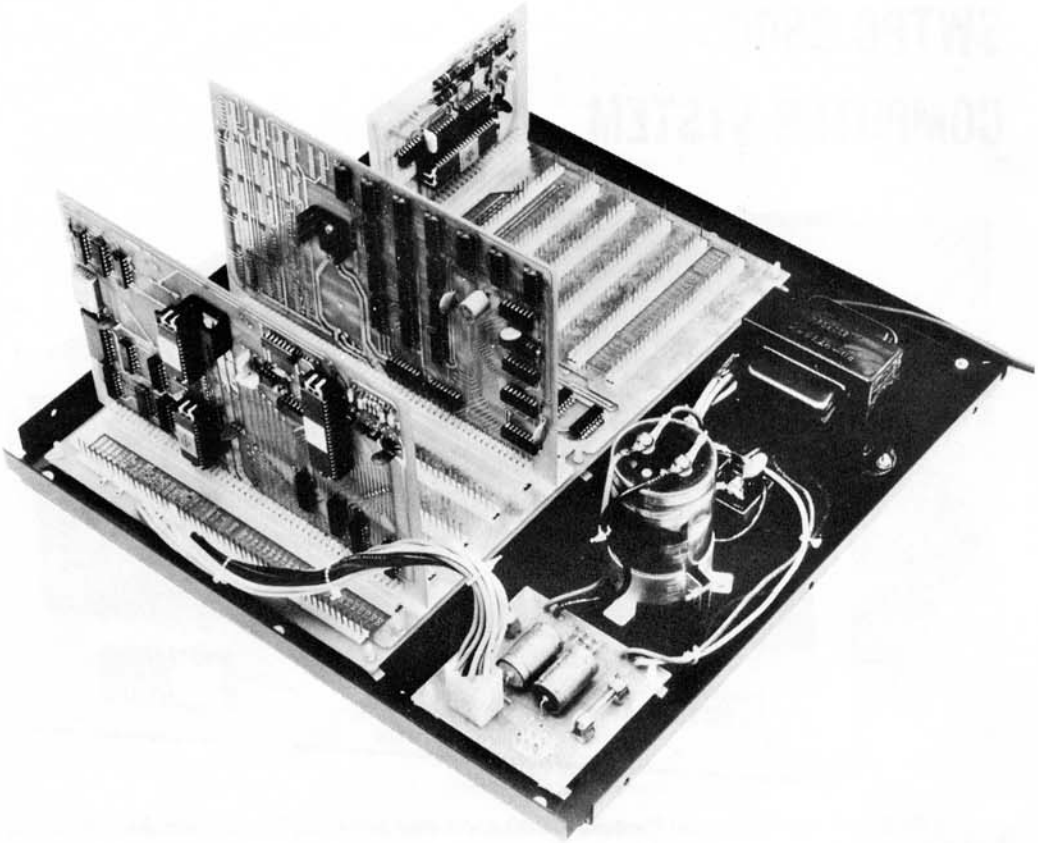
SWTPC 6800 COMPUTER SYSTEM

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 2,048 words of memory which we consider a practical minimum. If you want more memory it can be easily added since each memory card has space for a full 4,096 words. When you want the additional memory you simply remove the memory board, solder in the additional integrated circuits and reinstall the memory circuit board in the machine.

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?

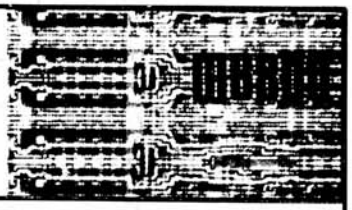
First of all, our computer requires a terminal to operate the system. The terminal is required for system control and is also used for data input/output after control is transfered to the user program. The terminal must be an ASCII terminal, communicating serially via either a 20 ma TTY current loop 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-1024 terminal system when connected to a modified television or unmodified video monitor gives you 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.

For those that do not have a terminal and wish to purchase our CT-1024 kit, the following items are recommended. Note that we do not supply a chassis or cover for this unit and it must be used in conjunction with a modified television set (instructions supplied) or an unmodified video monitor. Complete details on this terminal system are given in a separate section of this brochure.

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-1024 TERMINAL SYSTEM KIT

1 EA. CT-1024	Terminal System Kit	$175.00 ppd in US
1 EA. KBD-5	Keyboard Kit	$ 49.95 ppd in US
1 EA. CT-P	Power Supply Kit	$ 15.50 ppd in US
1 EA. CT-S	Serial Interface Kit	$ 39.95 ppd in US
1 EA. CT-CA	Computer Controlled Cursor Kit	$ 15.50 ppd in US
TOTAL COST—All above listed kits		$275.00 ppd in US

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 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-E	Editor/Assembler Package, Specify paper tape or audio cassette tape.	$ 14.95
MP-F	Chassis and cover—aluminum with black finish	$ 30.00
MP-M	Memory board with 2,048 words of static memory devices. Expandable to 4,096 words with MP-MX kit below	$ 80.00
MP-MX	2,048 words of static memory devices and regulator.	$ 45.00
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	$ 35.00
MP-S	Serial Interface—using MC6850 ACIA	$ 35.00
MP-L	Parallel Interface—using MC6820 PIA	$ 35.00

Circuit Boards*

MP-Ab	Processor circuit Board	$14.50
MP-Mb	Memory circuit Board	$14.50
MP-Bb	Mother Board	$30.00
MP-Cb, MP-Sb, or MP-Lb—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-B Mother Board

The MP-B mother board is a 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 MP-M 4,096 word memory boards plus two unused slots. This gives the user the ability to handle up to 16,384 words of memory. For those demanding even more memory, the 50 line buss may be paralleled onto another MP-B Mother Board with power supply expanding the system to a maximum of 32,768 words of random access 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-1024 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. For the user who has specialized I/O requirements, the data buffers may be removed from the board and each of the 16 data I/O lines may be individually programed for either input or output thru software in the user's program. Power for the board is supplied by a +5V voltage regulator and has a current consumption of approximately 0.3A.

MP-E Editor/Assembler Package The MP-E

The MP-E Editor/Assembler Package allows the user to considerably reduce the amount of time involved in writing programs. The editor allows one to compose or modify a program while easily making statement insertions, deletions, and modifications. The assembler allows the program to be written using easy to remember mnemonic phrases like ADD (add), LDA (load accumulator), BRA (branch always) instead of their hexadecimal equivalent. It also allows the use of 1 to 6 character alphanumeric labels which eliminate the need for all of those calculations when using relative addressing. The editor and assembler are meant to be loaded into the system via cassette or paper tape. Since our cassette and paper tape versions are different, you must specify at the time you order which version you want. The paper tape version should be used with teletypewriter systems while the cassette version has been designed for use with "Kansas City" compatible audio cassette systems capable of operating two recorders simultaneously with motor control, such as our AC-30 Audio Cassette Interface which is described in another section of this brochure.

6800 Computer System

We realize that you may have questions, or not understand exactly how our 6800 Computer System works and why it is different from other systems being offered. We will try to answer some of the more common questions. If you have others please write and we will try to explain.

QUESTION— The 6800 system doesn't have any console switches on the front panel to enter data. How do I use it?

ANSWER— The 6800 system loads the initial data needed at "start up" automatically from an internal ROM. Instead of spending several minutes entering a "loader" program each time you use the machine, this is done for you automatically when power is turned on. System control is turned over to the control interface at this point and you are ready to enter information, or work with the machine from any 20 mA Teletype, or RS-232 video terminal.

QUESTION— What type terminal do I use?

ANSWER— Any terminal that outputs ASCII coded data may be used. The ASR-33 series Teletypes, or any video terminal using a serial interface will in general work with the 6800. Our CT-1024 terminal system is a good low cost terminal. You cannot use terminals having the old five level Baudot code, or terminals having the "IBM Corp." EBCDIC code.

QUESTION– Why is this method of data entry used on the 6800 system?
ANSWER– Because the 6800 system was designed to be convenient and easy to use. Entering programs in binary form with console switches may be educational, but it is certainly not convenient. With the 6800, system address are entered in "Hexidecimal" form, which is far simpler and less confusing. The data is also on the screen where it may be inspected and changed if desired. You don't have to write down each line of data from a row of lamps, or LED readouts to keep track of things.

QUESTION– What will I need besides an input/output device to use the 6800 computer system?
ANSWER– Nothing–you will not be in for any nasty little surprises. The 6800 kit is complete with 2,048 words (BYTES) of memory, a serial interface and diagnostic program information to help you test the completed computer. You will not find that you must purchase additional memory or other plug-in units to make the system useful and practical to use.

QUESTION– What about Editor/Assembler software?
ANSWER– In addition to our test programs, a resident editor and assembler are available for the 6800 system. The editor and assembler require 8K of memory and are available to anyone. Cassette tape and paper tape versions are available. You must specify at the time you order which version you want.

QUESTION– What about game programs and higher level software?
ANSWERS– At the time of this writing, several game programs as well as several basic packages are available for the system, either free or on a "cost of documentation" basis. In fact, our 4K Microbasic package was actually printed in its entirety in our first newsletter.

QUESTION– What if I want additional memory, or more interfaces? The basic kit price is reasonable, but will I pay an arm and a leg for additional equipment?
ANSWER– Additional memory is $125.00 for the 4K kit. Additional interfaces are $35.00 per interface kit–serial, or parallel. We wouldn't call this more than a thumb and a finger.

QUESTION– I have already purchased a Motorola 6800 chip set and manual. Will you sell me just the boards to build up a system?
ANSWER– Sure thing. We will sell you almost any part of this system as a separate item excluding individual components of course. See our price sheet–you can buy just the boards, just the power supply, just the cabinet, or any individual board kit you want.

QUESTION– What about peripherals for the computer system?
ANSWER– At the time of this writing, we offer the CT-1024 Terminal System, AC-30 Audio Cassette Interface, PR-40 Alphanumeric Printer and the GT-61 Graphics Terminal. These are all described within this brochure. We will of course be offering more peripherals in the future.

CT-1024 TERMINAL SYSTEM KIT (TV TYPEWRITER II)

The CT-1024 Terminal System kit is a low cost alphanumeric character generator designed to simultaneously display sixteen lines of 32 character/line on a standard video monitor or slightly modified television set. Together with its low cost options it may be used to simply display messages and data on a TV screen, to communicate with either local or remote computer systems, such as the SWTPC 6800 Computer System or to store and recover data from an audio cassette tape recorder just to mention a few.

The terminal system is an upper case only, ASCII device. It is not compatible with IBM EBCDIC coded systems or the older 5 level Baudot coded Teletypewriters. With the exception of the 2513 character generator, the UART chip on the serial interface option and the 2102 static, random access memories, the entire system is constructed using low cost, easy to get TTL integrated circuits.

The six 2102 memories give the system the capability of storing 1024 characters. 512 of these are being displayed on the screen while the other 512 are stored and may be accessed and displayed just by flipping a switch.

The CT-1024 terminal system does not have scrolling. When you get to the last character position of the bottom line it will return to the first character position of the first line (home-up position) on either the same page or opposite page, switch selectable.

The terminal system does have both hardware and software carriage return/line feed. If you are entering data thru either the keyboard or interface board and reach the end of a line, the terminal will do a self-generated carriage return/line feed (home-up if on the last line) to prevent the loss of data. In addition to this you may at any time generate a carriage return or line feed by entering a Control M or Control J respectively, from either the keyboard or from a computer thru an interface board.

Both erase to end-of-line (EOL) and erase to end-of-frame (EOF) features have been incorporated into the terminal system. Since these erase functions always start from the cursor location, a home-up function has been provided as well. Each is enabled thru a separate pushbutton switch unless the CT-CA computer controlled cursor option is used in which

case either user selected control characters from the keyboard or pushbutton switches may be used.

The actual display device for the terminal system may be an unmodified video monitor or slightly modified television set. Although specific instructions are supplied for modifying a small screened Motorola set, almost any set may be used. Be sure to use one that does not have a "hot" chassis, otherwise you will need an isolation transformer. The suggested modification to the television set even includes a switch to allow one to select from terminal or normal television reception.

The circuitry on the terminal system was designed for the 60 Hz power line frequency and the U.S. standard 525 line television set; however, the circuit may be slightly modified for 50 Hz, 625 line TV sets. The terminal circuitry has been designed for sixteen lines of 32 characters/line and changing this figure for either more or less would entail complete redesign and is thus not recommended. The system is not adaptable to being fed from external sync sources which eliminates its use in superimposed video titling applications.

The following is a list of each of the items available for the terminal system along with a brief description of each:

CT-1024 Terminal System Kit

This kit includes the 9½" x 12" doubled sided, plated-thru hole main board, the 3" x 7" doubled sided, plated-thru hole memory board, plus all of the components that go on the two. There are connector provisions for a positive logic, positive or negative keypress strobe, ASCII keyboard such as one of our KBD options or another compatible keyboard if you wish. There is a connector position for the CT-CA computer controlled cursor board. There is also a connector position for either the CT-S serial interface (UART) option or the CT-L parallel interface option. There is also one connector position where the CT-E screen read option may be inserted. Power requirements for the entire system, including interfaces are +5 VDC, ±5% @ 2.25A, -5 VDC @ 20 Ma. and -12 @ 60 Ma. which are generated by the CT-P power supply option.

The main and memory boards do the storing and displaying of the alphanumeric data but to actually get data into the terminal's display you must use either a keyboard and/or in data communications applications one of the two interface options.

KBD-5 Keyboard Option Kit

The KBD-5 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-1024 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.

CT-CA Computer Controlled Cursor Option Kit

The CT-CA Computer Controlled Cursor option is a plug-on board used with the CT-1024 terminal system that provides complete computer as well as manual control over cursor positioning. The board is attached to the terminal system simply by plugging it onto connectors on the main terminal system board. The function of the computer controlled cursor board is to allow the operator to incrementally position the cursor one position up, down, left or right, or do a home-up, erase to end of line or erase to end of frame using either manual switches or control characters generated by either the keyboard or a computer feeding data to the terminal system thru one of the interface options. By using control characters from the keyboard, the manual switches may be completely eliminated or you may retain the switches (7 each which are not supplied with the kit).

The circuitry on the 3½" x 4½" doubled sided, plated-thru hole circuit board provides the manual switch debouncing and control character decoding for the various cursor movements. The selection of the various control characters and their chosen functions is left to the user thru programming jumpers. The board is plugged onto the main board vertically just behind the memory board. Manual switch connections to the cursor board are made thru a nine pin connector mounted on the board.

The CT-CA computer controlled cursor option has all of the features a manual option does plus it allows program (software) or keyboard control over cursor positioning. It's use is highly recommended in all CT-1024 Terminal System applications.

CT-S Serial Interface Option Kit

In order for the CT-1024 Terminal System to communicate via a three wire system, a phone line or a magnetic tape data storage system, the parallel ASCII data must be broken down into sequential one bit at a time form both when being transmitted out of the keyboard and when being received by the display system. The CT-S serial interface or UART (Universal Asynchronous Receiver/Transmitter) provides this conversion from the parallel form into a series of properly timed one's and zero's including not only the serial data, but the start, stop and parity bits as well. The reverse is true during the receive mode. The baud rate or speed at which the serial data is transmitted or received, is 110 baud, or if the optional CT-SO kit is installed, 110, 150, 300, 600 and 1200 baud. There is a provision for "echo" OFF (full duplex) where the data is transmitted to the receiver, but is not put up on the screen until it is "echoed" back by the receiver and displayed by the terminal; or "echo" ON (half duplex) where the data is transmitted and simultaneously put up on the screen and and is not "echoed" back by the receiver.

The input/output connections to the interface are RS-232 compatible and will attach directly to most couplers and data sets. However, to record on, or playback from magnetic tape it will be necessary to have some kind of FSK encoder/decoder system to get the digital data on and off the tape. You may use the AC-30 Audio Cassette Interface described in a separate section of this brochure.

The RS-232 pin connections include transmitted data, received data, terminal "ready" and ground. There are no provisions for automatic transmit/receive switching. Data to be transmitted can either be provided by the terminal's memory using the screen read board or the keyboard.

The CT-S Serial Interface option is constructed on a 3½" x 9½" doubled sided plated-thru hole circuit board and includes all components to make the terminal system operational at 110 baud only. To operate at 110, 150, 300, 600 and 1200 baud you will need to add several other components including a crystal and two TTL IC's. We do sell these components now as an optional kit called the CT-SO for $14.75 ppd in U.S.

The CT-S interface board is plugged onto the main board's interface connector vertically just behind the cursor and screen read boards. There is room for only one interface board; either the CT-S serial interface option or the CT-L parallel interface option. Only one may be plugged on at a time.

CT-L Parallel Interface Option Kit

Although there are standards for the exchange of serial data such as the RS-232 format, there are no such standards for parallel data exchange. This is unfortunate since it makes parallel interfacing difficult when interconnecting parallel devices supported by different manufacturers. Although we have tried to make the CT-L parallel interface option as universal as possible, we cannot guarantee that it will interface to any other parallel device, especially those supported by another manufacturer. We recommend that if at all possible you stay with serial interfacing unless you are sure there will be no problems or if your application requires maximum data transfer speed.

The CT-L parallel interface is compatible with the SWTPC 6800 Microprocessor's MP-L parallel interface, but it may not be used for the Computer's control terminal. The computer's mini-operating system will only work thru a serial interface. Some customers have reported problems interfacing to the Altair 8800's parallel interface so we recommend that you stay with the CT-S serial interface on this system.

The CT-L parallel interface option is constructed on a 4" x 9½" double sided, plated-thru hole circuit board with two separate input/output (I/O) connectors along the top edge of the board.

For high noise immunity, the interface has been provided with Tri-State outputs, line rejection/noise discriminators on the strobe lines, and heavy duty diode clamping on all inputs from the data buss. For maximum flexibility all data and strobe lines from the I/O buss(es) can be selectively inverted by programming jumpers on the P.C. card. The keyboard may be directed to just print data on the screen, to print the data on the screen and load it on the output buss (half duplex), or just load it on the output buss (full duplex). This is especially nice when you want to have all typed information echoed back by a computer for verification. The interface's input and output buss lines can be used separately, or if selected, may be paralleled for applications where a bi-directional buss system is used. To make interfacing really simple, the data flow control lines can be either strobed or operated in a demand/response handshake mode, here again, selectable.

The CT-L parallel interface board is plugged onto the main board's interface connector vertically just behind the cursor and screen read boards. There is room for only one interface board, either the CT-L parallel interface option or the CT-S serial interface option. Only one may be plugged on at a time.

CT-E Screen Read Option Kit

If you ever need to use your CT-1024 terminal system in a situation where you need to get edited information that has been typed onto the screen transmitted out of the terminal and into another device, you will probably want to use the screen read board. The screen read when activated starts accessing information in the screen's cursor location and continues reading, transmitting the data out either the CT-S serial interface option or CT-L parallel interface option, advancing the cursor as it reads, until the READ ON/OFF switch is flipped off or an exclamation point is read from the screen. If when reading, the end of the page is reached it will continue after executing a home up on the same or opposite page depending upon the setting of the "page select" switch on the main terminal board.

The use of the CT-E screen read board in computer related terminal applications is more the exception than the rule. Almost all computer systems operate in the interactive mode where each character is transmitted to the computer's instruction buffer as soon as it is keyed in. This includes those systems that do not process each line until a RETURN is keyed in thus eliminating the need for the screen read board. For those who insist on using the screen read in this type of application, there is a problem in that the terminal's memory does not store control characters which of course includes the RETURN key. Since most systems use the RETURN for line delimiters, not transmitting a RETURN at the end of each screen read line would thoroughly confuse most computers. While on the other hand screen reading one

line at a time and manually entering the RETURN does not make for very efficient use of the terminal system.

The CT-E screen read option is constructed on a 4 1/2" x 3 1/16" double sided, plated-thru hole circuit board and is plugged onto the main terminal system board just behind the memory board adjacent the cursor control board. Either the CT-M manual or CT-CA computer controlled cursor board must be used along with the screen read board for proper screen read operation.

CT-P Power Supply Option Kit

The CT-P power supply is the +5 VDC, ±5% @2.25A, -5 VDC @20 Ma and -12 VDC @60 Ma power supply designed to drive the CT-1024 terminal system including all of its option boards.

The circuit board itself is a 3 3/8" x 2 1/2" single sided circuit board containing a regulator transistor which must be heatsunk to a metal chassis or heatsink (not supplied with the kit). The power supply board itself is fed from a 117 VAC primary power transformer (included with the kit) mounted somewhere on the terminal system's chassis (not supplied with the kit).

Computer Application Customers

Since most individuals using the CT-1024 Terminal System for computer and/or modem applications will be using the same set of options, we have decided to offer the terminal system with the following options for a cost of $275.00 postpaid in the U.S.:

1 EA.	CT-1024	Terminal System Kit
1 EA.	CT-P	Power Supply Option Kit
1 EA.	KBD-5	Keyboard Option Kit
1 EA.	CT-S	Serial Interface Option Kit
1 EA.	CT-CA	Computer Controlled Cursor Option Kit

This is the recommended package when using the Terminal System for most computer applications which include the SWTPC 6800 Computer System, the MITS ALTAIR 8800 and 680, as well as acoustic coupler/modem applications. This package does not include the video monitor or modified television display, chassis or cover. We do not sell these items. In addition to this package you should consider the CT-SO optional baud rate option $14.75. It will be required for those customers using the terminal with our AC-30 Audio Cassette Interface.

General Comments

The unit is sold in kit form only and comes without a chassis or cover which we do not offer.

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, wiring diagrams, and theory of operation, they have not been written for the beginner. The various modules within the system simply plug together keeping the wiring to a minimum.

Assembly time will vary depending upon the number of options being assembled and the experience of the builder, however, most systems can be put together in less than twenty-four hours.

For those readers interested in finding out more about the circuitry in the unit, it was printed as a construction article series starting in the February 1975 issue of Radio-Electronics Magazine (TV Typewriter II page 27). If you do not have a copy of this magazine, you can probably find one in your local library. The CT-1024 (TV Typewriter II) is totally different from the TV Typewriter I printed in an earlier issue of Radio-Electronics Magazine. The two were designed by different individuals and their option boards are not interchange-

able with one another. We are no longer supplying any of the parts for this older TV Typewriter I.

Since its introduction in February 1975, we have sold many of the CT-1024 terminal systems and have been very happy with its performance and reliability. However, for those customers that have difficulty getting the system working properly or have it fail after assembly, we do have repair service available at a reasonable cost.

Southwest Technical Products Corporation

CT-1024 Terminal System Price List

CT-1024	Terminal system kit including memory but less the keyboard and chassis	$175.00 ppd. in U.S.
CT-P	Terminal Power Supply kit which powers the terminal system including a full complement of option boards	$ 15.50 ppd. in U.S.
KBD-5	Deluxe Keyboard kit with N key lockout, 2 key rollover with special character programmability.	$ 49.95 ppd. in U.S.
CT-S	Serial Interface kit with bi-directional RS-232 capability for computers and modems.	$ 39.95 ppd. in U.S.
CT-CA	Computer Controlled Cursor kit which gives both manual switch and program (software) control over cursor positioning.	$ 15.50 ppd. in U.S.

NOTE: Cost of the preceeding five items when ordered simultaneously is $275.00 ppd. in U.S.

CT-SO	Optional baud rate parts to allow the CT-S Serial Interface to operate at 110, 150, 300, 600 and 1200 baud..	$ 14.75 ppd. in U.S.
CT-L	Parallel Interface kit to connect the terminal to a parallel data buss device.	$ 29.95 ppd. in U.S.

Circuit Boards

CT-1024b	Main Terminal System and Memory boards (G-10 fibreglass with plated thru holes)	$ 47.50 ppd. in U.S.
CT-1024c	Connector Set for the above board set (sold only when purchased simultaneously with CT-1024b).	$ 2.50 ppd. in U.S.

No other Terminal System boards are 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 $\pm$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 CT-1024 (TV Typewriter II) Terminal System, 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 CT-1024 (TV Typewriter II) Terminal System 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.

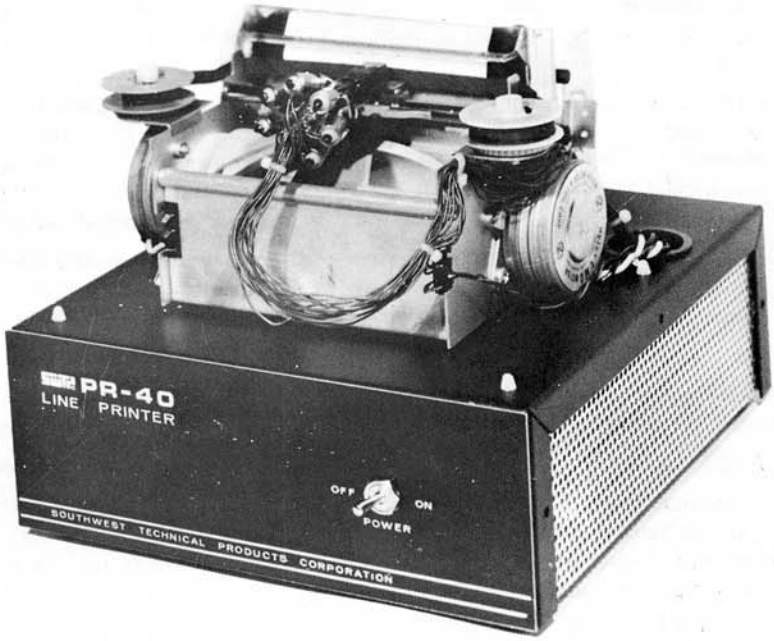
The AC-30 Audio Cassette Interface System is available in kit form only and includes the circuit board, components, chassis, cover, power supply and assembly instructions:

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

Those customers using the cassette interface with the SWTPC CT-1024 Terminal System will have to use the terminal's CT-S Serial Interface option configured for 300 baud. For those customers not already having the optional baud rate components installed on their inface board, a kit of parts is available from us.

CT-SO Optional Baud Rate Kit . . . . . $14.75 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

```
* 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.

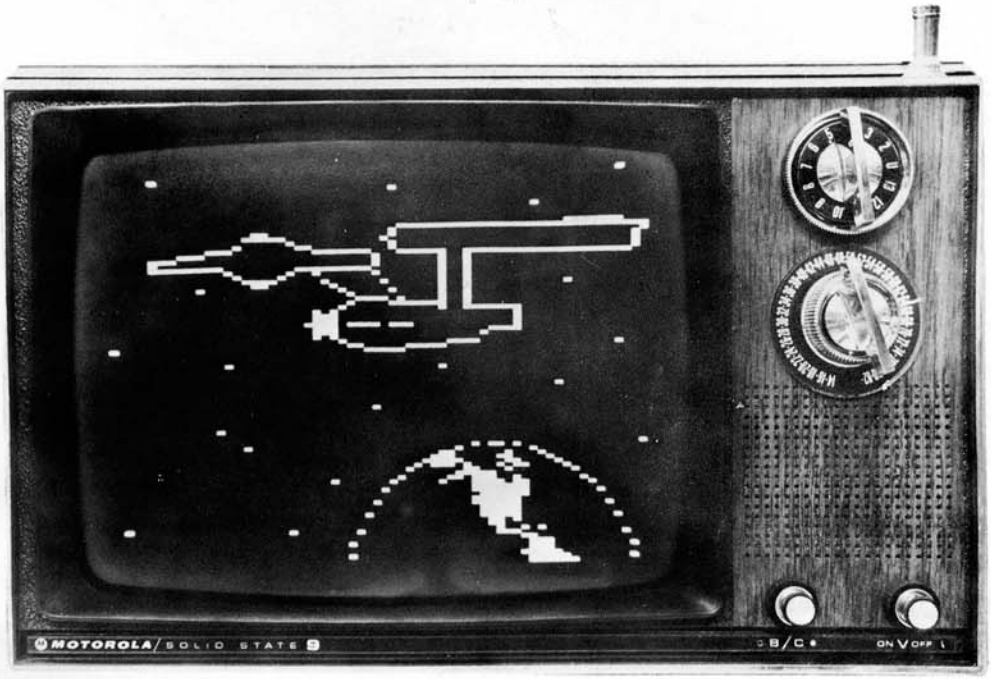
The PR-40 Alphanumeric Printer is available in kit form only and includes the print mechanism, chassis, circuit boards, components, power supply, assembly instructions, one ribbon and one roll of paper:

# 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.

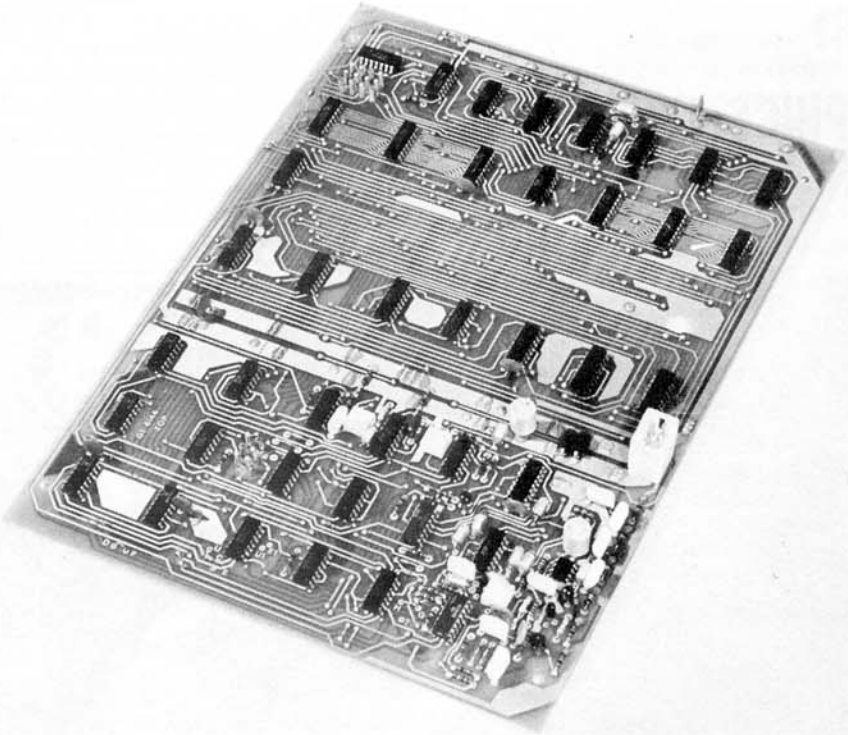
GT-61
GRAPHICS TERMINAL



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 tim 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 CT-1024 terminal system. In fact, control commands from your computer allow you to display graphic, CT-1024 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-1024 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-1024. 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".

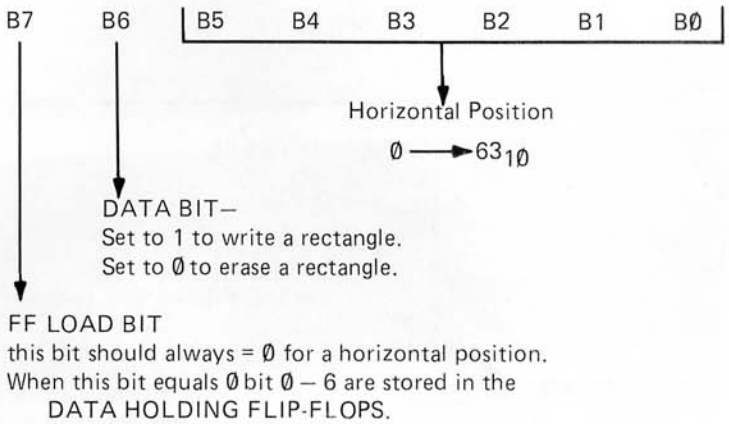
Programming

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

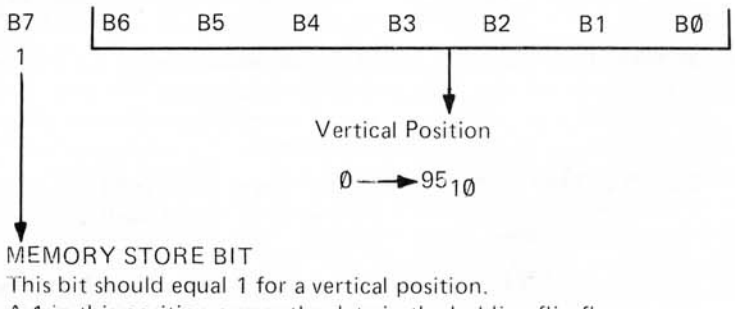
$B_0 - B_5$ and is in binary. When bit 6 = Ø a rectangle will be removed at the desired coordinates, when bit 6 = 1 a white rectangle will be generated. Bit 7 must always equal Ø for the terminal to know that a HORIZONTAL position is being loaded. A Ø in the bit 7 position causes the data holding flip 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 $B_0 - B_6$ of this second byte while bit 7 must equal a 1.

FIRST BYTE FROM COMPUTER–HORIZONTAL POSITION



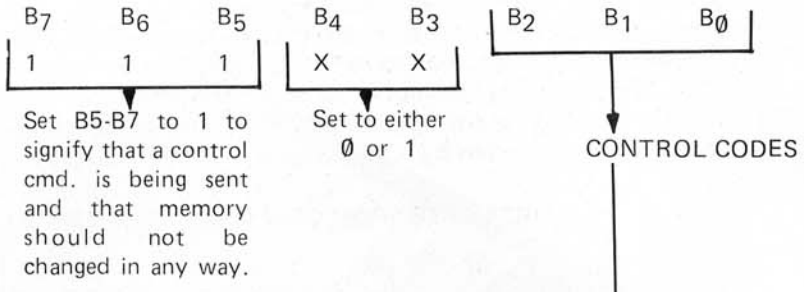
SECOND BYTE FROM COMPUTER–VERTICAL POSITION



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_{10}) locations giving us 32_{10} 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_0	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-1024 — In this mode video data from the CT-1024 is mixed with video from the GT-6144. If the 6144 is disabled, only alphanumeric data will appear on the screen.

DISABLE CT-1024 — No CT-1024 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.

Southwest Technical Products Corporation, 219 W. Rhapsody, San Antonio, Texas 78216

NAME _____
(FIRST NAME) (MIDDLE INITIAL) (LAST NAME)

Rural Route _____ Rural Box No _____ P.O.Box No. _____

Street Address _____

City _____ State _____

Date _____ ZIP _____

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C		F	PP	REA	SPH	CM	SAM	SPL	CSH	CHX	BAC	TOD	PO		

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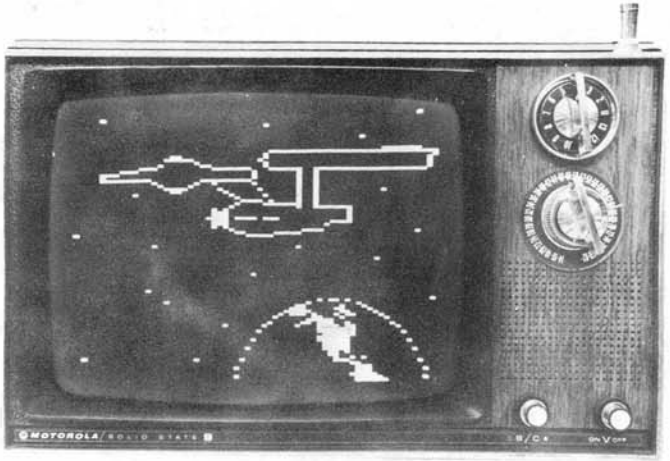

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