

SMART Card V3 for ZX Spectrum by Phil Ruston

www.retroleum.co.uk

Full Manual 17-4-2022 for CPLD core v3.1, BootROM.v03,
Game Launcher.v02 & DebugROM.v02

(Download: www.retroleum.co.uk/smart.zip for latest files)

WARNING: As with any Spectrum interface, the power should be disconnected before attaching or removing the SMART Card otherwise damage can occur to the Spectrum and / or interface. Please ensure the Spectrum's edge connector contacts are clean for reliable operation. Do not connect or disconnect anything to the SMART card when the power is on. The SMART Card was not designed to be used in conjunction with any other Spectrum interface.

Brief Description:

The SMART Card is an expansion interface PCB for the Sinclair ZX Spectrum, it offers ROM substitution, SD card support, a Kempston joystick interface and buffer SRAM. It is intended primarily as a simple low-cost game loader / freezer / diagnostics tool.

The interface forces the Spectrum to boot from one of sixteen external ROMs instead of its internal BASIC ROM. In normal operation, the first ROM (Boot ROM) is always executed at power up, though its code contains a switching mechanism which can select one of the other fifteen ROMs automatically (or manually) depending on whether the GOTO feature is set (or the Zero key is held on power up). As supplied, the GOTO feature is set to Slot C which contains the Game Launcher ROM.

The SMART Card's external ROM provides a way for test software to run even when the Spectrum's ROM and RAM are faulty. To this end, a diagnostic ROM is supplied in ROM Slot B. You can use the "Mode" switch on the back of the PCB to force the SMART Card to boot this slot directly, providing a way to quickly access diagnostic software on faulty Spectrums. (The GOTO setting is irrelevant when the switch is set to "Diag" as the Boot ROM in Slot A is completely bypassed in this mode).

As supplied, the ROM slots are configured as follows:

- Slot A: "Boot ROM" - ROM Menu / Manager program. Maintains an index of the ROMs installed.
- Slot B: "DiagROM" - Spectrum test software
- Slot C: "Launcher" - Game loader / freezer
- Slot D: "DebugROM" - Contains support code for the freezer features of the game launcher.
- Slots E-P : Empty.

(To manually select a ROM, hold down the Zero key on power up to go to the ROM Menu)

The V3 SMART Card automatically detects the Spectrum model so should work on all the standard UK Spectrums (48 / 128 / +2)(AB) / +3). It has not been tested on overseas models or clones and it is not advisable to use it in conjunction with any other interface.

Buttons, Switches and LEDs:

- The left button resets the system. If the reset switch is held during power-up, the SMART Card's external ROM is disabled so the Spectrum boots to the internal Sinclair ROM – this persists until the power is removed.
- The right button issues a Non-Maskable Interrupt (NMI) . When the NMI button is pressed whilst playing a game loaded from the launcher, a menu will appear with various options – details below. For other ROMs, the NMI button will trigger whatever NMI handling code is in that particular ROM.
- The slide switch selects the operating mode. “Norm” is normal mode (SMART Card boots from Slot A, and observes the GOTO setting). “Diag” forces the SMART Card to boot directly from (and is locked into) SLOT B where the diagnostic ROM usually resides
- The blue LED lights up whenever an external ROM image is active (when the internal Sinclair ROM is in control this LED is off).
- The green LED flashes during SD Card activity (and upon release of the NMI button for Core v3.1)

Joystick Interface:

The joystick port is wired as a standard Kempston (Port 31) format - 2 fire buttons are supported. A small amount of power is available on pins 5 and 7 for joysticks that require it (EG: Megadrive pads). The joystick port can be disabled using the Config option in the Boot ROM.

Disabling the SMART Card / Accessing Sinclair BASIC:

The interface can be disabled in various ways without removing it.

One-time options:

- Hold the reset switch on power up (and release after 1 second) The card is disabled until the power is removed and is usually only necessary for programming a blank or corrupted SMART Card.
- In the Game Launcher, press Caps Shift + Space. You will still be able to use the NMI button features.
- At the Boot ROM menu (hold the Zero key on power up) press “S” on the ROM menu screen. (The NMI button features will NOT be available because they are part of the Game Launcher ROM which will not have run).

“Permanently”

- Hold the Zero key whilst powering up to go to the ROM menu. Press Enter to go to the ROM Manager, then choose option 7 – “Config and Tools Menu”. Finally, press “2” to disable or re-enable the SMART Card. When the SMART Card is disabled the Spectrum will boot from its internal ROM (unless Zero is held to go to the ROM menu). The Kempston joystick port will still be usable unless it too is disabled. Note: When the card is in Diag mode, this setting is ignored (because the interface then skips the Boot ROM and boots directly from the ROM in Slot B).

Boot ROM (ROM Menu / Manager) in Slot A

When starting up, the boot ROM tests to see if the Zero key is held, if it is then the ROM menu is displayed (the menu system requires 48K RAM or more). If Zero is not pressed, the code checks to see if the GOTO feature is set – if it is then a ROM slot is automatically selected and the system resets (thus booting the desired ROM). To remove the GOTO permanently (and have the system boot to the ROM menu each time) just set it to go to Slot A with option 6 in the ROM Manager.

ROM Manager:

On pressing ENTER on the ROM menu screen, the ROM Manager options appear. This option allows ROM slots to be loaded, erased, copied, renamed etc - most of the options are self-explanatory. Note that there is a special option (1) for updating the Boot ROM (IE: The ROM menu / manager program itself) - this is to protect the ROM index which is also located in SLOT A.

Notes:

- Video glitches during FlashRAM writing are normal (an artefact of the EEPROM programming protocol)
- The Config option allows the joystick port (and SMART Card) to be disabled, should that be desired.

If the CPLD core is v3.1 or above, an option appears in the main menu to manage Spectrum 128 ROM groups. When a ROM is tagged as the base for a group and that ROM is booted (either manually or via the GOTO feature) the SMART Card will switch ROMs in the group based on the Spectrum 128 control bits in ports \$7FFD and \$1FFD. Note: Writing or deleting a ROM to a bank deletes any group tag it may have.

If for any reason the ROM Manager needs to be restored, it can be reloaded from tape via the EAR socket. For files and instructions see the troubleshooting section of this document.

Diagnostic ROM – Default Slot B

This ROM can be used to test and diagnose faults with Spectrums. It can be started from the ROM menu like any other ROM, however since the Spectrum under test may have faults that prevent user interaction it is best to use the Diag Mode switch to force the SMART Card to boot slot B directly. (The DiagROM itself does not need any good RAM to start). See the Diagnostic ROM manual for more information.

Game Launcher – Default Slot C

This ROM is a game loader / freezer. You can navigate the files on your SD card with the cursor keys, Q,A,O and P and Enter, the cursor keys or with a joystick. The SD card needs to be formatted to FAT16. (.sna files and most .tap files are supported but please note: some .tap files may not work - see the technical section for more info about Spectrum game file types.)

The following key combinations are active in the file browser:

- Caps Shift+Space (Break) = Boot to Sinclair BASIC. The NMI button features will be available. The Sinclair physical tape loading routine will be in play, unless a virtual tape has been inserted with the NMI meny "I" option.
- Symbol Shift + D = Delete a file
- Symbol Shift + N = Make a new folder
- Symbol Shift + 4 = Set Spectrum 128 to 48K mode until reset
- Symbol Shift + L= Lock Spectrum 128 to 48K mode until power off (or symbol shift + L is pressed once more)

Notes: .SNA files are indicated with a camera icon (Cyan for 48K, White for 128 snapshots). .TAP files have a tape icon. (It is not possible to determine from the file data whether a .tap is meant for the 16K, 48K or 128K Spectrum so all .tap icons are shown in the same colour.)

Debug ROM – Default Slot D

This ROM contains extra support code for the Launcher, specifically the hacking tools. It does nothing when booted manually (except show a notice).

NMI Menu

The following options are available on pressing the NMI button after loading a .sna (snapshot) file (or from BASIC)

X - EXIT TO PROGRAM (IE: Un-freeze)

S – SAVE A SNAPSHOT (.sna file) of the Spectrums memory.

Creates a .sna file - ie: a snapshot of the program currently running. This can be loaded like any other .sna file from the main browser. On the Spectrum 128 you'll be asked if you want to save a 128K snapshot or a 48K snapshot (but if a 48K snapshot was loaded or the machine is locked to 48K mode then the only option will be a 48K save so prompt will appear)

On selecting this option a requester appears for the filename. You can browse the SD Card by deleting [Caps shift + Zero] out of the filename entry box. Pressing Delete whilst browsing brings back the filename requester. You can cancel the operation whilst browsing with BREAK [Caps Shift + Space] or entering a blank filename. If you select a file whilst browsing, you'll be asked if you want to replace it. You can make a new folder with "Symbol Shift + N"

Note: Saving can be quite slow, especially on small capacity SD Cards and when saving Spectrum 128 snapshots. Bear in mind the 128 .SNA file format does not save the contents of port \$1FFD (found on the Spectrum +2A/B and +3) so software that relies on this port may not restart correctly.

H - HACKING DEPARTMENT

Brings up a command line window where Pokes etc can be entered. Please see details in the Hacking section below.

I - INSERT A NEW TAPE

Points the internal BASIC LOAD intercept system to a particular .tap file (rewound to the start)
Not usually relevant when using .sna files but can be useful should an unfrozen .sna file attempt to load from tape (and you'd prefer it to load from .tap on the SD Card).

Additionally, the following options are available after loading a .tap file, or after a tape has been inserted with the "I" option above:

R - REWIND TAPE

Sets the internal .tap position right back to the start

N - NOTE TAPE POSITION

Makes a note of the current .tap position for the "C" command. This can be useful for multi-loaders that require a rewind to a certain position.

C - CHANGE TAPE POSITION

Sets the internal .tap position to that saved by the "N" command

E – EJECT TAPE

Disables the SD card loading routines allowing physical tapes to be loaded from the EAR socket.

A note about NMI limitations:

Some games may not restart if frozen at certain points – this is unavoidable as they will have been programmed with very tight constraints regarding stack use. However, freezing during the title screen or whilst paused will usually get around this.

Hacking / Pokes Department:

When selected from the NMI menu, a terminal-like window appears showing the status of the CPU registers. More technical commands to be entered here. Note: All values - apart from when the P command (Peek / Poke) is used - are in hexadecimal.

Command List:

? - HELP (shows a summary of commands)

B - BANK (i.e.: Sets the bank of memory located at \$C000-\$FFFF in Spectrum 128s)

Usage: B *[bank]*

Notes: *[bank]* is 0 to 7

If no parameter is supplied, the current bank is displayed

The setting only affects the hacking commands, the original value from the frozen program is restored on exit.

G - GOTO (exits the hacking window and jumps to the address provided)

Usage: G *address*

D – DISASSEMBLE (Shows Z80 disassembly from one address to the other)

Usage: D *[address]* *[[address]]*

Notes: If no address is supplied, the disassembly continues from where the program stopped (or previous line)

If only one address is supplied, the disassembly runs from that location onwards

16 lines of code are shown per page, between each press SPACE to stop or any other key to continue

Data between \$0 and \$3FFF comes from the Internal Spectrum ROM

Data between \$4000 and \$5AFF comes from the display buffered when the NMI button was pressed

Non-standard Z80 instructions may not be recognized

L - LOAD (Reads in raw bytes from a file on the SD card to memory)

Usage - L *location*

Notes: You can cancel the LOAD by pressing BREAK [Caps Shift + Space]

If location is the display RAM [\$4000-\$5AFF], the new data will not be visible until the frozen program is restarted.

M - MEMORY MONITOR (shows bytes of memory in hex and ASCII)

Usage: M *[location] [byte1] [byte2] [byte3] ... and so on..*

Notes: If [bytes] are not supplied, the page of 128 bytes from [location] is displayed
If location is not supplied, the display continues from the end of the last page
If a byte in the screen area [\$4000-\$5AFF] is changed, it will not be visible until the frozen program is restarted.

P - PEEK / POKE (Allows cheats to be entered for games, in decimal format)

Usage: P *address [value]*

Notes: For this command only, the parameters [address] and [value] are in decimal.
If [value] is not supplied, the value at [address] is displayed, i.e.: A PEEK is performed.
If a byte in the screen area [16384-23295] is changed, it will not be visible until the frozen program is restarted.

R – REGISTERS (Shows the CPU registers - same as when entering the hacking window)

Notes:
The values shown were taken from the point when the NMI button was pressed, however:
The PC address shown is popped from the Stack (the Z80 pushes it there as part of the NMI response)
The SP value shown is that after the PC address was popped (so it as if no NMI was received and the program was just halted).
On the Spectrum 128 (if not in 48K mode), the RAM bank, ROM and video page bits are also shown.

S - SAVE (Writes bytes from memory to a new .bin file on the sd card)

Usage: S *location length*

Notes: You can browse the SD Card by DELETING [Caps shift + Zero] out of the filename entry box.
Pressing DELETE whilst browsing brings back the filename requester.
If you select a file here, you'll be asked if you want to replace it.
You can cancel the save whilst browsing with BREAK [Caps Shift + Space] or entering a blank filename.
A screen dump can be made with the command "S 4000 1B00" (Data saved from the screen is taken from the frozen display, not the current visible window.)
You can make a new folder when browsing with "Symbol Shift + N"
Data cannot be saved from the ROM area (below \$4000)

X – EXIT (Back to main NMI menu)

Troubleshooting:

Problem:

Spectrum does not boot when SMART Card is connected or operation is unreliable.

Solution:

It's very important that the Spectrum's edge connector is clean. Use isopropyl alcohol on a cotton bud to clean it, upper and lower sides.

Problem:

On booting (to the Game Launcher ROM) you see a flashing message on the splash screen saying "M1 signal bad – replace CPU"

Solution:

A lot of Spectrum have CPUs which have a faulty /M1 signal. This signal is required by the SMART Card for normal operation. Replacing the Z80 Chip will solve this.

Problem:

On booting (to the Game Launcher ROM) you see a large message saying there's a memory error.

Solution:

This occurs if the Game Launcher ROM was not able to copy data to the SMART Card's onboard RAM – first check that the Spectrum's edge connector is clean (no corrosion). Next check the Spectrum's own RAM is OK with the DiagROM (select with the switch on the back of the PCB). Finally, check the SMART Card's RAM with the program "memtest.bin" found in the Apps folder (Warning: memtest.bin deletes all ROMs on the SMART Card apart from the Boot ROM).

Problem:

SD Card is not recognized.

Solution:

Use a good brand card such as Kingston and Sandisk (preferably 1GB-4GB) and make sure it is formatted to FAT16. If in doubt you can use the SD Card Formatter in the ROM manager's config options (hold ZERO at power on, then Enter, then "9" to find the format command). This may be preferable because Windows will not (by default) format cards bigger than 4GB to FAT16, though it is possible – instructions included elsewhere in this archive. For formatting with a Mac information can be found at at: tinyurl.com/macsdifat16

Problem:

NMI button crashes/resets the Spectrum.

Solution:

- The active ROM must have a valid NMI handler. Ordinary Sinclair BASIC does not have such a routine – however the Game Launcher ROM sets things up so that it takes over when the NMI button is pressed (even if Caps Shift + Space was pressed to go to Spectrum BASIC).

Problem:

Certain games do not load or crash when loaded.

Solutions:

- If using a Spectrum 128 (and you're trying to load a 48K game) try locking the machine to 48K mode (Symbol Shift + L in the file browser) Ultimate games tend to require this - EG: Underwulde etc
- If the problem affects all .sna files, it may be an out-of-spec Z80 - try replacing the CPU.
- Check the Spectrum's memory with the DiagROM.
- Try an alternative version of the game. .Tap files will have had any turbo / protected loading routines replaced with calls to the Standard Sinclair LOAD code. On real hardware it is not possible to cover every possible way this has been implemented.

Problem:

Even when a ROM with a valid NMI handler is active, the NMI button crashes the Spectrum or does unexpected things.

Solution:

- Some Z80 CPUs do not seem to handle non-maskable interrupts correctly. Replacing the CPU invariably fixes this.

Problem:

Boot ROM or other ROMs do not run.

Solution:

You can check the data integrity of the EEPROM with the ROM Manager options (if you can get that far). If, for some reason a ROM has become corrupt – simply reinstall it. If the Boot ROM (Slot A) has been corrupted you will need to restore it from tape, as follows (these instructions assume a standard 48K Spectrum is being used).

1. Download the latest files from: <http://www.retroleum.co.uk/smart.zip>
2. Unzip the file and copy the Boot ROM file (EG: "BOOT_ROM.Vxx) from the "Boot ROM" folder onto your SD Card.
3. Connect the Spectrum EAR socket to a device that is able to play .wav files loud enough for the Spectrum to pick up.
4. Put the SD Card in the SMART Card. Hold the SMART Card's reset button for 2 seconds whilst powering on the spectrum, then release it – the Spectrum should boot to BASIC.
5. Enter the BASIC command LOAD "" [ENTER]
6. Play the file "Slot A Installer_Vxx.wav" from the "Fresh install from tape" folder. (You can use the .tap version of this .wav file with a PC app such as TAPIR instead if you wish)
7. Follow the on-screen instructions when the program has loaded. (Basically, you'll browse to and select the BOOT_ROM.Vxx file you placed on the SD Card earlier. The border will flash during re-programming.)
8. Upon completion, power off and back on, the card should boot to the ROM Selector.
9. Press Enter to go to the ROM Manager, using option [6] set the GOTO bank back to "C"

Please note: The above procedure will have erased the ROM index (but not the contents of the ROM slots) so you'll want to either manually rename the slots or just reinstall any missing ROMs using the ROM Manager. (By default the DiagROM goes in Bank B, the Game Launcher goes in bank C and the DebugROM goes in Bank D – these can be found in the ROMs folder)

The Technical Section:

Control IO Ports (When decoding ports, all address lines are considered except A4)

\$FAFF (or \$FAEF) – Config Port: WRITE (* Note bit 7 is a set / reset masking mechanism for bits 0:1, 3:6)

- Bit 0 - EEPROM write enable (set = writes enabled, see also bit 7) Cleared on power on / reset button.
 1 - Joystick port enable (set = joystick port disabled, see also bit 7) Cleared on power on only.
 2 - SRAM Control / Full 128 ROM Paging Control ¹
 3 - Selects the bits appearing in port \$FAFF on read [0 = port \$FE / \$7FFD, 1= Core ID / port \$1FFD] ²
 4 - 1 = enable LD_BYTES intercept – see the section below on ROM switching.
 5 - 1 = make LD_BYTES intercept consider the Spectrum 128 ROM bank (in \$7FFD & \$1FFD if applic)
 6 - Set to 1 to disable SMART Card control ports until Reset, LD_BYTES intercept or NMI
 7 - Controls whether writes to bit 0 and 1 are set or reset ³

¹ When bit [2] is written with bit 7 clear, it resets the SMART Card's SRAM enable flag on the next CPU read from external ROM in the address range \$0000-\$1FFF (this option is automatically reset when SRAM is paged out)

In CPLD core v3.1 the following feature was added: When bit [2] is written with bit [7] set, the SMART card will switch the ROM based on the contents of Spectrum port \$7FFD (and \$1FFD on the +2AB/+3) In this case, bit [0] of the SMART Card's ROM select port is ignored on the Toastrack (and +2) and bits [0:1] are ignored on the +2AB/+3. (The upper bits of the SMART Card's ROM select port still select the "base ROM"). The only way to clear this option is to reset the Spectrum.

² Added in CPLD core 3.1 (Core ID bits for 3.1 = binary '001'. Previously returns the same value as the border colour. Set border to black before reading this port and if bits [2:0] return '000' then core is v3.0)

³ This mechanism allows discrete writes to bits without affecting other settings in the same register. EG: Writing \$81 to this port sets the EEPROM write enable flip-flop without changing the joystick enable flip flop (writing \$01 clears the write enable flip-flop.. etc.)

\$FAFF (or \$FAEF) – Register capture port: READ

Returns bits captured from writes to port \$FE, \$7FFD and \$1FFD (if machine is 128+2AB/+3 ⁴)

- Bits: 0:2 – Captured border colour (\$FE [2:0]) if Select * is zero, or CPLD core ID bits otherwise.
 Bit 3:5 – Captured Spectrum 128 RAM Bank (\$7FFD 0:2) if select is zero, bits 0:2 of \$1FFD otherwise)
 Bit 6 – Captured Spectrum 128 Screen Selection (\$7FFD [3]) if select is zero, bit 3 of \$1FFD otherwise)
 Bit 7 - Captured Spectrum 128 ROM Bank (\$7FFD [4]) if select is zero. bit 4 of \$1FFD otherwise)

⁴ "Select" is bit 3 of \$FAFF when writing (ie: OUT \$FAFF, \$88)

Notes: Writes to port \$1FFD are only captured if machine is +2AB, or +3. Port \$1FFD capture was added in CPLD Core release 3.1 (binary '001' in ID bits) - April 2022.

To read version ID (on any V3 core) first set the border to black, set "Select" to 1 and read this port, keeping only bits [2:0]

\$FAFB (or \$FAEB) – External ROM (flash RAM) bank selection / switching control.

Read / write port. Cleared on power on / reset button

Bits: 0:3 - Select the 16KB section of FlashROM that appears to the CPU @ \$0000-\$3FFF*
4 - Write: Select signal on read: 0 = M1 Test Result, 1 = NMI Button Status
5 - Write: Strobe this to reset NMI Flag allowing further interrupts. Reads as Zero **
6 - Write: Strobe this to prime the SMART ROM switch-out system for restarting snapshot files etc. ***
7 - Set to 1 to disable the SMART card's memory (IE: Use Spectrum's own ROM)

* In Diag mode, the value in [0:3] is ignored, Slot B always selected.

** Holding this signal high prevents NMIs from being seen by the Z80. When read, returns Zero. Note: It is not necessary to clear the NMI Interrupt flag with CPLD core 3.1 – the NMI button is debounced and subsequent NMI pulses are ignored for about half a second.

*** See section below on ROM switching for details. When read, returns Zero.

\$FAF7(or \$FAE7) - Data to / from the SD card

Read / write port.

Bit 0:7 Data for SD card

Note: There is no serializer busy flag – Make sure at least 12 3.5MHz Z80 CPU cycles elapse between accesses to this register. (The SPI clock runs at 8MHz.)

\$FAF3 (or \$FAE3) - SRAM selection

Read / Write port. Cleared upon reset.

Bits: 0:3 – Selects which 8KB bank of SRAM appears at \$2000-\$3FFF (when enabled)
4 – Serial TX when written to, Serial RX when read.
5 – AUX SPI_CS signal (see 4x2 header) 1 to select, 0 to deselect (output is inverted by PCB)
6 – SD Card CS control (write 1 to select SD card, 0 to deselect) – also activates green access LED
7 – SRAM enable*. When set, SRAM replaces FlashRAM in memory locations \$2000-\$3FFF.
Note if the SMART card's memory is disabled, this has no effect.

- Note: The onboard FlashRAM chip is type 39SF020. The write protocol for this chip requires address \$2AAA (and \$5555) to be written before each programmed byte (which is why video “glitches” can be seen whilst data is written to the chip). Enabling SRAM at \$2000-\$3FFF prevents the FlashRAM chip being selected for address \$2AAA so it cannot be written to in this mode.
-

*** Notes ***

ROM switching:

- The simplest way of switching the SMART Card ROM manually in and out is via bit 7 of port \$FAFB. When this bit is clear the SMART Card ROM is enabled, and when set the Spectrum's internal ROM is enabled. Switching when code is actually executing from ROM space may be problematic. Bit 7 of port \$FAF3 controls whether or not an 8K page the SMART Card's onboard RAM replaces ROM at \$2000-\$3FFF (this can only occur if the Spectrum's internal ROM is disabled, ie: SMART Card RAM can only replace part of SMART Card ROM, not the internal ROM).
- There are two methods of automatically switching **from** internal Spectrum ROM to SMART Card-based ROM. The first is via intercepting the opcode read at \$056C (for the ROM routine "LD_Bytes") and the other is the Z80's NMI response. In the case of LD_BYTES the actual opcode \$CD is read from the internal ROM ("CALL" for \$056C) but the associated address bytes are read from the SMART Card ie: the ROM switch occurs after the first byte (opcode) is read but before its two address bytes. For compatibility across SMART Card logic cores, the opcode \$CD (CALL) should be placed at \$056c in the SMART Card ROM code. For NMIs, the external ROM is switched just before the Z80 pushes the PC to the stack (ie: after the NMI-response's dummy Opcode fetch) – the instruction at \$0066 is therefore read from the SMART Card-based ROM.
- The automatic mechanism to switch **to** the Spectrum ROM is based on the execution of the next JP instruction following the ROM switch enable being set (strobe Bit 6 of Port \$FAFB high then low). The actual ROM switch occurs after the JP instruction has executed, ie: all 3 bytes of the instruction are read from SMART Card ROM (if code execution is actually within the ROM area, of course)
- In CPLD core 3.1, the ability to switch the external ROM based on the settings of the Spectrum 128s own control ports was added. When the machine is determined to be a +2AB/+3, a 16K ROM from a group of four is paged in at \$0000-\$3FFF, and when the machine is a Toastrack or +2 a 16K ROM is selected from a group of two. See port register \$FAFF bit 2 for details.

Connectors / Pin headers:

The Joystick DSUB-9 pins are connected as follows:

Pin	1 – Up (10K pull-up)	6 – Button 1 (10K pull-up)
	2 – Down (10K pull-up)	7 – 3.3 v (via the same 47 ohm resistor)
	3 – Left (10K pull-up)	8 – GND
	4 – Right (10K pull-up)	9 – Button 2 (10K pull-up)
	5 – 3.3v (via 22 ohm resistor)	

The joystick is read from IO port \$1F as defined by the Kempston standard (address bits 7:0 are decoded.) Bits that are set indicate that a direction is selected (IE: The interface inverts the input level of the pins).

Bit 0 – Right	4 - Button 1
1 – Left	5 - zero
2 – Down	6 - zero
3 – Up	7 - Button 2

External device header pads: 5x2 pins - Uses the following layout / pin-outs:

1 3 5 7 9
2 4 6 8 10

- 1 – Serial TX (output from bit 4 of port \$FAF3 *
- 2 – 5 volts output (can also be used to power the SMART Card if not connected to Spectrum)
- 3 – SPI_CS (inverted output from bit 5 of port \$FAF3)
- 4 – Serial RX (input to bit 4 of port \$FAF3 when read) *
- 5 – SPI D_out (IE: Input to CPLD)
- 6 – SPI D_in (IE: Output from CPLD)
- 7 - GND
- 8 – SPI_Clock
- 9 – Reset switch input (pulled high via 10K, the left button pulls this low) **
- 10 – NMI switch input (pulled high via 10K, the right button pulls this low) **

Notes:

The functions of pins 1&4 and 9&10 are swapped compared to the V1 SMART Card

SPI bus lines D_out, D_in and SPI_Clock are shared with the SD card, the SPI_CS line is dedicated to this port).

* These are logic level input / outputs (LVTTTL 3.3v output, 5v tolerant input). Input has a 10K pull down resistor.

Misc Notes:

Game File Types:

.SNA files: These are simple snapshots of the Spectrum's memory (and CPU registers) taken at some point when a game was running. With these files it is straightforward to load a game back into memory and continue where it left off. However, games which loaded extra data (for levels etc.) cannot be accommodated. (.Z80 is a variation of this format and not currently supported by the SMART Card).

.TAP files: These files are a dump of a game's entire cassette tape, so multi-load games can be supported. To use .tap files on a real Spectrum, the SMART Card game loader redirects calls made to the Sinclair ROM loading routines to its own SD Card-based file handler. In theory this provides a system-transparent method of handling tape loading via SD card. However, things are not quite so straightforward: Most commercial games used non-standard loading routines (for protection etc.) which did not call the ROM's loading code. There is no way of intercepting their tape loading routines as they vary from one game to another. To get around this, most .tap games on World Of Spectrum have been modified to remove the protection. As a rule, if a .tap shows non-standard border stripe colours on loading under a PC emulator, then it won't work on the SMART Card. (Note: Sometimes .tap games will pause midway through loading until a key is pressed – they will then continue loading).

.TZX files: These are a more complex version of .TAP files which can encode non-standard loading protocols (turbo loaders etc.) directly. These files are only useful for PC-based emulation and are not supported by the SMART Card.

Files for SMART ROMs etc.:

All ROM files (except Boot ROM updates) are 16KB – they're simply .bin files with the extension renamed to show a version number. Boot ROM update files are shorter (12KB) because the final 4KB of SLOT A in the EEPROM is used for the ROM index etc. and is not to be overwritten when updating.

CPLD Core notes:

Changes in core V3.1:

- Timing of ROM_CS bus switching improved (some Z80s were not compatible with v3.0)
 - Writes to \$1FFD are captured and readable in \$FAFF if Spectrum is a 128+2A/B or +3
 - Allows paging of multiple ROMs based on Spectrum ports \$7FFD and \$1FFD
 - Reset switch now sends a long pulse to the Spectrum for better operation on 128 +2A/B, +3
 - NMI debounced, flag no longer needs to be cleared.
-

For more information you can contact me at: smart@retroleum.co.uk