

6800 COMPUTER SYSTEM

Southwest Technical Products Corporation

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 Applications Manual, for example, contains material on programming techniques, system organization, input/output techniques, hardware characteristics, peripheral control techniques, and more. Also available is a Programmers Manual which 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 type interface involved. The SwTPC 6800 computer system includes the control interface as part of the basic package, not as 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 A000₁₆ with 9E₁₆ 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 accidentally 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 the users program via the operating system, the terminal is totally available for user program input/output communication.

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 in the works that 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 will supply a resident editor and assembler to those buying the memory to support them (8K). The editor and assembler are great time savers when it comes to writing and modifying programs especially if those programs are long. There will also be a floppy disk and disk operating system (DOS) available for this unit for those demanding fast data file/program access speed and a large data storage capacity.

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 are planning to offer a user contributed software exchange newsletter compiled and distributed by us to our customers at a break-even cost providing 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 that 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 transferred 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.

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.

Southwest Technical Products Corporation

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 MCM6830 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	\$ 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, \pm 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.	\$ 2.00
	(specify serial or parallel type)	

* 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 5 1/2" x 9" double sided plated thru hole circuit board containing the 6800 micro-processor 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 inter-connections 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 accessible 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 5 1/2" 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-MX 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 5 1/4" x 3 1/2" 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 3 1/2" 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 5 1/4" x 3 1/2" 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 0.2 A.

MP-L Parallel Interface Board

The MP-L Parallel Interface is a 5 1/4" x 3 1/2" double sided, plated thru hole board implemented with the 6820 peripheral 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 0.3 A.

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. We will have the editor/assembler package as well as a low cost cassette tape interface available for our computer in early 1976. The editor/assembler will be sold for essentially the cost of the tape and the documentation. We will however sell it only to those people who are ordering the MP-M plus MP-MX memory options at the same time since the editor/assembler package requires as least 8,192 words of memory to function.

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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 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 addresses 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 (IO) 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 software and permanent storage.

ANSWER - In addition to our test programs, a resident editor and assembler is available for the 6800 system. The editor and assembler requires 8K of memory and is available to anyone purchasing the memory necessary to use the program. Cassette tape, or paper tape inputs are usable with this system.

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. See our price sheet - you can have just the boards, just the power supply, just the cabinet, or any individual board kit you want.

QUESTION - Will I be able to get additional programs and more elaborate equipment if I want to expand my system.

ANSWER - Since our computer uses the standard Motorola 6800 parts set and ROM, any software developed for this set of parts will run on your system. We will also offer a newsletter at cost to users so that information and tips can be exchanged. There are already companies offering diskette, or floppy disk systems complete with operating system software. We will be either offering these, or will supply information to interested users of the 6800 system.

QUESTION - When can I expect to get delivery.

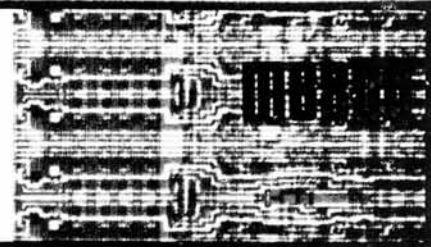
ANSWER - Our present schedule calls for shipment of the first kits in November 1975. Orders will be filled in the order they are received.

Feature Comparison *

	SwTPC 6800	MITS- Altair 8800
Basic Kit - Price	\$450.00	\$439.00
Memory - Basic kit	2,048 Words - Static	none
Interface - Basic kit	Serial Control Interface	none
Loader Program	Automatic - Internal ROM	Manual - Console Switches
Operating System for Terminal and Memory Debug	Automatic - Internal ROM	Manual - Console Switches
Processor Type	Motorola MC6800	Intel 8080
Additional Memory	2,048 Words Static \$50.00 4,096 Words Static \$125.00	2,048 Words Static \$145.00 4,096 Words Dynamic \$264.00
Interfaces	Serial, or Parallel \$35.00 Serial usable with RS232 or 20 Ma. TTY	Parallel \$92.00 Serial TTY \$124.00 Serial RS232 \$119.00
Card Capacity in standard cabinet with power supply provided	7 Processor and Memory 8 Interface cards	16 Processor, Memory or Interface cards
Editor and Assembler Software	Yes	Yes
Software Licence or copying restrictions	No	Yes
Disk Operating System	Available	Available

* Data compiled as of September 1975

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 to Accumulator
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.

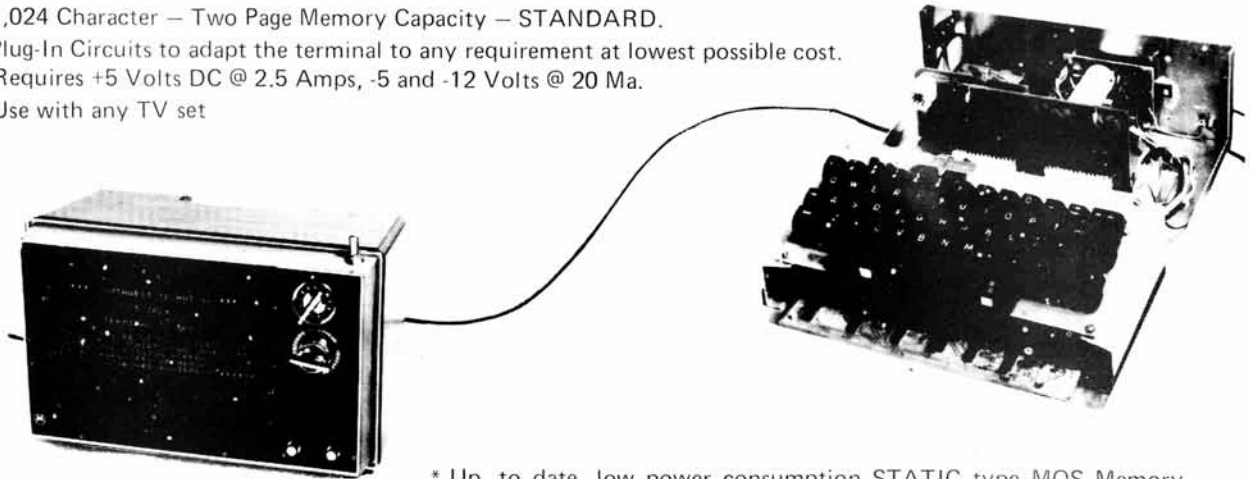
Relative Addressing

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.



IS PROUD TO ANNOUNCE: THE CT-1024 TERMINAL SYSTEM

- * DISPLAYS UP TO 16 LINES (of 32 Characters) AT ONE TIME.
- * 1,024 Character — Two Page Memory Capacity — STANDARD.
- * Plug-In Circuits to adapt the terminal to any requirement at lowest possible cost.
- * Requires +5 Volts DC @ 2.5 Amps, -5 and -12 Volts @ 20 Ma.
- * Use with any TV set



- * Up to date, low power consumption STATIC type MOS Memory.
- * No complicated refresh or power-down circuits needed.

At last we can tell you about the most versatile, video-display terminal kit available anywhere; the Southwest Technical CT-1024. Our terminal is designed around a basic mother board and a 6,144 bit memory that will display two pages of data on any standard television set, or monitor. The two pages consist of 16 lines with 32 characters on each line. Input may be any source of parallel ASCII code; keyboard, computer, etc. If the system is to be used for a display, teaching aid, deaf communicator, or other similar purpose; this is all you will need.

Other applications of a terminal system such as remote time share, RTTY, etc require an interface having a serial output. For these applications you add our #CT-S plug-in UART card to the mother board. This allows you to transmit and receive ACSCII coded data in serial form at a rate of 110 baud. (300 and 600 baud options are available). The standard RS-232 type interface connects directly to your transmitter FSK modulator, modem system, or what have you.

If you are going to use the CT-1024 directly with a computer I/O port that requires a parallel ACSCII input, then you will want our parallel interface card, #CT-P which

allows either the keyboard, or the computer to access the terminals memory and display data on the screen.

For those applications where it is useful, we also have an "off line edit", or "screen read" plug-in circuit #CT-E. This allows you to compose a program, or message on the terminals display screen and transmit it out a line at a time when you are finished and satisfied that everything is correct.

If you would like the convenience of complete cursor control, we have our #CT-CM plug-in board. This gives you Move Right, Move Left, Move Up, Move Down, Home Up, Erase to end of line and Erase to end of frame functions. These are operated by keyswitches, or any other type switches you may wish to use, giving you complete manual control of the cursor.

If the terminal is to be part of a computer system, you might prefer our automatic cursor control circuit #CT-CA. This plug-in not only allows you to control the cursor and to perform the functions listed above, but makes possible computer control of these same functions through the machines software.

#CT-1024	Terminal System Kit with memory (Less television, keyboard, chassis or Power Supply).....	\$175.00 PPd in US
#KBD-5	Keyboard Kit.....	\$ 49.95 PPd in US
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