Emu71/DOS Tips

Note: in all this document, Emu71 means "Emu71/DOS"

1. General tips

- The ON-/ sequence can be launched by pressing ctrl-/ (/ is the divide key in the numeric pad) or ctrl-pageup if you are using a laptop without separate numeric pad. The INIT 2 sequence (ROM test) doesn't show legible results to due fast processing, the Emu71 debugger command 'c' can be used instead.

- The CALC mode works, although not very useful in my opinion. There is no CALC key, but the CALC mode can be entered with [f][,], as on the real HP-71B.

- To disable the auto-shutdown feature, set flag -3 (SFLAG -3). Otherwise, Emu71 will terminate after 10 minutes of inactivity.

- To load a HP-71B binary raw files (sometimes called LIF files, because they include a LIF directory entry header) from a PC file into Emu71:
copy the file to emu_in.dat, then do in Emu71:
  COPY :DOSLINK
Conversely, to create a binary raw file from Emu71, do:
  COPY file TO :DOSLINK
then copy the emu_out.dat file with a relevant name.
Don't forget to either exit Emu71 or issue a HP-IL clear command (CLEAR) to close the emu_in.dat and emu_out.dat files before accessing them from Windows.

- To share files between Emu71 and HP-71B:
Use ILPer and share one disk image file between Emu71 and ILPer.
Then save the file on one side, and recover it from the other side.

- The HP-71B operating system manages 8 ports 0 to 7, but only ports 0 to 5 are accessible to the user in the real HP-71B. Emu71 doesn't have this limitation and manages all the 8 ports.

- It is possible to overwrite the default file name of the 64k operating system ROM (hardconfigured at address 0) by including the following line in emu71.ini :
  0 HRD 64 rom1bbbb.bin
Use of port 0 is mandatory.
This can be used to select different ROM versions, or to load the Diagnostic ROM for instance.

- As a side effect of previous tip, it is not possible to declare the Forth or HP41 Translator hardconfigured ROM in port 0 (anyhow this was not recommended). Use only ports 1 to 7 for the Forth ROM.

- The sep71.add file holds the HP-71B Supported Entry Points. If present in current Emu71 directory and if Emu71 is launched with /d option, then the address mnemonics will be used in disassembly listings and can also be used in debugger command arguments.

- Emu71 now supports the EEPROM module type. EEPROM modules are declared by using the 'EEP' tag instead of 'ROM' in the ini file:
  for instance:
    4 32 EEP myrom.bin
  EPROM ports are displayed by SHOW PORT as type 3.
  The HP-71B treats EEPROM modules in the same way than ROM modules (I didn't find any difference).
  Emu71 treats EEPROM ports as RAM ports in the sense that any change made inside Emu71 (using an unrestricted POKE for instance) is saved in the image file.
  This can be used to permanently patch a ROM image inside Emu71, by temporarily setting it as EEPROM in the ini file.

2. Advanced Emu71 information

- The I/O and display area from 20000 to 2FFFF is actually a 32k RAM area.
  Locations 20000-2002F are usually used by the HP-IL mailboxes.
  Locations 2E100-2E3FF hold the display driver and the timers.
  Locations 2F000-2F3FF are reserved for Emu71 (there are normally 0 in the real HP71B):
  locations 2F000-2F004 and 2F008-2F00C hold respectively the current date and time at Emu71 startup, and can be used to set the HP-71B real time clock (see the MAJDATE utility).
  Locations 2F400-2FFFF hold the first 1.5kb HP-71 system RAM.
  The area from F0000 to FFFFF is also a 32k RAM area with partial overlap with the I/O RAM area. The hardwired debugger ROM signature is at F0000 and the area from F2000 to FFFFF is a mirror of the I/O area 20000 to 2DFFF.

- To assembly level programmers:
  The emulated CPU is compatible with the classic 1LF2/1LK7 Saturn processors used in the HP-71B. Some minor differences exist:
  - the behaviour of some arithmetic operations in decimal mode on digits greater than 9 ('A' to 'F') may give different results and carry flag state.
  - the INTON, INTOFF, and RSI opcodes are ignored, because interrupts are not simulated,
  - Emu71 partially supports the extended opcode set as found in the later 1LR2 Saturn processors (such as in the HP48/49 calculators).
  - Emu71 CPU has 8 scratch registers R0 to R7, instead of the 5 Saturn registers R0 to R4.
  - Emu71 CPU has a 64-level stack, instead of the Saturn 8-level stack. Memory lost conditions due to stack overflow are no more very likely.

- Emu71 doesn't emulate the display/keyboard at low level: Emu71 takes the display content from the alpha buffer, not from the bit-mapped area, and puts keystrokes into the keyboard buffer but doesn't emulate the IN/OUT registers according to the keyboard.

- Emu71's debugger uses the RTNSXM opcode (code 00h) to set breakpoints. It is possible to set breakpoints into "ROM" areas, because all the codes are actually in RAM.

- Trace modes: actually, Emu71 provides 3 trace options:
   /t1: trace system configuration opcodes (default, documented option)
   /t2: trace HPIL module firmware commands, unsupported commands end with a '!'
   /t4: trace read/write access to the HPIL mailbox

- HPIL monitor modes:
   /m1: HPIL scope mode (default, documented option)
   /m2: HPIL display is listen only mode (doesn't take an HPIL address, displays all data frames)
   /m3: log all outputs to the HPIL display and printer to the disp.log and printer.log files

- Hard-configured debugger ROM details:
  The hard-configured debugger is supposed to be a ROM hard-addressed at F0000, which was likely to be used in conjunction with the Forth/Assembler (this is plausible due the presence of the DEBUG keyword in this ROM). It was never released to the public, later on a RAM-based debugger (HP82478) was available instead.

  Code for the DEBUG keyword in the Forth/Assembler ROM is:
  ```
  C6582 3474244      LC(5)  #44247     ; debugger ROM signature ('DBG')
  C6589 D5           B=C    A
  C658B 137          CD1EX
  C658E 1F4000F      D1=(5) #F0004
  C6595 143          A=DAT1 A
  C6598 135          D1=C
  C659B 8A421        ?A<>B  A / GOYES #C65B0
  C65A0 3484A80      LC(5)  #08A48
  C65A7 06           RSTK=C
  C65A9 8D0100F      GOVLNG #F0010
  ```

  Emu71 initializes the memory at F0000 with:
  ```
  F0000 85A374244402   ; ' DBG:X'     debugger version for VER$
  F0010 00             RTNSXM
  ```

  Emu71's debugger takes control after executing the RTNSXM opcode at F0010, so PC is set to 08A48, which is the NXTSTM entry point.

- HP82478 debugger
  Emu71 now also supports the RAM-based debugger (HP82478).
  It manages it by checking the VECTOR (2F43C) location: if 0, Emu71 assumes that the debugger is not present and manages the display and the keystrokes in the normal way, otherwise if the VECTOR value is INTVEC (=x0159), then it assumes that the debugger is present in the port pointed by VECTOR and tests the MANHOL (x08B2) location in DBGLEX1A. Then it manages the display and the keystrokes in the normal or debugger way accordingly. Emu71 also handles the RECOVER functionality.
  The [ON][g] keystroke sequence is not supported.

3. Advanced information on memory layout:

2xxxx space:
20000-2002F: IL mailboxes (softwired) *
20030-200FF: reserved for other I/O mailboxes (~100 bytes)
20100-2DFFF: free volatile scratchpad space (**)
2E000-2E0FF: free (128 bytes)
2E100-2E3FF: display driver and timers *
2E400-2EFFF: free (~1.5k)
2F000-2F00F: reserved for Emu71 date setting
2F010-2F01F: reserved for platform/emulator/cpu identification
2F020-2F1FF: free for other Emu71 data storage (~200 bytes)
2F200-2F3FF: reserved for Emu71 extended CPU registers
2F400-2FFFF: 1.5k HP-71 system RAM *

(*) genuine HP-71B
(**) Note that 2C000-2C01F is the card reader space (hardwired)
If the CR detection is patched, then the space 20100-2e100 is free (28k)

The area 2E000-2FFFF is saved in the sys71.dat state file.

Platform/emulator/cpu information:

2F010 Platform ID
 0: HP-71B
 1: Emu71 (DOS)
 2: Emu71w (Windows)
 3: Emu71m (Mobile)
2F011 Saturn Opcode Level
 0: 1LF2 (HP-71B set)
 1: 1LK7 (HP-28C, PC=(A) and RSI added)
 2: 1LR2 (HP-48S/G)
 3: Emu71 extended set
2F012 Host CPU type
 0: Saturn
 1: x86 (Intel 16 bits)
 2: i32 (Intel 32 bits)
 3: SH3
 4: ARM
 5: AMD64
2F013 Emulator version
2F014 Emulator revision

Emu71 extended CPU registers:
2F200-2F22F: Emu71 extended registers R5 to R7
    (3*16=48 nibbles)
2F240-2F3FF: Emu71 extended Stack (56 entries)
  each entry is 8 nibble long

Support of the 1LR2 Saturn processor opcode set (such as in the HP48/49 calculator):

Emu71 supports:
opcodes 808xx..: LAHEX h, rBIT=n, ?rBIT=n - r={A,C}, 0<=n<=1
opcodes 818xxx: r=r+CON(n) f, r=r-CON(n) f - r={A,B,C,D}, 1<=n<=16
opcodes 819xx: rSRB f - r={A,B,C,D}
opcodes 81Bx: PC=r, r=PC, rPCEX - r={A,C}

Emu71 does not support:
opcodes 81Axxx: Rn=r f, r=Rn f, rRnEX f - r={A,B,C,D}, 0<=n<=4