# SMART Card for ZX Spectrum 48 by Phil / retroleum.co.uk

## Full Manual 08-05-2015

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

**WARNING: As with any Spectrum interface, the power should be disconnected before attaching or re-moving the SMART Card otherwise damage can occur to the Spectrum and / or interface. To prevent movement of the edge connector contacts, do not connect anything to the SMART card or change its DIP switch settings 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 (16 banks, 16KB each), SD card support, a Kempston joystick interface and buffer SRAM. It is intended primarily as a simple low-cost game loader for 48K Spectrums and/or a diagnostic cartridge for all models of Spectrum (note that the card will not physically fit +2 / +3 model Spectrums with their cases on.)

As supplied, the first ROM slot (Slot A) is occupied by a Menu / Manager program (which is referred to in this document as the firmware). Slot B contains a Spectrum hardware test ROM and Slot C contains a snapshot game loader. The firmware maintains an index of the ROMs that are installed and allows new 16KB ROM im-ages to be loaded, selected etc.

Buttons and Switches:

The left button resets the system (and also clears the ROM / SRAM bank select registers thus enabling the SMART Card's memory – as long as it not disabled by DIP Switch 1).

The right button issues a Non-Maskable Interrupt (NMI) and re-enables the SMART Card's memory (following a snapshot file load). There needs to be an NMI handler in the currently selected ROM for anything useful to hap-pen - if not, pressing this button will usually just crash / reset the Spectrum.

The DIP switches have the following functions:

- Switch 1 – Enables / Disables SMART Card memory. When set to ON, the internal Spectrum ROM is dis-abled and the SMART Card's ROM takes over, indicated by the blue LED being lit. (There is also a software control that can override this to force Spectrum internal ROM mode.)

- Switch 2 - Enable / Disable SMART Card EEPROM writes . The FlashRAM on the SMART card can only ac-cept new data when this switch is set ON. (The red LED is lit when writes are enabled).

- Switch 3 - Bank B Override Mode. When set to ON, the SMART card starts directly from - and can only ac-cess - ROM slot B. This is useful when using the card as a diagnostic tool to test faulty Spectrums (as long as a suitable DiagROM is loaded into Slot B, of course!). Rationale: The firmware relies on good working memory and always runs before switching to other slots via the GOTO mechanism. Bad memory could crash the Spectrum before a diagROM has chance to execute.

- Switch 4 is used on PCB versions 1.05 and above to enable/disable the Kempston joystick port. Previously it was unused.

Kempston 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). On PCB versions v1.05 and above, DIP Switch 4 enables/disables this port.


Firmware (ROM Menu / Manager) – Default Slot A

The ROM Menu tests to see if the GOTO feature is set. If not, a menu is displayed with a prompt for the user to select a ROM (or press ENTER to use the ROM Manager.) If a GOTO slot has been set up then that slot is selected and the system resets. The GOTO feature can be overridden by holding down the Space key on power up.  Afterwards, Keys A-P select their respective ROMs and Enter brings up the ROM Manager. To remove the GOTO permanently, just set it back to Slot A with option 6 in the ROM Manager.


ROM Management Tools:

On pressing ENTER on the ROM menu screen, the ROM Manager options appear. This option allow 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 Firmware (IE: The ROM menu / manager program itself) - this is to protect the ROM index which is also located in SLOT A.

Notes:

- The write enable DIP switch must be ON to update anything in the SMART card's FlashRAM.
- The GOTO feature can be used to make the SMART card switch immediately to a different ROM.
- Video glitches during FlashRAM writing are normal (an artefact of the EEPROM programming protocol)

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: www.retroleum.co.uk/smart.zip


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 the firmware relies on the Spectrum having good RAM so it may not start if it is faulty. Therefore, it is best to use the "Slot B override" switch (DIP Switch 3) to force the SMART Card to boot slot B directly. (The Diag ROM itself does not need any good RAM to run). See the Diagnostic ROM manual for more information.


Snapshot Loader – Default Slot C

This ROM is a simple snapshot file selector. You can navigate with the keys QAOP and Enter, or with a joystick. An SD card formatted to FAT16 which contains your snapshots must be inserted. The software supports 48K .sna files - and from v.03 - some .tap files.

Tap file support: To activate .tap support, a patched version of the Sinclair ROM must be installed in slot D. Unfortunately Amstrad have a caveat in their Sinclair ROM distribution permissions which prevents this being pre-installed on new hardware. However, it can be automatically installed the first time a .tap file is selected (Note: EEPROM writes must be enabled – DIP Switch 2 set to ON). Please note: some .tap files may not work - see the technical section for more more info.

# The Technical Section:

## Control Ports:

**FlashRAM** selection / switching is controlled from **IO port $FAFB** - this is a read / write port which is cleared on power up or when the reset button is pressed.

Bit      0:3 - Select the 16KB section of FlashROM at appears to the CPU @ $0000-$3FFF*
           4:5  -Not used, reads back as written.
           6    - Prime the ROM switch-out system for restarting snapshot files**
           7    - Disable the SMART card's memory IE: Use Spectrum's own ROM (software equiv. of DIP switch 1)

*  When DIP Switch 3 is set to ON, the value in [0:4] is ignored, Slot B always selected.

**  When set, the SMART card's memory is automatically paged out when the Program Counter reads from address $xx72 (bits 6,5,4 and 1 are decoded). When reading, this bit always returns 0.

---

**SRAM selection** is controlled by **IO port $FAF3**, this is also a read/writeable port that is 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.

---

**Data to from the SD card** is controlled via **IO port $FAF7** – this is a read/write port.

Bit 0:7 Data for SD card

Note: There is no serializer busy flag – make sure at least 12 Z80 cycles elapse between accesses.

-----------------------------------------------------------------------------------------------------------------------------------

**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

**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 47 ohm resistor)


---

**The 4x2 pin header** has the following layout / pin-outs:

**1 3 5 7**
**2 4 6 8**

1 – Serial TX RS232 level output (where optional ST232 chip is fitted)
2 – 5 volts
3 – SPI_CS
4 – Serial RX RS232 level input (where optional ST232 chip is fitted)
5 – SPI D_out
6 – SPI D_im
7 - GND
8 – SPI_Clock

(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).


---

**The 6x1 pin header** is for JTAG configuration of the CPLD:

**1 2 3 4 5 6**

1 - TMS
2 - TDI
3 - TDO
4 - TCK
5 - GND
6 – Vcc (3.3v – provided by onboard voltage regulator).

To re-program the CPLD, disconnect the interface from the Spectrum, connect 5volts to pin 2 / Gnd to pin 7 of the 4x2 header) and a JTAG cable header to this connector:

---

**The 3x1 pin header** is used to select compatibility with the different edge connectors used across the Spectrum range. IE: It determines whether ROM_CS is applied to pin 25 or pin 15 of the lower edge connector. (The ROM_CS signal is always sent to upper pin 4)

The jumper must be set appropriately for the host machine. (It will almost always be set to "48" since the SMART Card will not physically fit the Spectrum 128+2 onwards, at least when the top of the case is attached.)

**1 2 3**

- When the jumper is across pins 1-2, the edge connector mode is set for the original Sinclair Spectrum style - this includes the Spectrum 128 (known as the "toast rack")  and Amstrad's Spectrum 128 +2 (the grey-cased version).

- When the jumper is across pins 2-3, the edge connector mode is set for the Amstrad Spectrum +2A, +2B or +3)

---

**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 this 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. (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. This is really only useful for PC-based emulation and these files are not supported by the SMART Card.

---

**Files for SMART ROMs etc:**

All ROM files (except the FIRMWARE) are 16KB – they're simply .bin files with the extension renamed to show a version number. The FIRMWARE.Vxx file is 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.

---

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