EINSTEIN MOS 1.1 MCAL (ROM CALL) INFORMATION

Source: Nigel Deakin - 3.12.84

The following is a list of legitimate machine calls to Einstein MOS 1.1.

The calls (MCAL's) are executed on a RST08 (Restart 8 instruction) followed by the function number (given in Hex). Return is to the address after the function number.

e.g.

ADDRESS	OBJECT	MNEMONIC	
100	CF	RST08	{ROM CALL}
101	9C	data 9CH	{FUNCTION NUMBER}
102	FF	RST38	{NEXT INSTRUCTION}

On G100, the above will perform MCAL 9C (ZKEYIN) which will wait for a key to be pressed and return the value in the A register

(On return, the Restart 38 will perform a break)

Abbreviations used

CTC - Counter Timer Circuit
VRAM - Video RAM
VDP - Video Display Processor
PSG - Programmable Sound Generator
FDC - Floppy Disc Controller
MCAL - Machine Call

EINSTEIN MOS 1.1 MCAL INFORMATION

Function Number	Source Label	Description
80	ARITH	Performs as 'A' (ARITHMETIC) from MOS Values Passed xxxx in HL pair yyyy in DE pair (See manual)
81	BAUD	Performs as 'B' (BAUD) from MOS Values Passed x - Receive rate - upper nibble of L register y - Transmit rate - lower nibble of L register ww - Mode Byte - D register zz - Command Byte - E register (see manual) If DE is zero, the mode and command bytes will remain unchanged. For the correct receive and transmit rates, the baud rate factor X16 must be used.
82	COPY	Performs as 'C' (COPY) from MOS Values Passed xxxx - Start - in HL pair yyyy - finish - in DE pair zzzz - destination - in BC pair (see manual)
83	DECIML	Performs as 'D' (DECIMAL) from MOS Values Passed xxxx in HL pair (see manual)
84	EXEC	Performs as 'E' (EXECUTE) from MOS Values Passed xxxx - Break point - in HL pair (see manual)

Function Number	Source Label	Description
85	MFILL	Performs as 'F' (FILL) from MOS Values Passed xxxx - Start - HL pair yyyy - Finish - DE pair zz - Value - C register (see manual) 52 -7B
86	GOTO	Performs as 'G' (GOTO) from MOS Values Passed xxxx - execution address - HL pair yyyy - break point - DE pair (see manual) If DE is zero, no break point is set
87	HEX	Performs as 'H' (HEXADECIMAL) from MOS Values Passed Pointer to text (in RAM) - DE pair The decimal number is held at (DE) and terminated with 00 The hexadecimal number is returned in the HL pair in addition to being displayed.
8C	MODIFY	Performs as 'M' (MODIFY) from MOS Values Passed xxxx - address to modify from - HL pair
91	RDBLOK	Performs as 'R' (READ) from MOS Values Passed Pointer to text (in RAM) - DE pair The text takes the format as shown in the manual. (See ZRBLK function no. A4)

Function Number	Source Label	Description
93	TBLATE	Performs as 'T' (TABULATE) from MOS Values Passed xxxx - Start address - HL pair yyyy - finish address - DE pair zz - no. of columns - C register If C is passed as zero, zz will default to 8 columns
96	WRBLOK	Performs as 'W' (WRITE) from MOS Values Passed Pointer to text (in RAM) - DE pair The text at (DE) takes the format as shown in the manual (See ZWBLK function no. A5)
97	COLD	Performs as 'X' (COLD START) from MOS
98	WARM	Performs as 'Y' (WARM START) from MOS
99	REGSTR	Performs as 'Z' (REGISTER EXAMINE) from MOS Values Passed x - registers to be displayed - L register (0, 1 or 2) Note: This does not display the current register contents but the register contents at the last RST 38H (FFH encountered.)
9A	ZINIT	Re-entry point to MOS

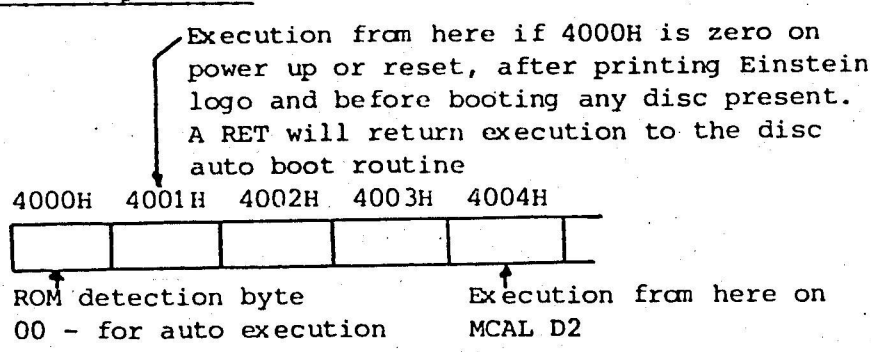
Function Number	Source Label	Description
9B	ZRSCAN	- Repeat key scan This will return the value of any key pressed, in the A register. 00 is returned if no key is pressed. 00 can also be returned if the keyboard poll rate (polled with this MCAL) is greater than the key repeat speed. This repeat speed can be altered in scratch pad location FB43H Note: This works as the KBD command in XBAS
9C	ZKEYIN	- Input key This will return the value of any key pressed, in the A register. Unlike MCAL 9B, this will wait for a key to be pressed. Note: This is similar to the INCH command in XBAS
9D	ZGETLN	- Get Text from keyboard This will enter a line of text from the keyboard into RAM from the address held in the DE pair. The text is displayed on the screen on pressing the keys and the line is terminated with an ENTER.
9E	ZOUTC	- Character Output. Outputs a character to screen held in the A register.
9F	ZPOUT	Outputs a character to the parallel printer held in the A register.
A0	ZSLOUT	- Serial Output Outputs a character to the serial port from the A register.

Function Number	Source Label	Description
A1	ZSRLIN	- Serial Input Read a byte from the serial port and returns the value in the A register.
A2	ZRSECT	- Sector Read Reads a sector from the disc into the sector buffer (A sector is 200H Bytes) The fcllowing are set up in the scratch pad Location Label FB50H HSTDSC - Disc drive (0 - 3) FB51H HSTTRK - Track (0 - 27H) FB52H HSTSEC - Sector (0 - 9) FB53H HSTDMA - Sector buffer address (normally FE00H)
A3	ZWSECT	- Sector Write Writes a sector from the disc into the sector buffer (see MCAL A2)
A4	ZRBLK	Read Block Read a block of data from the disc Values Passed Drive no. (0-3) in A register Start address in HL pair Finish address in DE pair Sector (0-9) in B register track (0-27H) in C register Memory is filled to the next complete sector (220H bytes) i.e. if the start and finish address is specified as 6000H and 6001H respectively, 6000H to 6200H will be read from the disc .

Function Number	Source Label	Description
A5	ZWBLK	Write Block Writes a block of data to the disc. The values passed are the same as for MCAL A4 and again is written to the next complete sector (200H bytes)
A6	ZCRLF	Outputs a CR (0DH) and and LF (0AH)
A7	ZCRLFZ	Outputs a CR and LF if the cursor is not at column zero.
A8	ZSPACE	Outputs 1 space
A9	ZPR4HX	Outputs 4 hex digits held in the HL pair. e.g. if HL = 1234H, 1234 is output
AA	ZP2HXZ	Outputs two hex digits held in the A register followed by a space.
AB	ZPR2HX	Outputs two hex digits held in the A register (as MCAL AA with no space output)
AC	ZFC4HX	Get a hex number (up to 4 digits) from text into the HL pair. DE points to the text (in RAM). The number is terminated on a non hex character.
AD	ZFCZHX	Get a hex number (up to 2 digits) from text into the A register. DE points to the text. The number is terminated with a non hex character.

Function Number	Source Label	Description
AE	ZDCMD	Outputs a command to the FDC. The command type is passed in the A register. On return A is set to 00 unless the FDC is not executing the command then A is set to FFH.
AF	ZHMDSC	Takes the drive head to track 00 The drive no. is passed in the A register
B0	ZIGBLK	Returns a value in the A register from RAM pointed to by the DE pair if DE > 7FFFH, or from ROM if DE < 8000H. Note: Commas and spaces are ignored (i.e. the first non comma/non zero character is displayed).
B1	ZRDMEM	Returns a value in the A register from RAM pointed to by the HL pair.
B2	ZRCPYU	Performs an LDIR instruction (switches ROM out first)
B3	ZRCPYD	Performs an LDDR instruction (switches ROM out first)
B4	ZMOUT	Outputs a value held in the B register to the PSG port no. held in the C register.
B5	ZKSCAN	Returns the value in the A register of any key pressed. 00 is returned if no key is pressed. This is similar to MCAL 9B (ZRSCAN) except that it is unaffected by the key repeat speed. That is for each MCAL execution, a value is returned.
BC	ZZTIME	Set up CTC channels 2 and 3 to generate 1 second interrupts for clock

Function Number	Source Label	Description
BD	ZFDRST	Resets the FDC after an error. Also resets the PSG (using MCAL C0 (ZPINIT))
BE	ZSYSRS	This performs the following:- 1. Clears the screen to 40 columns 2. Resets all characters 3. Removes sprites 4. Resets the FDC and PSG 5. Masks the keyboard, fire and ADC interrupts
BF	ZLOGO	Outputs '***EINSTEIN***' Logo.
C0	ZPINIT	Sets PSG register 7 to 7FH and all other registers to 00.
C1	ZSREG	Sends an address held in the BC pair to the VDP. Data can then be output to VRAM from port 8. Subsequent data bytes sent will be loaded into subsequent VRAM locations. Note: A delay of 8µ is necessary between any VRAM reads or writes (e.g. PUSH/POP) Note: When ROM is switched in, RST 20H will execute this MCAL.
C2	ZVRIN	Returns a value in the A register from the VRAM address pointed to by the BC pair
C3	ZVROUT	Writes data held in the A register to the VRAM address held in the BC pair.

Function Number	Source Label	Description
CE	ZIMULT	Multiplys the contents of the DE pair and the contents of the BC pair and returns the value in DEHL (The DE pair is the most significant)
CF	ZPRM	Outputs a message to the screen. The data follows the CF data byte and must be a character in the range 0 to 7FH. The message is terminated by adding 80H to the last character in the message.
D0	ZVOUT	Outputs a character from the A register to the current cursor position without incrementing the cursor position. This can be useful to prevent scrolling, linefeeds etc.
D1	ZSCURS	Returns VRAM addresses relating to the current cursor position. The ASCII text map address is returned in the BC pair (will be in the range 3C00H to 3FBFH) The table pattern generator address (first byte) is returned in the DE pair (will be in the range 0000 to 17FFH). The start of the sprite pattern/text pattern table is returned in the HL pair (normally 1800H).
D2	ZROM	Starts execution from address 4004h in the 2nd ROM. All registers can be used to pass and return values. Return is achieved by a RET instruction. 2nd ROM protocol 

GRAPHICS ROUTINES STORED IN ROM

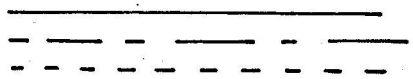
An understanding of these routines can be gained from using the graphics commands in XBAS. e.g. DRAW, FILL, ELLIPSE, POLYGON, PLOT.

<table>
<tr><th>Function Number</th><th>Source Label</th><th>Description</th></tr>
<tr><td>C4</td><td>ZPLOT</td><td>PLOTs or UNPLOTs a pixel.

A = 1 for PLOT
A = 0 for UNPLOT
IX holds the x coordinate
IY holds the y coordinate</td></tr>
<tr><td>C5</td><td>ZPLTXY</td><td>Plots a point according to the line type (see below).

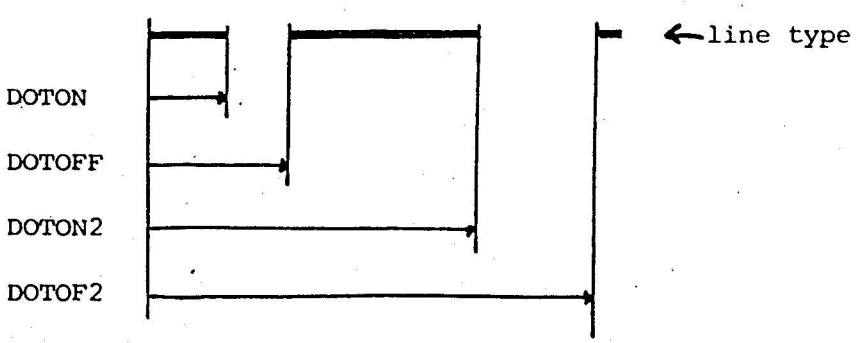
IX holds the x coordinate
IY holds the y coordinate

<u>Line Type</u>

Four scratch pad values contain information as to the line type to be drawn e.g.
 

these are:-

<u>SCRATCH LOCATION</u>

FBABH DOTON - Length to end of first line
FBA9H DOTOFF - Length to end of first space
FBAAH DOTON2 - Length to end of second line
FBABH DOTOF2 - Length to end of second space
 

Normally these 4 values are in accending order.
For a continuous line, DOTON is set to FFH and the other 3 zero.
For a continuous unplot, DOTOFF is set to FFH and the other 3 zero
<u>Note:</u> If all line type bytes are zero, the system will hang up.</td></tr>
</table>

Function Number	Source Label	Description
C6	ZPOINT	Returns the status of any pixel in the A register. 1 = foreground 0 = background BC contains the x coordinate DE contains the y coordinate The VRAM address of the pixel is returned in the BC pair.
C7	ZPNTXY	Returns the status of any pixel in the A register. This is identical to MCAL C6 except IX contains the x coordinate and IY contains the y coordinate The VRAM address of the pixel is returned in the BC pair.
C8	ZDRWTO	This will draw a line from the coordinates held in the IX and IY registers to values in scratch pad locations FB96H (X1) and FB98H (Y1). Each is a two byte number The type of line drawn is determined by the line type values (see MCAL C5)
C9	ZPOLYG	This draws a polygon (or ellipse) The polygon centre coordinates are held in scratch pad locations FB9EG (CX) and FBA0H (CY), each is a two byte number. The horizontal and vertical radii are held in locations FBA2H (RADX-2BYTE) and FBA4H (RADY-2BYTE). The number of sides on the polygon is determined by a two byte number in scratch pad location FBA6H (CINC). A value of 4 will give a circle. A value of 80H will give an octagon A value of 100H will give a rectangle etc. The start angle is passed in the DE pair, the finish angle is passed in the BC pair, each is in the range 0 to 1024. The lines drawn to the polygon centre are selected by setting the carry flag. The type of line drawn is determined by the line type values (see MCAL C5)

Function Number	Source Label	Description
CA	ZORGCO	Adds the x coordinate Origin value held in scratch location FB9AH (ORGX - 2Byte) to the contents of BC and returns the result in the BC pair and adds the y coordinate Origin value held in scratch location FB9CH (ORGY - 2 Byte) to the contents of DE and returns the result in the DE pair. This MCAL is of little use and is called from within other graphics MCALS. The values ORGX and ORGY are normally zero but when altered will cause all graphics output to be offset by that value. This is similar to the ORIGIN command in XBAS.
CB	ZCALAD	Returns the VRAM address in the BC pair for coordinates x and y passed in the IX and IY registers respectively. The pixel position within the 8 pixel row is returned in the E register, counting from the left hand pixel (0 -7)
CC	ZSETCL	Writes data held in the A register to the pattern generator table address passed in the BC pair (0 to 17FFH) and sets the corresponding byte in the pattern colour table (2000H to 37FFH) to the contents of scratch locations FB39H (GCOLR)
CD	ZFILL	Fills an area on screen surrounding coordinates passed in the IX and IY registers (x and y coordinates respectively). If the fill is in foreground (i.e. the point at x, y is not set)then scratch location FBADH(FILLMOD)must be set to FFH. If the fill is in background (i.e. the point at x, y is set)then scratch location FBADH(FILLMOD)must be set to zero. MCAL XPNTXY (C7) can be used to find the fill type needed.

EINSTEIN MOS 1.2 MCAL (ROM CALL) INFORMATION

(Detailing changes from MOS 1.1)

Source: Nigel Deakin 4.12.84

New MCALS on MOS 1.2.

Function Number	Source Label	Description
D3	ZIN80	Initializes the 80 column card as follows:- 1). Checks if the 80 column card is present (return if not). 2). Programs the 6845 registers (programmed for 525 or 625 line operation according to 80 column card switch). 3). Selects 40 columns or 80 columns according to 80 column card switch. This MCAL is performed on power up/reset.
D4	ZIN80	Programs the 80 column card status line (25th row). DE points to the text in RAM (80 bytes) and must be greater than 7FFFH. Note: A clear screen can be performed on the 80 column screen leaving the status line intact with output codes IEH (HOME) and 16H (CLEAR TO END OF SCREEN)

Altered MCALS from MOS 1.1

All MCALS in MOS 1.1 which output information to the screen will output information to the 80 column card if present and selected. The exception to this is MCAL C3 (ZVROUT) and the graphics MCALS's (C4 to CD) which still output to the VRAM.

MCAL C2 (ZVRIN) works differently on MOS 1.2. When the 80 column card is present and selected, MCAL C2 reads from the 80 column card RAM and not VRAM. BC is still passed containing the address and the data returned in the A register. The 80 column card RAM addressing is as follows:-

M.S. Byte C - 40H to 47H)
L.S. Byte B - 0 to FFH) 2K total.

If it is necessary to read from VRAM whilst the 80 column card is present and selected (useful as function key data is stored in VRAM) then reset bit 2 of scratch location FB45H (PCFLGS), perform the MCAL C2 (with BC passed as the VRAM address) and then set bit 2 of FB45H (PCFLGS) on return.

Other changes from MOS 1.1

1. 80 column card module (selected with Ctrl P (code 10H)).

2. Direct cursor addressing (selected with code IDH), the following 2 bytes output set the x and y cursor coordinate respectively.

3. Inverse characters (Toggle on Ctrl W (Code 17H)).

4. The interrupt routines have moved up 9 bytes on MOS 1.2 from FC00H to allow for the 80 column buffer in scratch.

   Note: Programs which use interrupts must reprogram the interrupt vectors FB00H to FB13H to vector into main memory and not use the current interrupt routine area FC00H to FC90H as these routines change between versions.

   In addition, if interrupts are generated whilst in ROM, any interrupt routines should be above 7FFFH to prevent vectoring to ROM.

5. On MOS 1.2, Restarts 10H, 18H and 20H are available to the user, but on MOS 1.1 this area contains the MCAL selection code. This could cause compatability problems for software developed on MOS 1.2 using this area, which is intended to be executable on MOS 1.1 also.

6. The graphics characters generated on codes 220d and 252d have been swapped on MOS 1.2 to match the keyboard.

7. Double key generation does not occur on MOS 1.2 on catching a second key as in MOS 1.1

It is advisable that all software generated should be tested on all versions of MOS on which it is intended to run, especially where the software uses interrupts, MCALS and restarts.