

ZXpand

Expansion Interface
For the Sinclair ZX81

© 2011 Charlie Robson/EightyBits

for RWAP Software

MANUAL

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NOTICE

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The manual has been written specifically for users of the ZXpand Expansion Interface for the Sinclair ZX81 home computer.

The manual is intended to provide the user with detailed information adequate for the efficient installation and operation of the equipment involved. However, while every effort has been taken to ensure accuracy, the manufacturer assumes no liability resulting from errors or omissions in this manual, or from the use of the information contained herein.

The manufacturer reserves the right both to change the specifications of the ZXpand and its firmware and to revise this publication from time to time without obligation to notify any person of such revision or changes.

RWAP Software
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OVERVIEW

The ZXpand is an all-in-one expansion solution for Sinclair ZX81 computers. It provides the following features:

- 32K of static RAM with software configurable mapping.
- SD/MMC card storage with transparent LOAD/SAVE integration.
- New support commands in an overlay ROM for instant availability.
- Support for all common software based hi-resolution systems.
- Uses the standard .P file format.
- Sub-directory support on the SD/MMC card.
- A reset button to save wear on the power jack connection.
- Firmware update via SD card.

In addition the following features may be enabled with add-on PCBs and/or some soldering:

- Atari-style joystick adapter for specially written or modified games.
- AY-3-8910 daughter card with Zon-X compatible IO address decoding.

COMPATIBILITY

The ZXpand will work with all standard Sinclair ZX81 and TS/1000 Computers. However, it is quite common to come across ZX81s which have been modified in some way and so we cannot guarantee that the ZXpand will work in all circumstances.

The ZXpand can also be adapted to work with the Sinclair ZX80 computer, although you will need to use a replacement ROM inside the ZX80 itself (see below).

To date the following issues have been identified:

1. Computers with internal RAM upgrades *may* not be compatible - please contact us for advice.
2. Computers with the internal regulator bypassed will also not work without a small modification to the ZXpand interface.

Some hi-resolution programs require additional modifications to the ZX81 in order to work. These will usually be identified as requiring 'CHR\$128' or 'UDG' add-ons. These schemes cannot be implemented in external hardware such as ZXpand due to the way the ZX81 video generation works.

WHAT DO I NEED

The ZXpand comes ready to plug into your Sinclair ZX81 home computer, switch on and go. However, you will need a standard SD card to be able to store files.

If you wish to insert the interface into a case, then it is designed to fit within a Memotech memory expansion case with some modification to allow access to the card slot - see section on fitting the ZXpand in a case below.

GETTING STARTED

Format an SD card - you can use any of the standard FAT format types: 12, 16 and 32 are supported.

Once formatted, you can save some ZX81 programs to it. These are widely available around the internet. They typically have the extension '.P'. If you come across files with the .81 extension, these should be renamed – the formats are identical.

Because of program space restrictions in the firmware long filenames are not supported. Filenames should use a maximum of 8 characters, followed by the extension.

You may want to organise your files on the card by creating directories, again 8 characters maximum in the name, and putting a few files in each. The ZX81 was never designed to make use of a file system and this should make finding the file you want much easier.

Now, you can connect the ZXpand to your ZX81 computer, insert the SD card and switch on.

Enter the command:

LOAD "MAZOGS"

This will load the file MAZOGS.P. It is not normally necessary to add the .P extension, it is assumed.

Once you have explored the joy of the 3D Monster Maze or the fields of the Fungaloids then kindly proceed to the command reference to see what else there is to play with!

COMMAND REFERENCE

The built-in commands relating to the ZX printer have been replaced with those required to usefully operate the ZXpand interface. For example the *CAT* command replaces *COPY* - therefore to get *CAT*, you press the Z key in K mode as you would for *COPY*. If your program needs access to one of the original commands then you will need to disable the ZXpand's overlay ROM at *LOAD* time or by using the appropriate configuration option. The necessary information follows.

Note: The key assignments are different when used with a ZX80. These differences are noted in the ZX80 section.

CONFIG

CONFIG "x"
CONFIG "x=y"

(Press shift-G in K mode – replaces 'LLIST' command)

The *CONFIG* command is the main method of communicating with and configuring the ZXpand interface. As the working of some programs and commands is affected by how the interface is set up, this will be dealt with first.

Parameters to the command and their effects are:

"V"	Displays the interface's version string.
"R=nnnnn"	Sets RAMTOP to the specified value and executes <i>NEW</i> .
"M=L"	Sets the 'Low' or 8-40K RAM mapping. See notes below.
"M=H"	Sets the 'High' or 16-48K RAM mapping.
"M"	Displays the RAM mapping configuration, one of 8-40K or 16-48K.
"D=pathname"	Sets the current working directory (CWD).
"D="	Sets the CWD to the root directory. Same as specifying '/'.
"C="	Sets one of 7 flags (0 to 7) – currently only bit 7 is used (see Autoboot section below)
"X"	Disables the overlay ROM until next reset.

CONFIG "V" will display something like the following:

ZXPAND INTERFACE 1.0

Setting RAMTOP to 29700 would be performed by typing:

CONFIG "R=29700"

Changing the current working directory to, for example, a folder called 'games':

CONFIG "D=GAMES"

The RAM address mapping is preserved in the interface's EEPROM until it is next changed or a factory reset is performed. The CWD is preserved only until the interface is reset.

Some hi-res programs expect RAM in the 8-16K area. These are usually identified as using the 'WRX' scheme.

CONFIG "M=L"

Most 32K programs expect a continuous memory block from 16-48K.

CONFIG "M=H"

CAT

CAT ""

CAT "directory"

(Press Z in K mode - replaces 'COPY' command)

It is sometimes useful to know what files are available on the card. The *CAT* command will do this.

Providing an empty string will list the content of the current working directory (CWD). To list the content of directories relative to this then you must specify the path as you might for a DOS based system.

'.' is the current folder.

'..' is the parent folder, if any.

Directories are shown in catalogue listings between angle brackets.

For example: *CAT ""*

...would display:

<GAMES>

MYPROGRAM.P

<UTILITIES>

CAT "GAMES" would then display:

MAZOGS.P

3DMONST.P

CONFIG "D=GAMES"

CAT""

...would show:

MAZOGS.P

3DMONST.P

...and from there:

CAT "../UTILITIES"

...gives:

CLOCK.P

DEMO.P

LOAD

LOAD "filename"
LOAD "filename;X"
LOAD "filename;address"
LOAD ""

LOAD will take data from the specified filename on the card and place it in memory. The basic *LOAD* command will work just as you expect. Specifying an empty name will invoke the tape loader as normal to allow you to load a program from cassette.

Some programs may require access to the printer routines (including commands such as *LPRINT*) or character table in ROM. These are unavailable when ZXpand is present - action is required in order to make them available. Use the following command in this case:

LOAD "filename;X"

Once the program is loaded the overlay ROM is disabled and full access to the internal system ROM is given. The overlay ROM remains disabled until the current session is ended with a hard reset (press and hold) or power cycle.

To put data into specific locations in memory you can use the following form:

LOAD "filename;12345"

Here 12345 is the target address.

Folders can also be used, depending on the current working directory set by the *CONFIG* command, for example:

LOAD "../games/mazogs"

SAVE

SAVE "filename"

SAVE "filename;ssss,llll"

SAVE writes data to the specified file on the card. As with the *LOAD* command, the basic *SAVE* invocation will do as you expect. You will not be able to *SAVE* to cassette tape, unless you have explicitly disabled the overlay ROM with a *CONFIG "X"* command or used the *LOAD "filename;X"* form to load your program.

An alternate form of the command is used to save a specific memory location to the card, with a start address specified by *ssss*, and a length of *llll* bytes.

SAVE "filename;0,8192"

This would, for example, save the content of the overlay ROM to the desired file.

Attempting to save a file with a name which already exists will result in an error. You must delete the conflicting file from the card or specify a different name. This is by design and should prevent accidental loss.

DELETE

DELETE "filename.p"

(Press shift-S in K mode – replaces 'LPRINT' command)

Unlike *LOAD* and *SAVE*, the *.P* extension is not assumed for this command. This is by design and is intended to provide a small amount of extra security.

AUTOBOOT

The ZXpand can be configured to automatically run a program called 'menu.p' when the ZX81 is switched on or reset. Nominally the ZXpand is set to autoboot when the SHIFT key is pressed during power on.

However, you can force the ZXpand to always autoboot by clearing bit 7 in the configuration parameters:

CONFIG "C=7F"

CONFIG "C=FF" will re-enable it.

THE RESET BUTTON

Pressing the reset button has different effects depending upon how it is pressed. The three available reset types are:

- **SOFT RESET**

A short tap will reset the ZX81 only. The green LED will flash.

- **HARD RESET**

A longer press, approximately 1.5 seconds, will reset the ZX81 *and* the interface controller. The green and red LEDs will flash.

- **FACTORY RESET**

A 5+ second press of the button will restore the content of the EEPROM to its factory default. The red LED will blink.

As of issue 1 the only factory default setting is:

- Ram mapped 8..40K

PLACING THE ZXPAND IN A CASE

The ZXpand has been designed to fit in a Memotech RAM expansion case. A slot will have to be cut in the left hand end-plate unless a mini-SD card is used (as they fit entirely within the SD socket). A small tab made from sticky tape will aid removal of the card in this case.

There are contacts on the board to allow you to mount external LEDs, although the built-in LEDs must be removed in order to use this facility. Contact us for further advice if you wish to use this.



INFORMATION FOR PROGRAMMERS

The interface lives on I/O port 7 which is fully decoded. Bits 15...13 of the address bus are latched when port 7 is accessed and then used as a channel number in order to perform different tasks. Therefore the only valid IO instructions for accessing the port are:

```
out (c),a
in a,(C)
```

The B register should hold the channel number in its top 3 bits. Here is an example which sends the value 23 to command channel 5:

```
ld bc,%1010000000000111
ld a,23
out (c),a
```

So what can usefully be done? Many of the interface's functions require a conversation protocol which would take up a document of its own. For example opening a file requires the following steps:

- Instruct interface to prepare to receive data
- Send filename
- Open file
- Wait for response
- Instruct interface to read next file block
- Wait for response
- Read data
- Loop until all data received

That said there are some very short and sweet functions which may have a use to the developer. Test for the presence of the interface:

```
ld bc, %1110000000000111
ld a,$aa
out (c),a
[some small delay, 10 clocks or so]
in a,(c)
cp $f0
jr nz,nointerface
ld a,$55
out (c),a
[some small delay, 10 clocks or so]
in a,(c)
cp $0f
jr nz,nointerface
```

Programmatically disable the interface's overlay ROM until the next reset:

```
ld bc, %1110000000000111
ld a,$b0
out (c),a
```

Read the joystick port:

```
ld bc, %1110000000000111
ld a,$a0
out (c),a
[some small delay, 10 clocks or so]
in a,(c)
```

The direction bits will be in the accumulator and have the following meanings:

Bit	--	Direction
7		Up
6		Down
5		Left
4		Right
3		Fire

The corresponding bit will be 0 when the joystick is pushed in that direction. Bits 2 to 0 inclusive are undefined, but you might just work out that bit 0 represents whether a card is present...

Alternatively you can call a function at 8190 (\$1ffe) to retrieve the value.

The ZX81 firmware source is available for instructional use. Any suggestions for improvements/bug reports will be welcomed.

FIRMWARE UPDATES

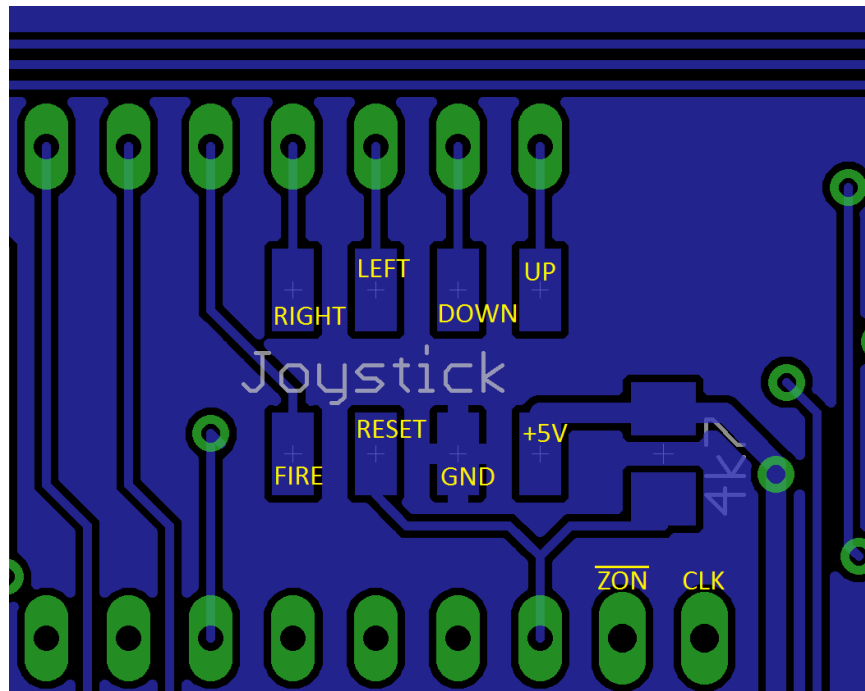
Interface firmware updates are performed via the SD-card boot-loader. The firmware's binary image should be copied to a freshly formatted card. This is then inserted and the interface rebooted by executing a hard reset. The red LED will come on and the green will flash. When the firmware has updated then the ZX81 will be reset.

The boot-loader is restricted to FAT12 or FAT16 file systems. FAT32 formatted cards will not work. It's useful to have a small capacity card handy just for firmware updates.

What firmware do I have? If you've just asked this question you can interrogate the interface using the command *CONFIG "V"*. To determine which revision of overlay ROM you have, type *PRINT PEEK 7679*.

HARDWARE

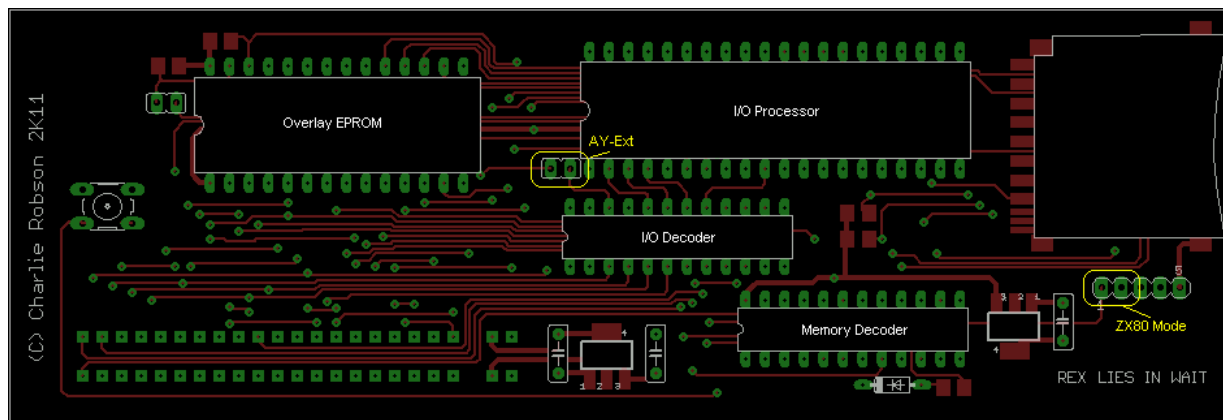
THE JOYSTICK PADS



The above image shows the break-out pad assignments. The inputs have built-in pull-ups and are active low. A joystick break-out board will be available in the near future.

The reset pin is not enabled in the current firmware.

Here is an overview of the various components and pads on the ZXpand. Refer to this diagram when making changes to your hardware.



ZX80 COMPATIBILITY

The ZXpand is capable of being driven by a ZX80 though it's not as simple as with its intended host system (the ZX81). Some non-destructive alterations to both computer and interface need to be made. The physical location of the '80s expansion connector provides another challenge.

The most significant hardware difference to the ZX81 is the ZX80's lack of a ROM-select signal on the expansion connector. This means that the overlay facility is not possible as there is no way of controlling access to the ZX80's internal ROM. The best solution to this is to replace the ZX80's ROM with an adapted copy much like the ZX80 to ZX81 conversion did.

The ZXpand also needs to disable both its RAM at 8K and the EPROM, and this requires the use of an updated memory decoder chip and a jumper.

As a result there are various changes required:

1. Change the existing new memory decoder chip with an updated version.
2. Solder a jumper to the interface (this is a very simple soldering job). Refer to the diagram above, the jumper is labelled 'ZX80 mode'. The interface disables the overlay and RAM at 8K when the jumper is closed.
3. Open the ZX80 computer and change the original ZX80 ROM for the new firmware. The new ZX80 firmware comes as an 8K ROM.

The original 4K and (ZX81 upgrade) 8K ROMs are unfortunately obsolete models that do not have a modern drop-in replacement, so we have utilised a Flash EPROM replacement on a special adaptor.

KEEP THE original ZX80 ROM chip, as this will retain the value of the ZX80 into the future.

4. Consider the practical problem of the location of the expansion port on the ZX80. When fitted to a ZX80 the board overlaps the modulator output. This means that some way of physically moving the interface back may need to be found. We can supply a 'ZXtend' cable which will do the job, and the ZX Printer may be useful in this regard too. It may be possible to find a suitable cable that doesn't foul on the board.

Having modified the ZXpand, you may still use it with the ZX81 by removing the small plastic jumper (just remove it from the two pins you soldered to the board). The new memory decoder GAL works for both systems, so that is all you need to do.

Although the changes to the boards may seem daunting they are actually very simple once the correct parts are obtained. We will be pleased to assist with any aspect of using the ZXpand with a ZX80, and any parts which may be required. The GAL program code is available to those with the ability to reprogram the chip.

Operation is transparent once the required upgrades are performed. ZX80 files have the extension .O or sometimes .80, these are identical in operation and so any .80 files should be renamed to have the .O extension.

As with the ZX81 firmware, the LOAD and SAVE commands will invoke the tape routines when entered without a filename or an empty string "".

The keys used to generate the extended commands are:

Z – CAT

L – CONFIG

P – DELETE

The CONFIG command does not support the 'R', 'X' or 'M' parameters in ZX80 mode.

ERROR CODES

The interface can report the following errors. They are shown in inverse video to distinguish them from standard system report codes.

1	Disk error - the card file system may be damaged
2	Internal error - the filing system data structures are inconsistent
3	Not ready - the card is not responding or no card is present
4	File not found - no such file exists
5	No path - no such directory exists
6	Invalid name - file name contains illegal characters
7	File is marked as read-only
8	File already exists - an attempt was made to open a file for writing
9	Hardware fault – usually a computer/interface communication error
D	No file system - card is not formatted or is damaged
F	Timeout - a timed operation did not complete in the expected time