# ZEUS MONITOR May 2023

## 8-BIT HOBBY COMPUTER BOOTSTRAP CODE

**Bootup sequence**

At the bootup the Monitor..

1. ..jumps PRIMER ($7F00); copies memory block $0000-$2FFF from bank F (EEPROM) to $8000 (Monitor code); copies memory block $7F20-$7FFF from bank F (EEPROM) to $FC00 (Call table); updates reboot jump pointer ($8002); jumps $8000.
2. .. jumps SETUP ($A000); sets SP and INT table; generates table of variables and pointers at $FE00.
3. ..initiates IOs; tests IO ports then prints and sends to UART POST letters "S, "P", "G" for SIO, PIO, GPIO modules respectively if detected in the system.
4. ..initiates lowmem banks 0-E (if present), i.e. copies memory block $8000-$8070 to $0000 of each bank in order to keep RST and NMI primers functional whatever bank is ON; counts number of available memory banks in the system, enumerates them (writes bank ID to $0007) and prints (in hex) the calculated number of banks.
5. ..switches to lowmem bank E; updates and prints system register state ($FE81).
6. ..sets INT mode 2; sends "OK" to UART; enters HALT state and awaits for interrupt.

**List of implemented commands**

### >clr

Fills most of the screen (everything except command line) with background color.

### >dump (saddr)

Dumps on the screen 0x70 bytes starting from specified source memory address.

### >send (saddr) (nbytes)

Sends to UART specified number of bytes starting from specified source memory address.

### >load (daddr) (byte1) (byte2)…

Writes specified byte set to specified destination memory address.

### >move (daddr) (saddr) (nbytes)

Copies data block of specified number of bytes from source memory address to destination memory address.

### >jump (daddr)

Sets Program Counter register (jumps) to specified memory address.

### >exec (byte1) (byte2)…

Executes specified byte set. By default, saves the byte set augmented with 0xC9 (RET) to $0100.

### >sysl (nibble)

Sets system register low nibble value. Doesn't affect system register high nibble value. The command is intended for memory bank switching with no effect on high nibble bits.

### >sysh (nibble)

Sets system register high nibble value. Doesn't affect system register low nibble value. The command is intended for sys reg bits control with no effect on memory bank switching.

### >out (port) (value)

Outputs specified byte value to specified IO port.

### >inp (port)

Reads register byte from specified port and prints it.

### >crc7 (byte1) (byte2) …

Calculates crc7 sum augmented with bit0 = 1 (check SD phys. layer specs) for specified byte set.
By default saves the byte set (the message) ended with calculated crc7 byte to $0100.

**Table of IO ports**

| port | description |
|---|---|
| Fxh | SYSR register (write only) |
| 00h | UART channel data (SIO) |
| 01h | PS/2 channel data (SIO) |
| 02h | UART channel instructions (SIO) |
| 03h | PS/2 channel instructions (SIO) |
| 10h | TFT + SD controls data (PIO) |
| 11h | TFT data bus data (PIO) |
| 12h | TFT + SD controls instructions (PIO) |
| 13h | TFT data bus instructions (PIO) |
| 20h/**24h**/28h/**2Ch** | channel A data (GPIO) |
| 21h/**25h**/29h/**2Dh** | channel B data (GPIO) |
| 22h/**26h**/2Ah/**2Eh** | channel A instructions (GPIO) |
| 23h/**27h**/2Bh/**2Fh** | channel B instructions (GPIO) |

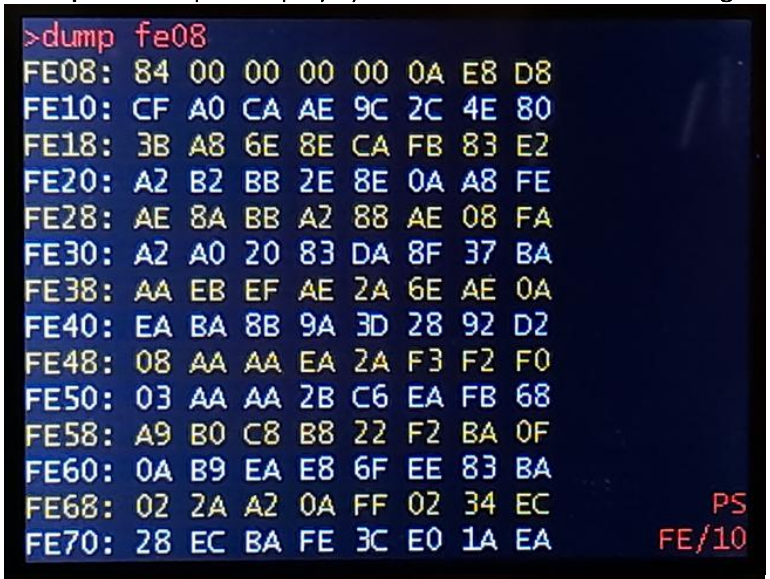
**Table of variables and pointers ($FE00h)**

| address | description | state on reset |
|---|---|---|
| FE00h | font table pointer | 8200h |
| FE02h | keyboard scan codes table pointer | 9200h |
| FE04h | keyb buffer pointer | FD00h |
| FE06h | UART buffer pointer | 0100h |
| FE08h | font color (R=0080h, Y=0084h, W=1084h) | 0080h |
| FE0Ah | background color | 0000h |
| FE0Ch | TFT char position row/col | 0000h |
| FE80h | prev keyb char | 00h |
| FE81h | system register state | FFh |

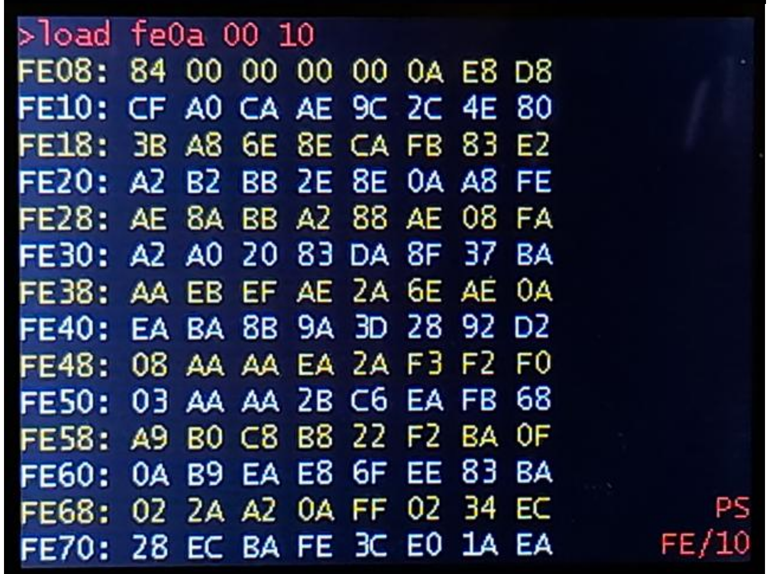
**Table of bootload memory blocks (highmem bank)**

| address | memory block description | Call table range |
|---|---|---|
| 8000h | page 0 | |
| 8100h | interrupt vectors table | |
| 8200h | font table (8x16) | |
| 9200h | keyboard scan codes table | |
| 9300h | bios subroutines | FC00h – FC2Ch |
| 9500h | command line parser | FC30h – FC4Ch |
| 9700h | command routines | FC50h – FC9Ch |
| 9B00h | SD command routines | FCA0h – FCDCh |
| A000h | setup | |
| FC00h | call table | |
| FE00h | table of variables and pointers | |
| FF00h | stack | |

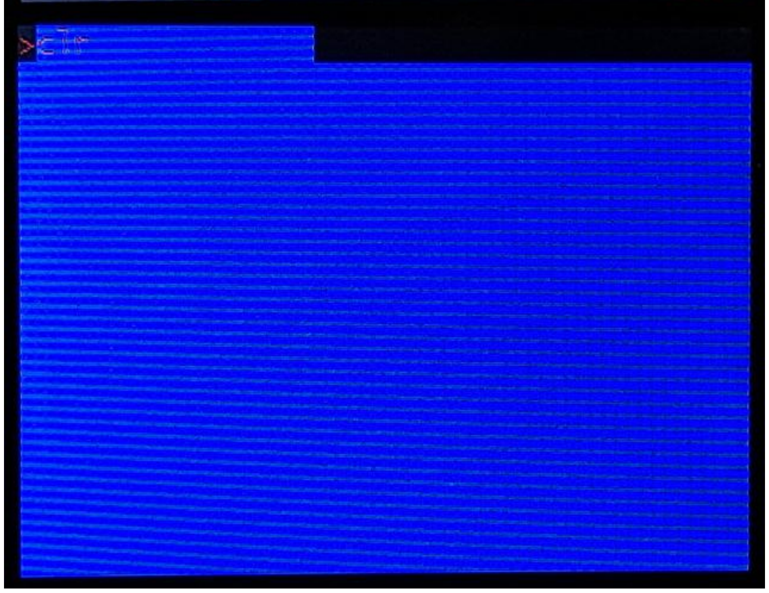
**Example 1** Dump to display system variables block and change background color.



```
>dump fe08
FE08: 84 00 00 00 00 0A E8 D8
FE10: CF A0 CA AE 9C 2C 4E 80
FE18: 3B A8 6E 8E CA FB 83 E2
FE20: A2 B2 BB 2E 8E 0A A8 FE
FE28: AE 8A BB A2 88 AE 08 FA
FE30: A2 A0 20 83 DA 8F 37 BA
FE38: AA EB EF AE 2A 6E AE 0A
FE40: EA BA 8B 9A 3D 28 92 D2
FE48: 08 AA AA EA 2A F3 F2 F0
FE50: 03 AA AA 2B C6 EA FB 68
FE58: A9 B0 C8 B8 22 F2 BA 0F
FE60: 0A B9 EA E8 6F EE 83 BA
FE68: 02 2A A2 0A FF 02 34 EC          PS
FE70: 28 EC BA FE 3C E0 1A EA       FE/10
```

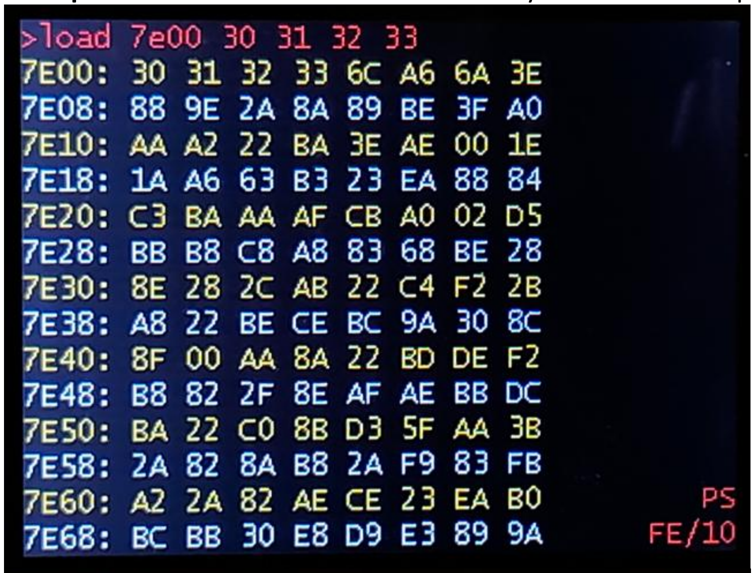


```
>load fe0a 00 10
FE08: 84 00 00 00 00 0A E8 D8
FE10: CF A0 CA AE 9C 2C 4E 80
FE18: 3B A8 6E 8E CA FB 83 E2
FE20: A2 B2 BB 2E 8E 0A A8 FE
FE28: AE 8A BB A2 88 AE 08 FA
FE30: A2 A0 20 83 DA 8F 37 BA
FE38: AA EB EF AE 2A 6E AE 0A
FE40: EA BA 8B 9A 3D 28 92 D2
FE48: 08 AA AA EA 2A F3 F2 F0
FE50: 03 AA AA 2B C6 EA FB 68
FE58: A9 B0 C8 B8 22 F2 BA 0F
FE60: 0A B9 EA E8 6F EE 83 BA
FE68: 02 2A A2 0A FF 02 34 EC          PS
FE70: 28 EC BA FE 3C E0 1A EA       FE/10
```

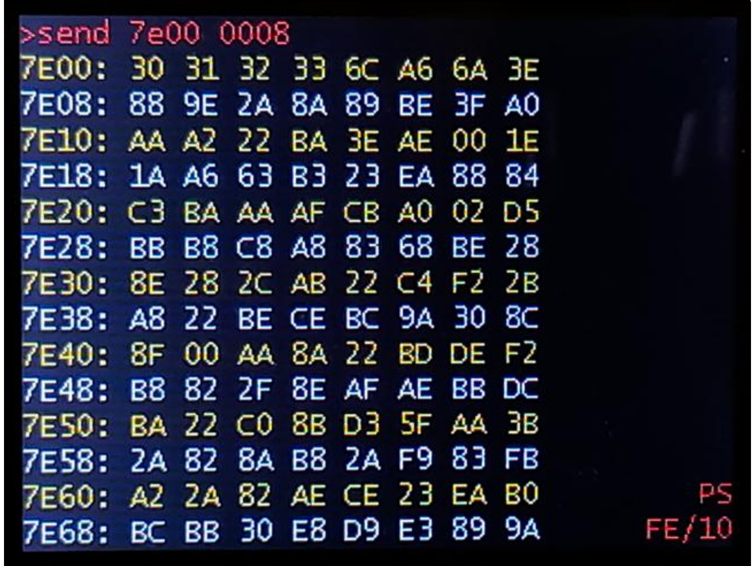


```
>[illegible]
```

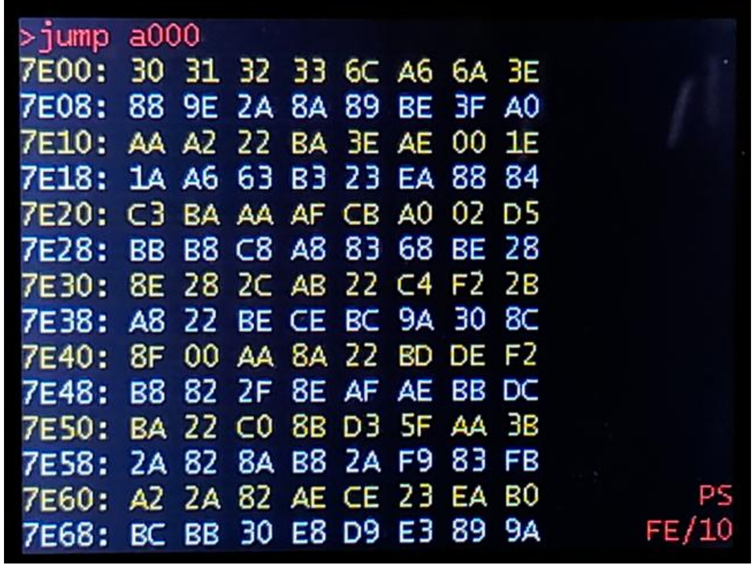
**Example 2** Load a data block to free memory address and output it to UART, then jump to the boot address.



```
>load 7e00 30 31 32 33
7E00: 30 31 32 33 6C A6 6A 3E
7E08: 88 9E 2A 8A 89 BE 3F A0
7E10: AA A2 22 BA 3E AE 00 1E
7E18: 1A A6 63 B3 23 EA 88 84
7E20: C3 BA AA AF CB A0 02 D5
7E28: BB B8 C8 A8 83 68 BE 28
7E30: 8E 28 2C AB 22 C4 F2 2B
7E38: A8 22 BE CE BC 9A 30 8C
7E40: 8F 00 AA 8A 22 BD DE F2
7E48: B8 82 2F 8E AF AE BB DC
7E50: BA 22 C0 8B D3 5F AA 3B
7E58: 2A 82 8A B8 2A F9 83 FB
7E60: A2 2A 82 AE CE 23 EA B0          PS
7E68: BC BB 30 E8 D9 E3 89 9A       FE/10
```

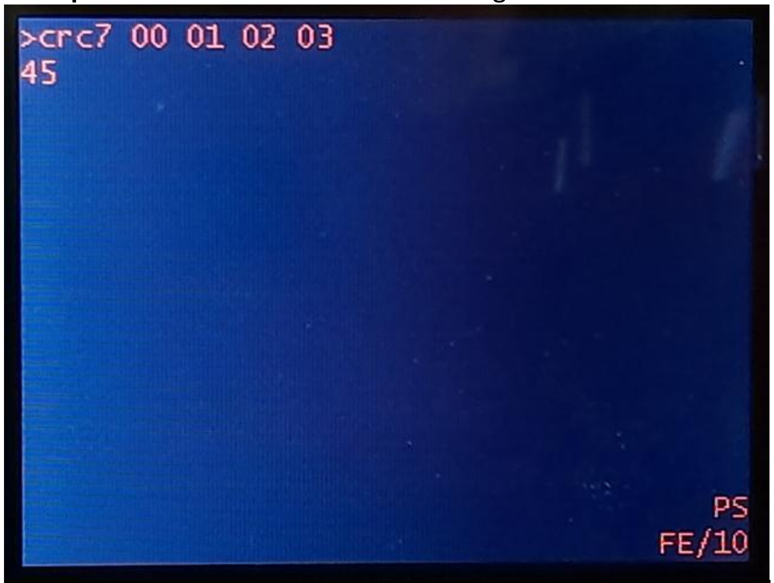


```
>send 7e00 0008
7E00: 30 31 32 33 6C A6 6A 3E
7E08: 88 9E 2A 8A 89 BE 3F A0
7E10: AA A2 22 BA 3E AE 00 1E
7E18: 1A A6 63 B3 23 EA 88 84
7E20: C3 BA AA AF CB A0 02 D5
7E28: BB B8 C8 A8 83 68 BE 28
7E30: 8E 28 2C AB 22 C4 F2 2B
7E38: A8 22 BE CE BC 9A 30 8C
7E40: 8F 00 AA 8A 22 BD DE F2
7E48: B8 82 2F 8E AF AE BB DC
7E50: BA 22 C0 8B D3 5F AA 3B
7E58: 2A 82 8A B8 2A F9 83 FB
7E60: A2 2A 82 AE CE 23 EA B0          PS
7E68: BC BB 30 E8 D9 E3 89 9A       FE/10
```

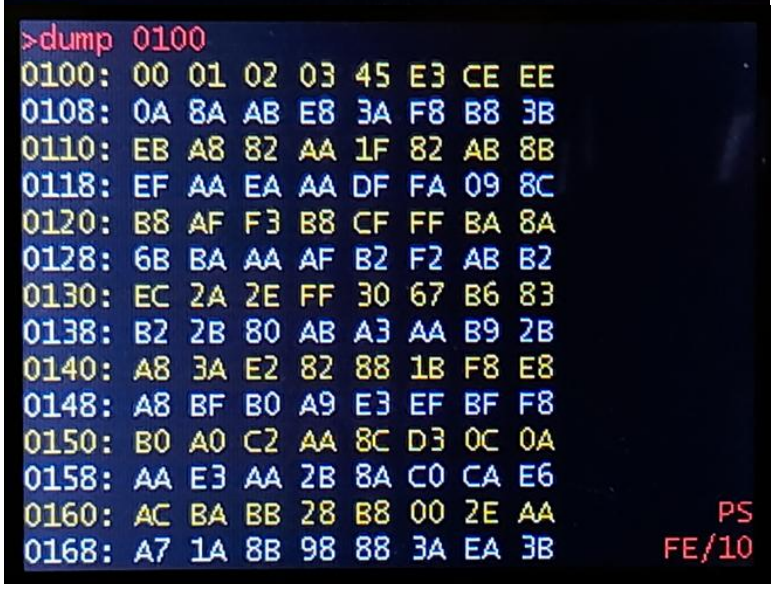


```
>jump a000
7E00: 30 31 32 33 6C A6 6A 3E
7E08: 88 9E 2A 8A 89 BE 3F A0
7E10: AA A2 22 BA 3E AE 00 1E
7E18: 1A A6 63 B3 23 EA 88 84
7E20: C3 BA AA AF CB A0 02 D5
7E28: BB B8 C8 A8 83 68 BE 28
7E30: 8E 28 2C AB 22 C4 F2 2B
7E38: A8 22 BE CE BC 9A 30 8C
7E40: 8F 00 AA 8A 22 BD DE F2
7E48: B8 82 2F 8E AF AE BB DC
7E50: BA 22 C0 8B D3 5F AA 3B
7E58: 2A 82 8A B8 2A F9 83 FB
7E60: A2 2A 82 AE CE 23 EA B0          PS
7E68: BC BB 30 E8 D9 E3 89 9A       FE/10
```

**Example 3** Calculate crc7 sum of a message and save it all to 0x0100.



```
>crc7 00 01 02 03
45
                                        PS
                                     FE/10
```



```
>dump 0100
0100: 00 01 02 03 45 E3 CE EE
0108: 0A 8A AB E8 3A F8 B8 3B
0110: EB A8 82 AA 1F 82 AB 8B
0118: EF AA EA AA DF FA 09 8C
0120: B8 AF F3 B8 CF FF BA 8A
0128: 6B BA AA AF B2 F2 AB B2
0130: EC 2A 2E FF 30 67 B6 83
0138: B2 2B 80 AB A3 AA B9 2B
0140: A8 3A E2 82 88 1B F8 E8
0148: A8 BF B0 A9 E3 EF BF F8
0150: B0 A0 C2 AA 8C D3 0C 0A
0158: AA E3 AA 2B 8A C0 CA E6
0160: AC BA BB 28 B8 00 2E AA        PS
0168: A7 1A 8B 98 88 3A EA 3B     FE/10
```