

8-bit input/output port expansion card, with through connector and RESET button.

Allows to easy connect MUMIO-standard devices, safely separated from the ZX Spectrum bus and without knowledge of bus internal structure.

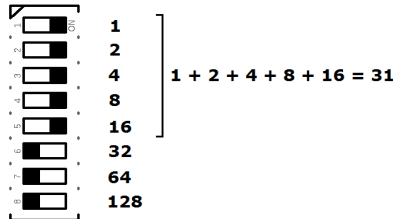
I/O Port is main platform to attach MUMIO devices.

Each card can be assigned an I/O port address in the range of 0-255 using an 8-position switch. Multiple cards, set to different I/O port numbers can be connected in series.

The output port has 8 bits/pins on which the latched state of the last value sent to the port is fixed. The status of the output port is presented by LEDs. The input port is not latched. Both ports (input and output) are separated from each other.

First steps

1. Use the 8-position switch to set the I/O port address. For example, the standard Kempston joystick interface port number is 31. Each switch is responsible for one address bit and has assigned a decimal value. To set address 31, set switches 1-5 to ON, others to OFF. This way you can set an address from 0 (all OFF) to 255 (all ON).



2. Connect card to ZX Spectrum edge connector and turn the computer power on.
3. Enter **OUT 31,170** and press **ENTER** - every odd LED should light up, showing the status of the output port.
4. Enter **PRINT IN 31** and press **ENTER** - the status of the input port will be displayed on the computer screen. Value 0 means, that all pins of the input port are in a logical „zero“ state - they have a voltage of 0V, i.e. they are shorted to GND.
5. Use a cable, to short one of the **IN 0-7** pin with the +5V pin. For example, **connect pin 6 to +5V**. After entering **PRINT IN 31**, the value 64 will appear on the screen. This means that pin 6 (with the value of 64) is in the logical “one” state, i.e. it has a voltage of +5V. This way you can short any combination of pins IN 0-7 to GND or +5V.

In this way, you can control the output port with BASIC and read the state of the input port. You can send information to external devices, control them, or receive data and their status.

Examples in ZX Spectrum BASIC

Send to output port no. 31, sequentially values from 0 to 255:

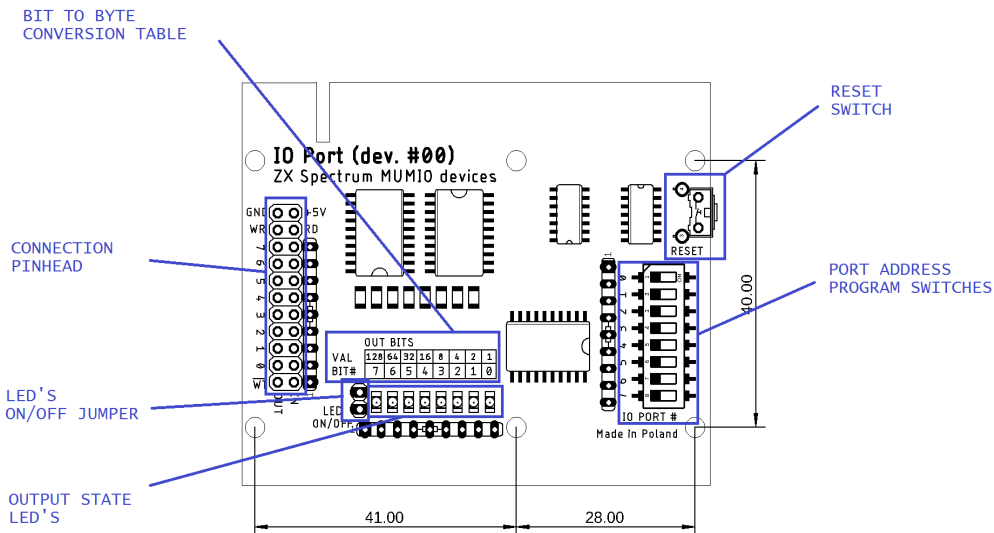
```
10 FOR X=0 TO 255
20   OUT 31,X
30 NEXT X
40 GOTO 10
```

Display the status of input port no. 31, on the screen:

```
10 PRINT AT 0,0; IN 31; "  "
20 GOTO 10
```

Copy to output port no. 31 the state of the same input port no. 31. The LEDs will show the status of input port no. 31.

```
10 OUT 31,IN 31
20 GOTO 10
```



IO PORT # - a group of switches to set the I/O port address in the range of 0-255. It is recommended to use odd port numbers (lowest bit 0 always ON). Set the address as an 8-bit binary word. The lowest bit is at the top, next to the RESET key. The most-significant eight bits of the 16-bit I/O port address are ignored.

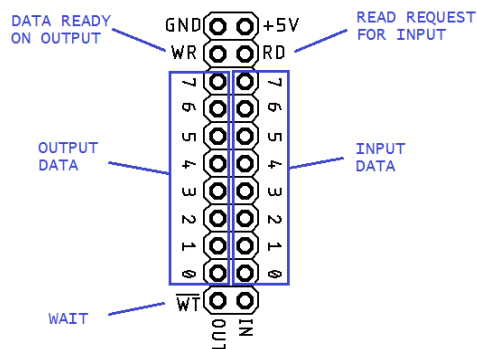
LEDS - LEDs showing the current state of the OUT pins.

LED ON/OFF - removing the jumper disconnects the power supply to the LEDs.

OUT BITS - a table that allows easy conversion of the set bits to a decimal value.

RESET - button resets the ZX Spectrum processor.

CONNECTION PINHEAD - allows you to connect MUMIO devices or other devices compatible with TTL signals (0V/5V). It allows to control slow-changing signals or fast data transfers. For example relays on the output or joystick on the input are slow-changing signal devices. Connector allows you to transfer data in parallel at a theoretical speed of up to 100 bytes/s in BASIC program, or up to 250 kB/s in machine code (assembler) program.



OUT 0-8 - (output) data bus FROM ZX Spectrum

IN 0-8 - (input) data bus TO ZX Spectrum

GND - ground (logical „0” signal)

+5V - supply (logical „1” signal)

WR - (output) data ready signal on the OUT bus

RD - (output) signal of willingness to read data from the IN bus

/WT - (input) WAIT signal - if the connected device needs more time to prepare data for the IN bus

The IN and OUT buses are not connected and can work independently. If a device uses only one of these buses (e.g. a joystick uses only the IN bus and an external display only uses the OUT bus), then these two devices can be operated from one I/O port.

Data flow

Receiving data by ZX Spectrum

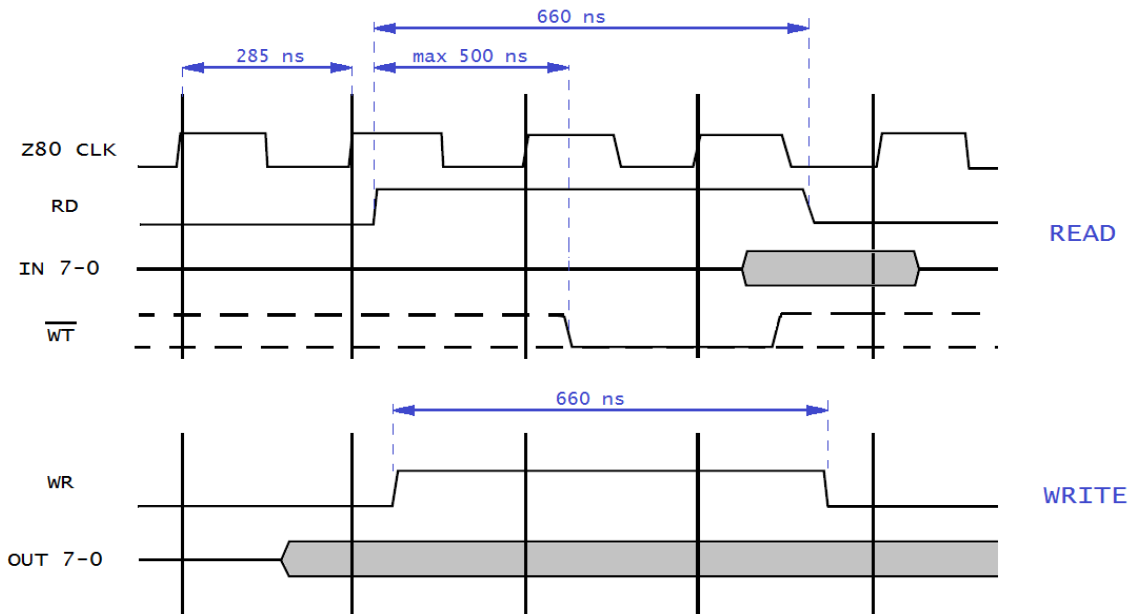
Rising edge of the **RD** signal informs about the Z80 processor's willingness to read data from the **IN** line. The data should be delivered to the line in time no longer than ~500 ns (2 ticks of the ZX Spectrum clock) from the rising edge of the **RD**. After this time, the Z80 processor will read the data. If the data preparation will take longer, the sender should put a logical "0" on the **/WT** (WAIT) pin and keep it in this state until the data is delivered. The **/WT** signal, if not used, may be not connected. If used, it can only be in a high impedance or logic "0" state. Providing a logical "0" causes the Z80 processor to pause.

warning! The **/WT** signal is the only pin connected directly to the bus of the Z80 processor. Do not short-circuit the **/WT** pin directly to +5V!

Sending data by ZX Spectrum

Rising edge of the **WR** signal informs that there are data ready on the **OUT** lines. Data is latched and held until the Z80 CPU sends another byte to that port. In the case of fast transmission, the receiver should read data in no longer time than ~2000 ns (a dozen of Z80 clock ticks). After this time, the Z80 processor may send another byte of data.

One **OUT** pin can be loaded with max. 35 mA, while the sum of currents on all pins cannot be higher than 70 mA. To reduce the load on the **OUT** line, you can turn off the LED using the LED ON/OFF jumper. Each of the LEDs consumes a current of approx. 3 mA (maximum load is $8 \times 3\text{mA} = 24\text{mA}$).



ZX Spectrum MUMIO devices

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