65V PROM MONITOR

INSTRUCTIONS

Anyone wishing to become proficient in programming at the machine language level should be well acquainted with the PROM Monitor which is necessary to examine and change the contents of memory locations. The Monitor used in conjunction with the 6502 video system is the OSI 65V PROM Monitor.

As explained above, OSI's 8K BASIC comes up when the computer is reset. When this is done, the letters "C/W/M?" or "D/M?" appear on the video screen or terminal. If you wish to enter a program by means of the Monitor instead of BASIC, type an "M" on the keyboard. This brings up the Monitor and starts it in the Address Mode, that is, the mode in which you can specify memory addresses or locations to simply examine their contents. Appearing on the screen are four digits in hexadecimal notation followed by two spaces and, finally, another two digit number, also in hex. The four digit number is a location, and the two digits are the contents of that location. To examine another address, type the address on the keyboard. The same address will appear on the terminal, as will the corresponding contents of that address.

If you wish to change those contents and thus enter programs using the Monitor, you must exit the Address Mode and get into the Data Mode. To do this, type a slash (/). Then type any two hex characters, and they will be inserted into that location as its new contents. The normal procedure for entering programs via the Monitor is to use consecutive memory locations. While still in the Data Mode, you can open the next address by typing the return key. You can do this continually, each time altering the memory contents according to the needs of the program you are writing. If you want to jump to a non-consecutive location, you need to get back into the Addressing Mode by typing a period (.). Then type the new address you want. Type another slash to get back into the Data Mode and continue as before until you want to open a non-consecutive address. Extreme caution should be used whenever the Monitor is in the Data Mode as you are directly manipulating the computer's memory.

If you wish to enter a program from an audio cassette instead of manually from the keyboard, first get into the Address Mode, then turn on the cassette. Let the tape advance to the point where the program of interest begins, and type L. This transfers control to the audio cassette, such that all ASCII commands are supplied by the cassette instead of by the keyboard. The L command also puts the Monitor into the Data Mode. If the contents of ØØFB are ØØ, the Monitor will accept commands from the keyboard.

If the cassette does not load ØØFB (hex) with ØØ, to transfer control back to the keyboard, press reset. Otherwise, commands are accepted from the Audio Cassette UART.

To run any program which you have entered via the Monitor, get into the Address Mode, i.e., type a period, type the starting address of the program, and type a "G."

Label	Program Entry Points
VM	FE00 - Restart Location FE0C - Bypasses UART and Stack Pointer initialization and the clearing of decimal mode but does clear the screen.
IN	FE43 - Entry into address mode, bypass initialization
INNER	FE77 - Entry into data mode, bypass initialization
Label	**Subroutines**
OTHER	FE80 - Input an ASCII character from Audio Cassette UART
LEGAL	FE93 - Returns stripped ASCII number if 0-9 or A-F. Otherwise returns a FF.
INPUT	FEED - Input an ASCII character from keyboard

Required Hardware

The 65V Monitor requires as a minimum the following hardware: an OSI Model 400 board with a 6502 microprocessor, 1,024 words of RAM memory located from ØØØØ to Ø3FF, and the 65V monitor itself. It also requires an OSI Model 440 Board populated for alphabetic display and keyboard input. The 440 Video Board must be located at DXXX which will automatically locate the keyboard input at DFXX.

The keyboard must be a seven-bit high true ASCII keyboard with a positive or negative going strobe pulse at least 100 microseconds long.

The 65V Monitor will additionally support input from a generalized serial communications subsystem of an OSI 430 board located at FBXX. Specifically, the monitor contains a load program for a 430 board-based audio cassette interface. The same program can be used with a 430 board configured for digital cassette or ASCII teletype input.

Commands

Address Mode Commands:
/ - Change to Data Mode
G - Go -- Jump to location seen on screen and execute program found there.
L - Transfer control to audio cassette.

Data Mode Commands:
. - Change to Address Mode
RETURN - Open next address. In other words, increment location pointer by 1.

If the 65V is in address mode, typing 0 - 9 or A - F will cause that number to be rotated into the LSD of the location pointer. Typing a 4 causes 0123 XX to become 1234 XX.

If it is in Data Mode, the number is rotated into the data contents and memory is thus modified. This permits the easy correction of errors. If, for example, the user typed 0478 when intending to look at location 047B, he would simply type 047B.

All of the non-command keys and non-hexadecimal characters are ignored by the monitor.

65V Demonstration Program

The following is a program which may be entered using the 65V Monitor from the keyboard or audio cassette. An "*" indicates a return key depression.

```
.0002     Loads the ASCII Message Starting at Location 0002
/4F * 53 * 49 * 20 * 36 * 35 * 56 * 2E * 5F

.0200     Loads the Main Program at 0200
/ A9 * 02 * A2 * 00 * 20 * 00 * 03 * A2 * 00 * 20 * ED * FE * 9D * 24 *
D2 * E8 * 4C * 09 * 02

.0300     Loads the Subroutine at 0300 to Output an ASCII Character String.
/85 * 00 * A9 * 00 * 85 * 01 * A0 * 00 * B1 * 00 * C9 * 5F * F0 * 0A * 9D *
E4 * D1 * E8 * E6 * 00 * D0 * F2 * E6 * 01 * 60

.0200G    Loads the Starting Address of the Program and Execute it.
```

You should see the message "OSI 65V." on the screen. Now, you may type any keys and they will be echoed just below the message. Press reset to re-enter the 65V Monitor.

If this were entered off of the audio cassette, it would be self-loading and auto starting. Since the cassette is in complete control, it can load the starting address and execute the program without user interruption.

CHECKOUT WITH THE 65A PROM MONITOR

On serial-based systems, once you are confident that you have interfaced the computer correctly, plug in both the terminal and the computer to a common grounded three-wire outlet. It is also recommended that you do not operate the system in areas which produce high static discharges.

First turn on the terminal and allow it to warm up. Then turn on the computer. On Model 500-1, Challenger II and Challenger III, reset lights should glow rather brightly. If the light is very dim or does not come on, turn the unit off and proceed to Section E. On Challenger III systems with the manual processor select switch, be sure that the 6502 is selected by rotating the switch at the rear of the unit counter-clockwise. On systems where you are utilizing your own power supply, monitor the -9V and +5V together with a voltmeter. If the voltage is not 14V, turn the power off and proceed to Section E.

Next, quickly depress the reset switch. On all Challenger systems equipped with ROM BASIC, the message "C/W/M?" should be printed out. On systems configured for use with the floppy disk, "D/M?" should be printed out. On older Challenger configurations, a simple carriage return-line feed will be put out. Occasionally, on the first reset operation under power-up, one or more of the characters may be mistyped due to warm-up. In any case, repeat the reset procedure three or four times and observe the output on the screen. If you are not getting the proper message, but are getting a somewhat garbled message of approximately the same length and characters, your baud rate is probably misadjusted. On systems using the 500 Board or on Challenger IIIs (110 baud), it is necessary to fine-adjust the baud rate. A rough adjustment of the baud rate can be made by rocking the pot back and forth over its range and resetting the computer until you get the desired output. If you are not qualified or experienced in electronic servicing, you should not attempt this procedure with power applied. Simply turn the computer off, remove the cover, adjust the potentiometer, place the cover back on, and turn the computer back on (reset) until you get the proper message. If it is not possible to get the proper output with this procedure, refer to Section E.

Once you have obtained the proper output message, type M. This will place you in the 65A Monitor. Then type PØØØØ. The computer should now start listing memory incolumns of eight hex bytes, or 16 hex characters with spaces between characters, i.e., 0-9 and A-F, with even spacing between characters. If there are any illegal characters or uneven spaces, then your baud rate requires fine tuning. This can be accomplished by moving the potentiometer baud rate pot adjustment clockwise until it provides a large number of errors, and then rocking the back to the right until it provides a large number of errors, and then setting the pot in the middle of its range, thus fine-tuning the baud rate.

Next proceed to the 65A PROM Monitor instructions and execute the sample program. You may or may not desire to become familiar with the machine language operation of the computer. If you do, refer to the MOS Technology Programming Manual which provides an excellent discussion of machine language programming of the computer and, also, to the Ohio Scientific Small Systems Journal which occasionally provides short routines which can be entered directly in machine code. Another excellent introductory source for machine language programming is Ohio Scientific's Model 300 Computer Trainer Manual. This manual provides twenty experiments on the 6502-based Model 300 Computer Trainer, but, these experiments can also be executed on any Challenger system. The manual can be ordered directly from Ohio Scientific for ten dollars postpaid. Once you are satisfied with your familiarity with the 65A Monitor, proceed to Section C.

65A PROM MONITOR
INSTRUCTIONS

The 65A PROM Monitor is used with 6502 serial systems by the programmer who wishes to write at the machine language level. When the reset button is pressed, the letters D/M? or C/W/M? may appear on the screen. To get into the monitor, type an M on the keyboard (D is used only in conjunction with the diskette, which contains BASIC). While using the Monitor program, you can directly manipulate the computer's memory, and write programs using the computer's own language.

First of all, to examine memory locations before changing them, type a P, then the initial location in the block of addresses you wish to inspect. When you do this, the contents of that block will scroll up the screen. You may halt this scrolling by typing any key on the keyboard.

To change memory contents, type an R to return to the Command Mode. Then type an L, together with the location whose contents you wish to change, then an optional space for clarity, followed by the "new" contents which you select. If you are altering the contents of consecutive addresses, simply type the new contents one after the other. You may type spaces, carriage returns, and line feeds between these contents if you wish to make it more legible, but this is not necessary. In any case, the next successive address in memory is opened with each set of contents you type. If the next location you wish is not immediately consecutive, type R to get back into the Command Mode, then type L and the new address, plus the contents you wish to place there. Continue typing new contents if you are changing those of consecutive addresses, otherwise type R, then L, and so on.

To verify any changes you have made, use the P command to examine memory blocks as explained above.

While you are using the L command, the Monitor ignores all non-hexadecimal characters except R. When you use the P command, the monitor inserts spaces, carriage returns, line feeds and nulls.

The fourth command available when using the 65A Monitor is the G command which is used to run programs. This will be illustrated in the sample program below. Some of the following subroutines are used in the course of the program.

Subroutines

FE00	INCH (input character and echo)
FE0B	OUTCH (output character)
FE35	CONTROL (Note: FE40 will bypass ACIA initialization)
FE77	LOAD
FE8D	PRINT
FEC7	BUILD ADDRESS (constructs an address from input at 00FC [low] and 00FD [high])

Go and Breakpoint Locations

0129	Index Register Y
012A	Index Register X
012B	Accumulator
012C	Status Register
012D	Stack Pointer
012E	Program Counter High
012F	Program Counter Low

Vectors:

NMI	0130
RESET	FE35
IRQ	01C0

Sample program to illustrate OSI 65A Monitor

This program prints in double any character you type on the keyboard. Beginning at location 0200, the program would look as follows in user source code:

```
10*=$200
20 JSR INCH
30 JSR OUTCH
40 JMP $200
```

The assembled version of this short program would look as follows:

```
10 0200          *=$200
20 0200 2000FE   JSR INCH
30 0203 200BFE   JSR OUTCH
40 0206 4C0002   JMP $200
```

These lines are interpreted as follows:

Line 10: initialization of program counter

Line 20: actual program begins at given initialization point (0200); 20 is the ASCII code representation for JSR; 00 is the low address byte of INCH; FE is its high address byte.

Line 30: since three bytes have been used since program initialization, we are now at location 0203; 20 is ASCII for JSR; 0B is low address byte for OUTCH; FE is its high address byte.

Line 40: as this is the sixth byte since program initialization, we are at location 0206; 4C is the ASCII code for JMP; 00 is the low address byte for location 0200; and 02 is its high byte.

The bytes in this program are all to occupy consecutive memory locations. Therefore, only one L command will be necessary while we are in the Monitor, until we are ready to run the program. To enter it, engage in the following dialogue with the computer: press reset (your responses are underlined).

```
D/M? M
L0200 2000FE 200BFE 4C0002 R
```

To verify that these contents truly are loaded into memory, type: P0200
The contents of all the addresses beginning with location 0200 will immediately scroll up the screen. To stop the scrolling, type any key and examine the contents displayed on the screen. Then type R to get back into Command Mode.

To run the program, you need to set the stack pointer (located at address 012D) to 28, and the program counter high (012E) at 02 and low (012F) at 00, because the starting address is 0200. Since these locations are consecutive, you need only type : L012D280200R
To execute the program, type G
Then any character you type will appear in duplicate on the screen.

d-special features

The following special features may be present on your computer system. These special features are described here in abstract form; complete instructions are provided in the manual only if your computer is equipped with those special features.

1) Graphics This option has an additional 420 Memory Board and graphics circuitry (on the 440B Board) such that it is capable of 128 X 128 dot graphics. This option requires the addition of a graphics enable/disable switch on the keyboard utilized by the 440B Video Board. Refer to its section for installation details.

2) Auxiliary RS-232C port. The Model 430B Audio Cassette Interface Board can be populated as an RS-232C port instead of as an audio cassette port. This port is supported under the I/O distributor of OS-65D. If this option is present on your computer, refer to the accompanying 430B assembly and operating manual for details.

3) Fully Populated 430B Board The 430B Board can be ordered fully assembled including high-speed A/D converter, D/A converters, and audio cassette or RS-232C. Refer to the discussion of operation of a fully assembled 430B Board in this section and to the 430B Board manual which is included if this option is present on your system.

4) Parallel Interface PIA based parallel interfaces can be ordered as a CPU Board option or on 450 and 455 EPROM Boards. If a parallel interface is present, that board's assembly and operating instructions will be present in this section of the manual. Further information on programming PIA based parallel interfaces is covered in "Get the Most Out of BASIC, Part I", Ohio Scientific's Small Systems Journal, Vol. 1, No. 2, page 4, August 1977.

5) Memory Management on the 500 Board This option allows the lower PIA lines, that is, output lines A_0 and A_1 to drive additional lines A_{16} and A_{17}. The PIA is addressed normally at F7ØØ so that by normal PIA programming, these two upper address lines of a system can be manipulated. The standard system memory boards have provisions for utilizing these upper two address lines. If not used, the operation of the upper address bits is simply ignored by the memory boards. If they are used, then bank-switching will occur. This bank switching allows changing partitions in time-sharing and distributed processing as well as allowing the user to address up to 256K bytes of workspace. This option is required by our distributed processing operating system, but, is not currently supported by any other software.

6) Challenger III 510 CPU Board The Model 510 CPU Board is equipped with 6502, Z-80, and 6800 microprocessors. The main portion of this manual is concerned with 6502 operation. The auxiliary manual optionally included in this section (on the 510) covers the operation of the Z-80 and 6800, and special features such as memory management, software processor switch, and swappable RAM memory.

7) Line Printer Interface The standard Challenger II and Challenger III can be provided with OKI DATA Model 110 or OKI DATA Model 0-22 line printers, complete with Centronix interface to the Challenger System and supporting software. Or, one can purchase just the Centronix printer interface and connector cable. Line printers are generally shipped by air freight or truck and come complete with their own operating manuals. If this option is present on your computer, the interface specifications and turn on procedures are