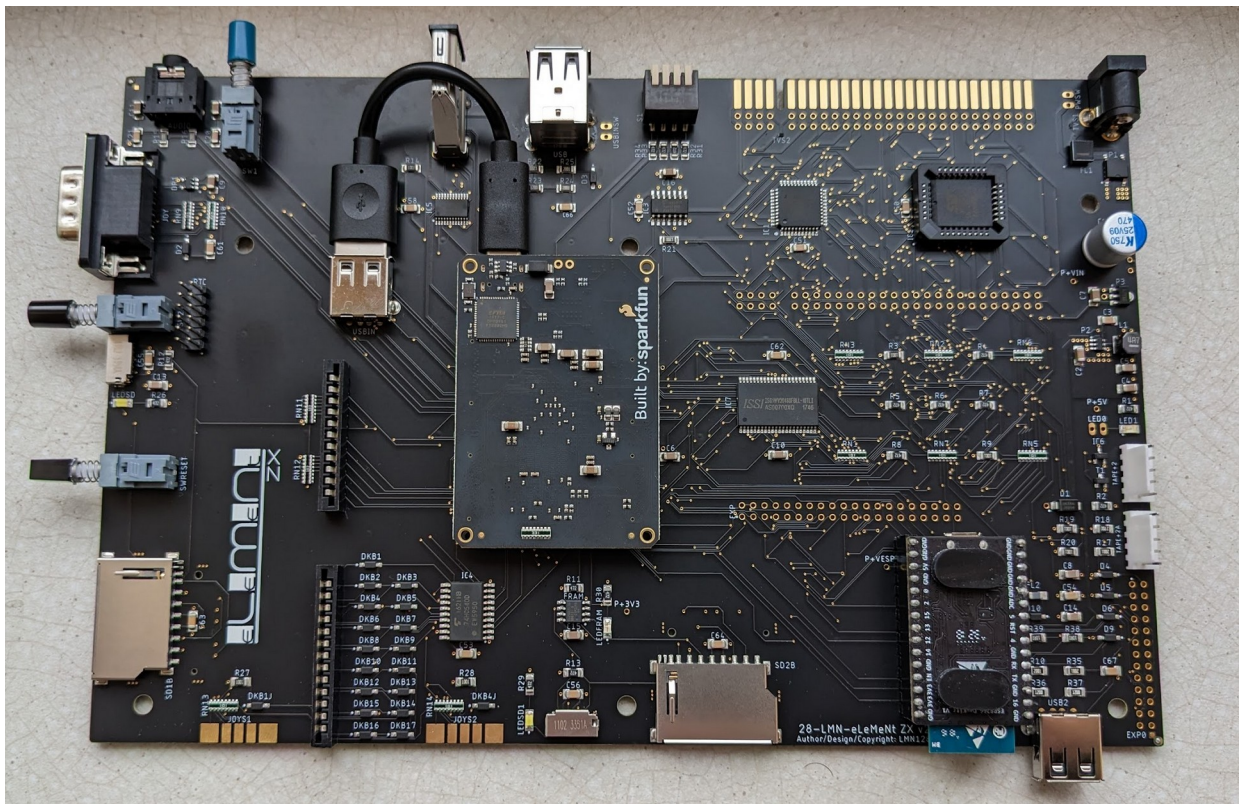


Powerful smart 8bit home computer  
Highly integrated, all-in-one ZX Spectrum and Pentagon  
Motherboard replacement for models +2/+2A/+2B

# User Manual



version 2.0

Welcome! Before turning the eLeMeNt ZX on, please read the first chapter of this manual, **Quick start**.  
The eLeMeNt ZX has a built-in the **divSD** interface with two SD card slots, available in all its hardware models, from the 48K, through the +2 and +2A, to the latest Pentagon. If you have never dealt with a similar device, read the chapter **esxDOS** on the page 20.

I need to find information on how to...

view the PC keyboard layout	go to	page 12
use the Extra button		page 6
upgrade the system		page 18
solve an issue (not listed in the SetUp)		page 19
change a BASIC ROM		page 18

eLeMeNt ZX - User Manual, version 2.0  
written by SCjoe/SamC

2021-23 (C) Jan Kučera / LMN128, [www.128land.com](http://www.128land.com), Zlín / Czech Republic

## Dear eLeMeNt ZX user,

thank you for using a new enhanced ZX Spectrum computer.

Your **eLeMeNt ZX** is a machine, that can work in various configurations and provide performance and user convenience not commonly available on this type of 8-bit computers.

The **eLeMeNt ZX** is mainly a classic ZX Spectrum compatible with several older models. You can work with the eLeMeNt ZX immediately after switching on, without any complicated settings or introductory menus. Unlike other modern ZX Spectrum computers, the built-in Z80-CPU is a real original chip, running at 20 MHz.

The **eLeMeNt ZX** contains many hardware features, only those are described in this manual that you need for daily use of the computer or for connecting older interfaces and can be easily reconfigured without programming knowledge.

I made this motherboard as a thank-you and in memory of those who created the phenomenal ZX Spectrum, the hardware, the ZX BASIC and also the all timeless design. I believe that you will be as happy with the eLeMeNt ZX as I and my friends who helped me with this project.

I wish you a lot of fun and satisfaction with your new smart and powerful ZX computer.

Jan Kučera

## Quick start with the eLeMeNt ZX

### What you get

The eLeMeNt ZX computer motherboard version 2, a new powerful ZX Spectrum with fast Z-80 CPU running at multiple speeds, equipped with a lot of hardware accessories, all already installed and easily accessible. You can find most of old buttons and some connectors in usual places or there is a modern equivalent of them.

It is up to you how you will use this modern and reliable machine, whether as a replica of the basic "rubber" 48K model or you will gradually switch on some extensions.

### What else do you need?

- Alchitry Au Artix-7 FPGA add-on board, a heart of the eLeMeNt ZX
  - Two Alchitry FPGA development boards, the AU and AU+ models (made by Sparkfun) with Xilinx Artix 7 XC7A35T and Xilinx Artix 7 XC7A100T are supported.
- PS/2 compatible PC keyboard
  - For more comfort, we recommend the **eLeMeNt PC keyboard** with original labels of ZX Spectrum keys printed and abrasion resistant.
- standard digital video cable for your TV or monitor
- FAT32 formatted SD card, with esxDOS system files installed on it
- 7-12V power supply (9V recommended), at least 1A, polarity does not matter
- 3D printed case, the new eLeMeNt „**Tiny**“ case or the case of Amstrad +2,+2A, +2B
  - The motherboard of the eLeMeNt fits into the case of Amstrad models and can be used as a replacement of the original motherboard. Another suitable alternative is a **3D printed shortened +2 case** (without a space for a cassette recorder).
- Optional internal expansions: 2 MB RAM, Wi-Fi, RTC, joystick slots no. 2 and 3
- PS/2 compatible PC mouse is highly recommended, but also optional.

### A look into the case

Open the top cover of the Tiny case. You will see 6 screw holes that are prepared for the motherboard, which is supplied with 6 chrome-plated screws. You do not need to put any pads between the motherboard and the bottom of the case.

The Tiny case version 2 is prepared for all necessary connectors and buttons. You don't have to drill or saw anything in the case until you decide to improve your eLeMeNt ZX with more add-ons, such as the other two joysticks connectors.

### Installing the motherboard

Before the installation, connect the Alchitry add-on board to your eLeMeNt ZX. Turn it so that its USB connector points towards the digital video connector. The shape of mini connectors on the board do not allow to insert the add-on board incorrectly.

Before an installation, remove the blue cap of the NMI button. Now insert the motherboard carefully so that buttons and connectors on the left fit into relevant holes of the case. Use chrome-plated screws to attach motherboard. Connect the Alchitry FPGA add-on board to the motherboard with a short (10 cm) USB-A to USB-C cable.

## SD card

Insert the SD card into the card-slot on the left side, next to the rounded Extra button (it is the place originally used by +2/+2A models for a second joystick connector).

You can order a card with pre-installed software. Or use any SDHC or SDXC FAT32-formatted card and copy the content of the card from the [www.128land.com](http://www.128land.com) (goto Download section).

## Turn on the computer

The power connector is located in the usual place. The start-up is quick and ends with an well known introductory BASIC screen.

**Hint:** Because ZX Spectrum computers do not have turn-on/off switches, you are advised to purchase Power Supply adapter with additional ON/OFF switcher.

**Before you connect any device to your eLeMeNt ZX, read the relevant SetUp settings!**

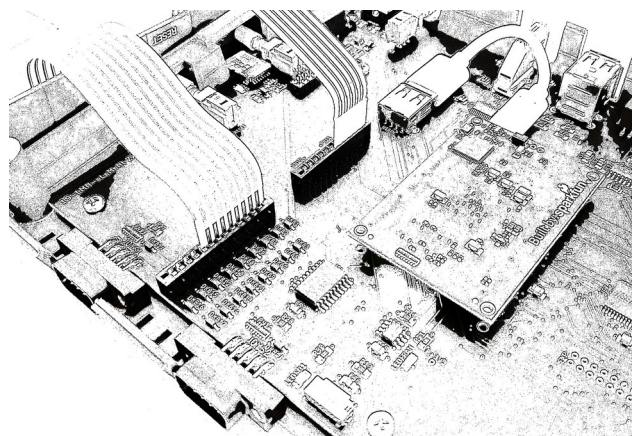
**Use standard Atari joysticks only** (if possible, check any switch on the joystick).

## Amstrad +2, +2A, +2B cases

Place the case upside down and unscrew 6 black screws, turn the computer back over, lift the top of the case and flip it to the left. Disconnect the power-led cable and the internal cable of the cassette deck on the right. Disconnect two keyboard cables on the left. To uninstall the original motherboard, remove 6 chrome-plated screws that secure the board to the bottom of the case.

On the left side, the eLeMeNt ZX has a pair of wide connectors for keyboards. From your point of view, plug the cables of the **+2 grey keyboard to upper edges** of both connectors. On the contrary, the **black keyboard** of +2A model you should mount close **on the lowest pin** of both connectors.

The picture shows the position of +2 keyboard cables on the eLeMeNt ZX motherboard in gray +2 case. The two joystick connectors below are OPTIONAL and you had to mod the case after their installment.



Depending on the model of Amstrad computer, connect the cassette recorder cable to one of the connectors on the right, marked as TAPE +2 or TAPE +2A.

## Round the motherboard

Put the motherboard on the table so that the row of 27 golden faces is oriented away from you.

### Buttons

There are three buttons on the element, two on the right side, one in the back, near the upper right corner. All buttons are mapped to keys on the PC keyboard (see the section *External keyboard layout*).

The **blue NMI button** in the upper left corner is used to interrupt any running program and to start a special NMI Menu or an esxDOS File Browser. It is mostly used to find and run a software from SD cards quickly.

The **reset button** has the usual angular shape and you will find it on the right, at its old place. A **long press of reset** button (at least 1.5 sec) results into the SetUp utility, which is part of firmware flashed in ROMs.

### Extra button

Next to the reset button is the rounded **extra button**. It helps to switch some hardware options quickly, by a **short press**. The button can be linked to the memory models and timings, speed options or GigaScreen modes (see the Chapter *SetUp II*).

Or add a **Warm boot** to the extra button. The warm boot performs fast reboot of the computer while preserving the state of the machine and the divSD.

A **long press of the extra button**, if you hold down the extra button for more than 1.5 sec, puts the computer in so-called "**Spectrum Menu**" (accompanied by a speccy-rainbow in the border). Now you can press keys 1 to 4. If the **Overclock** is enabled in the SetUp, you can also use keys 5 to 8 for higher speeds.

To **switch a CPU speed in the Spectrum Menu**, proceed as follows: 1) Press the Extra (side) button. 2) While holding down the Extra button, press the 1-8 key.

<b>1</b>	3.5 MHz	<b>5</b>	OverClock: 22 MHz
<b>2</b>	7 MHz	<b>6</b>	OverClock: 28 MHz (BASIC ROM limit)
<b>3</b>	14 MHz	<b>7</b>	OverClock: 28 MHz (RAM area only)
<b>4</b>	20 MHz	<b>8</b>	OverClock: 30 MHz (RAM area only)

Note: If you want to get a **visual overview** of what speed the eLeMeNt ZX is running, you can turn on the "CPU speed option" in the last SetUp's Diagnostics page, then outer frame of border (so-called "big order") will be colored according to the given speed.

### Connectors

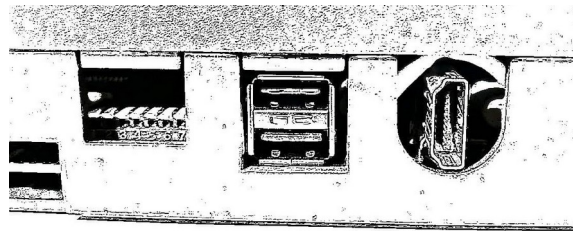
The computer is booting from the **primary SD slots** on the left. Next to a small microSD slot is located a standard SD slot. Remember that you can ever use one of them (larger or

micro) only, what better suits the size of your fingers. Other two slots, for the **second SD** are oriented on the side in front of the user. The slot order can be changed in SetUp.

A standard **Atari joystick slot** on the left can serve for several types of joysticks or pads, incl. **SEGA** Master and Mega Drive (Genesis) controllers with up to 8 buttons. **Kempston** joystick with two buttons is by default.

Do **not** use **Amstrad's SJS** joysticks, these could damage your eLeMeNt ZX.

**Stereo Audio Out** and **Digital Video/Sound** output in the top right corner use the 3.5mm minijack and the high definition multimedia interface.



In the following pair of USB connectors, the **top USB (USB1)** is for a PC mouse or keyboard. The **lower USB (USB2)** connects the eLeMeNt ZX with a PC and serves for file transfers or Alchitry Au Artix-7 FPGA core updates.

The **third USB (USB3)** socket you can find on the opposite site of the motherboard, on the right.

Note: The eLeMeNt ZX does not have any legacy connector: printer, discdrive, tape-in, special amstrad joysticks, serial, midi, TV or RGB output. You have to add these peripherals by use of an appropriate external interface or an internal expansion.

## Internal connectors

On the motherboard you will find several series of pins to mount more connectors and various internal extensions. The most important ones are: pins for the **RealTimeClock** module (right), connectors for the **other two standard Atari joysticks** (bottom), 2 internal **zx-expansion bus** pin rows. And there are some others prepared, intended to connect modern **I2C** and **SPI** devices to your eLeMeNt ZX in the future.

## External interfaces

The computer has a system expansion bus compatible with the ZX Spectrum 128+. For a pin description of the system expansion bus, see the chapter **Technicals**.

Please note the eLeMeNt ZX has a vast range of interfaces already built-in, by older ZX Spectrum models you previously had to connect as separate interfaces. Instead of using old interfaces, to attach Kempston joystick, mouse or double AY interface, simply go to the SetUp and make a switch in the menu.

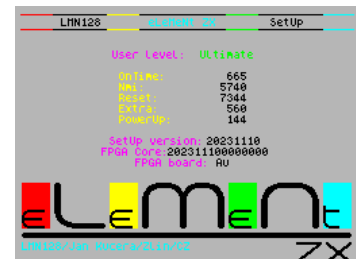
# SetUp (firmware)

To enter the SetUp, hold down the reset button for more than 1.5 sec.

In the SetUp you can configure and/or turn on/off a lot of peripherals and hardware options. You can combine various hardware expansions with several ZX Spectrums models ("machines") and as you may have been used to, also connect your favorite external peripherals.

The SetUp introductory screen, in addition to statistics of use of your eLeMeNt ZX, finds out a type of FPGA board, a version of the FPGA Core and a version of the SetUp.

This firmware built in the Flash ROM is also available as a standalone SETUP program.



Here are all options of the eLeMeNt ZX SetUp menu:

## Machine (memory/timing)

ZX Spectrum 48  
ZX Spectrum 128/+2  
ZX Spectrum 128+2A  
Pentagon 128  
Pentagon 512  
Pentagon 1024 v2.2  
Pentagon 4096 (KAY/Profi  
/Scorpion/Phoenix/ATM1)  
Didaktik Gama 80

## Storage/Memory interface

none (disabled)  
divSD (512KB divSD)  
divSD+MB (512KB divSD & MB02+)

## CPU speed

3.5 / 7 / 14 / 20 MHz

## CPU OverClock and advance mode

allow OverClock  
enable a wait state  
for access to ROM

## CPU speed alternative change

enable ZX-Uno speed change  
enable Pentagon 1024  
v2.2 turbo

## Joystick/Gamepad interface

none (disabled)  
Kempston  
Sinclair 1 (left: 12345+mn)  
Sinclair 2 (right:67890+mn)  
Keyboard OPQA+Space+mn+bhr

## Joystick/Gamepad type

standard 8-bits era  
Sega controller (3-8 buttons)

## External Keyboard/Mouse

none (disabled)  
K-Mouse (USB1)  
K-Mouse Slave (USB1)  
Keyboard (USB1)  
Keyboard (USB1)  
and K-Mouse Master (USB3)  
K-Mouse Master (USB1)  
and Slave (USB3)

## EXTRA button – short press

none (disabled)  
CPU speed  
Machine  
GigaScreen  
Warm reset  
Joystick/Gamepad interface

## EXTRA button – long press

none (disabled)  
Spectrum menu

## Audio output

enable ULA audio  
enable TurboSound FM  
enable MonsterBlaster DA  
(Soundrive,Covox)  
enable SID  
enable SAA1099  
enable TAPE input

## TurboSound FM

chip model: 0-AY, 1-YM  
stereo: 0-ACB, 1-ABC

## SID

chip model: 0-6581, 1-8580  
frequency: 0-PAL, 1-NTSC

## TIMEX graphics modes

enable

## ULApplus

enable ULApplus palettes  
enable TIMEX mode  
select by ULApplus regs

## GigaScreen – old TV/Monitor sum colours effects

none (disabled)  
mode0: 2 VRAMs always mixed  
mode1: two video frames mix  
mode2: autodetect mode1

## Scan line (old CRT/TV) effect

none (disabled)  
1/2 1/4 1/8 1/16  
1/32 1/64 1/128

## Digital Video Interface

enable legacy DVI  
enable ULTIMATE sync.  
- only for some TVs

## DMA

enable

## IO LIFO stack

enable

## RTC

none (disabled)  
internal batteryless

## RTC Time Zone

GMT -8...+5

## divSD

select esxDOS ROM:  
0-FPGA (rescue), 1-FLASH  
swap order first/second SD

## Z-Controller SD

none (disabled)  
on first SD slot  
on second SD slot

## Expansion pack A

none  
2048KB memory exp. (AA-RAM)

## Expansion Pack B

- UART (Mi-Fi) & USB3  
UART MB03 via USB2 to PC  
UART MB03+  
UART ZX-Uno  
UART ZX128-AY / USB3 disabled

## Flash ROM Area (motherboard v2)

Area 0-3

## Diagnostic

none (disabled)  
Video sync.  
Audio level  
CPU speed  
Status info  
Video test text pattern  
Video test color moving patt.

If you use **any external interface** with the eLeMeNt ZX,  
please check and turn off duplicate internal devices in this SetUp .



## Machine (memory and timings)

“Machine” means an appropriate memory layout and exact system timings of a specific computer. Choose from **all classic models**, the **Didaktik Gama** and **Pentagons**. The **+2A/+3 allram** mode is also available. Some Pentagon software needs 512 KB of memory, newer programs (e.g. *NS/D*) may require 1024K.

**Machine (memory/timing)**  
ZX Spectrum 48  
ZX Spectrum 128/+2  
ZX Spectrum 128+2A  
Pentagon 128  
Pentagon 512  
Pentagon 1024 v2.2  
Pentagon 4096 (KAY/Profi  
/Scorpion/Phoenix/ATM1  
Didaktik Gama 80

## Memory interface (divSD/MMC, MB02+)

This option enables a memory of divSD/divMMC and MB02+ interfaces and determines whether it is available in divSD mode only or also through the MB02+ memory paging registers. You should switch it off when using an external SD/CF interface that has its own memory.

**Storage/Memory interface**  
none (disabled)  
divSD (512KB divSD)  
divSD+MB (512KB divSD & MB02+)

## CPU speed (7 to 30 MHz, overclocking)

The eLeMeNt ZX has got a fast 20 MHz Z80-CPU installed on the motherboard. Higher speeds are nowadays used by software, appreciated not only in the esxDOS file browsing.

Four basic speeds up to 20MHz are available. An **OverClock** option in the SetUp enables more than 20 MHz. The eLeMeNt ZX can also speed up in a way compatible with ZX-Uno and Pentagon 1024 clones.

**CPU speed**  
3.5 / 7 / 14 / 20 MHz  
**CPU OverClock and advance mode**  
allow OverClock  
enable a wait state for access to ROM  
**CPU speed alternative change**  
enable ZX-Uno speed change  
enable Pentagon 1024 v2.2 turbo

The ZX BASIC editor is capable to work flawlessly at 28 MHz. For a safe system start-up, a default speed greater than 20MHz cannot be selected in SetUp. This is a security fuse, the OverClock is not recommended for system operations or when storing data to SD cards. Besides the SetUp menu, there are **two faster ways to change a CPU speed** - see the section **Extra button**, page 6.

To allow a flawless **cooperation between faster CPU and external devices** plugged to the zx-expansion bus, enable the **wait state** for access to ROM.

## Joysticks (interfaces, Sega)

**Joystick** allows to switch on or off and to select: Kempston, Sinclair 1 (left) and Sinclair 2 (right). Switch off the Kempston if using some external interface with this joystick built-in. Various **Sega gamepads** are supported, with up to 8 buttons, SEGA Master and Mega Drive (Genesis) compatible.

**Joystick/Gamepad interface**  
none (disabled)  
Kempston  
Sinclair 1 (left: 12345+mn)  
Sinclair 2 (right: 67890+mn)  
Keyboard OPQA+Space+mn+bhr  
**Joystick/Gamepad type**  
standard 8-bits era  
Sega controller (3-8 buttons)

You can **redirect** a joystick or a Sega gamepad to a **keyboard**, joystick/gamepad movements and buttons will appear as keypresses of a popular keys combination Q, A, O, P and SPACE. Additional Sega buttons will be mapped to keys M, N, B, H and R.

If you want to use more than one joystick with the eLeMeNt ZX, there are already a pins prepared on the motherboard for two more connectors. This is OPTIONAL and needs to cut a hole in a computer case.

Beware, only a standard Atari joystick can be attached to the 2<sup>nd</sup> a 3<sup>rd</sup> joystick port (the FPGA redirects signals to a Sinclair type, keys 1 to 5 and 6 to 0).

## Mouse, external keyboard (USB1 and USB3)

**Mouse** is the K-Mouse with two buttons, available on the USB1 connector. If an external K-Mouse interface is plugged to the eLeMeNt, you can use the second mouse on the USB1, use the "slave" option.

**External Keyboard/Mouse**  
none (disabled)  
K-Mouse (USB1)  
K-Mouse Slave (USB1)  
Keyboard (USB1)  
Keyboard (USB1) and K-Mouse Master (USB3)  
K-Mouse Master (USB1) and Slave (USB3)

**External keyboard** (always on the **USB1**) means a PC keyboard with an USB plug, compatible with PS/2 standard. Or a keyboard with a PS/2 plug and a PS/2 to USB adapter attached to the USB1. If you have an external keyboard and a mouse connected at the same time, the keyboard must be on USB1 and the mouse on USB 3.

In case of accidental disconnection of the external keyboard, perform a **long reset** (1.5 sec) while holding down the NMI button. This action will bring the keyboard back.

A list of PC keyboards and USB mice with the PS/2 protocol you will find on [sites.google.com/view/elementzx/docs](https://sites.google.com/view/elementzx/docs). Use a "passive" USB-PS/2 adapter for old PS/2 keyboards! Most modern adapters are "splitters" with two cables for both mouse and keyboard and do not work with the eLeMeNt ZX.

## Extra button settings

**EXTRA button – long press**  
none (disabled)  
Spectrum menu

Here you can set the way the extra button is used. Set a **short press**, to toggle between ZX machines CPU speed options or GigaScreen modes. For the "**Spectrum Menu**" see page 6.

**EXTRA button – short press**  
none (disabled)  
CPU speed  
Machine  
Gigascreen  
Warm reset  
Joystick/Gamepad interface

## Audio expansions

**Audio** allows to link all outputs from various audio devices together, incl. traditional **beeper** (from ULA) and the Spectrum 128K **AY chip**. Two AY compatible sound chips joined together are known as the **TurboSound**, AY or YM types in ABC or ACB stereo modes are available, incl. the **FM synthesis**.

**Audio output**  
enable ULA audio  
enable TurboSound FM  
enable MonsterBlaster DA  
(Soundrive, Covox)  
enable SID  
enable SAA1099  
enable TAPE input

**Philips SAA 1099** is a 6-voice soundchip used in the SAM Coupé computer, for the ZX Spectrum available on the ZXM-Soundcard. The popular **SID (Sound Interface Device)** is presented in all versions 6581/8580/PAL/NTSC and prepared for future stereo (triple, quadro or more) combinations.

**TurboSound FM**  
chip model: 0-AY, 1-YM  
stereo: 0-ACB, 1-ABC

**SID**  
chip model: 0-6581, 1-8580  
frequency: 0-PAL, 1-NTSC

And finally the **MonsterBlaster**, the **D/A sound converter** with four 8bit stereo channels, for a sample based music. This hardware is compatible with the **Soundrive**. When some program „asks“ for a port number, input #3F (63 decimal).

## Graphics enhancements

The performance and design of the eLeMeNt ZX allows to combine different graphics modes in one high-quality output. The **digital video output** perfectly displays all modes and timings on all machines and eliminates imperfections such as a GigaScreen flickering.

**Timex:** switch on/off HiColor (8x1 attributes) and HiRes (512\*192 pixels, monochrome). **ULA+** provides new colour palettes, from total 256 colours.

```
TIMEX graphics modes
enable
ULApplus
enable ULApplus palettes
enable TIMEX mode selectby ULApplus regs
```

**GigaScreen** provides a mix of colours and deals with both (current and shadow) screens of two videoRAMs. For the most software, set this option to **"auto"**. Mode0 joins data from both videorams. Mode1 reads two video frames, if the program quickly alternates screens with a speed of 50Hz. Mode2 detects frame switching (or video buffer switching) and if so, it turns Mode1 on. Screens are mixed in advance and then a digital output is generated, which results into a perfect stable display. GigaScreen is popular not only in demo-software, but also used in games: see *Gyron, Nether Earth, Soldier of Light*.

```
Gigascreen - old TV/Monitor
sum colours effects
none (disabled)
mode0: 2 VRAMs always mixed
mode1: two video frames mix
mode2: autodetect mode1
```

## New graphics capabilities

The eLeMeNt ZX provides **several graphic modes**, known from the ZX-Uno or from the MB03+ Ultimate interface. They follow the original ZX and Timex resolutions (256 and 512 points per line) and are able to use a memory space of two ZX videoRAM pages.

The **KeyLayer** graphic mode allows to display image data from the second video RAM at a place of one selected color in the video RAM no. 1.

512 \* 192 pixels of **HiResColour** (HRC) and **HiResindexColour** (HRXC) modes use colour attributes and an extended, true-colour palette (better than ULA+).

**ZX-Uno's Radastan** is a neat 128\*96 graphics without attributes limitations, with 16 colours per pixel from 256 ULA+ palette and with an hardware scroll.

**HGFX** adds a powerful "planar" and "chunky" graphics, which enables to colour each individual point (pixel) with an unique indexed colour. The screen memory is relocatable (not only limited to the zx-screen area), can manage up to 8 bitplanes and consists of several modes. **LowRes** and **HiRes** modes provide resolutions of 256\*192 and 512\*192 pixels. **Fill mode** makes it easier to render 2D and solid 3D graphics. **HAM8 mode** presents images close to photographic quality with up to 98304 colours. Up to 256 colours can be selected from a large true-colour palette. **SuperHiRes** (SHR) provides a planar 512\*384 graphics with 16 colours and **PAL546** does chunky 720\*546 pixels (4 colours).

Note: Unlike old graphics enhancements, **the new graphics modes** (Radastan, Keylayer, HR(X)C and HGFX) are **not listed in the SetUp**. They are implemented in such a way that does not collide with other hardware enhancements and, if needed, they can be easily disabled by software.

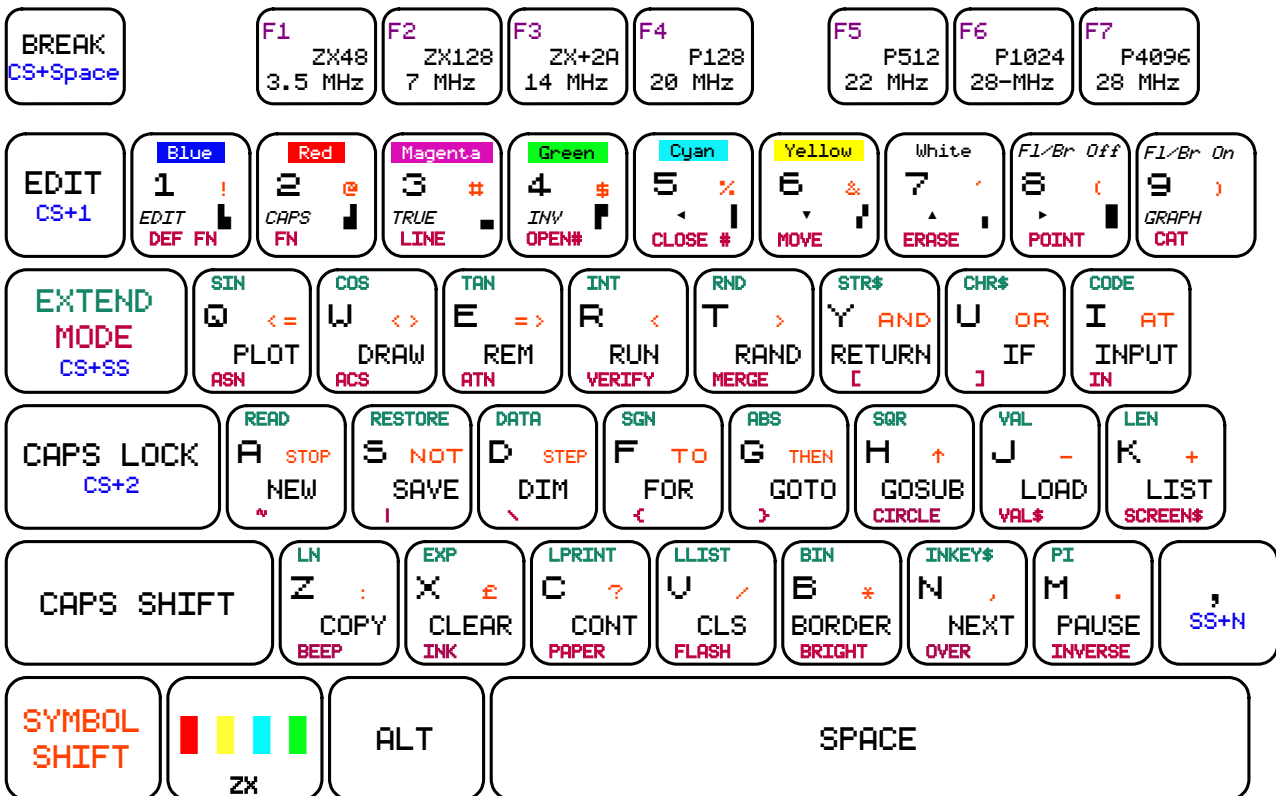
# External keyboard layout

Here is the eLeMeNt's PC keyboard layout. Use keycap stickers with other PC keyboard.

PC	eLeMeNt ZX
Win	ZX (COLOUR or Meta)
Ctrl	Symbol shift
Shift	Caps shift
Esc	Break
Tab	Extend Mode

ZX + F11	EXTRA button
ZX + F12	NMI button
ZX + P	Pause
ZX + G	GigaScreen (switch)
ZX + D	DVI mode (switch)
ZX + Alt + D	Status (diag) info
SymbolShift + Alt + Delete	Reset
SymbolShift + Alt + Space	Reset + esxDOS reboot

The ZX Spectrum Delete key is the PC Backspace, next the PC Delete key!



Shifts and extra keys of the ZX keyboard are mapped to a PC keyboard as follows:

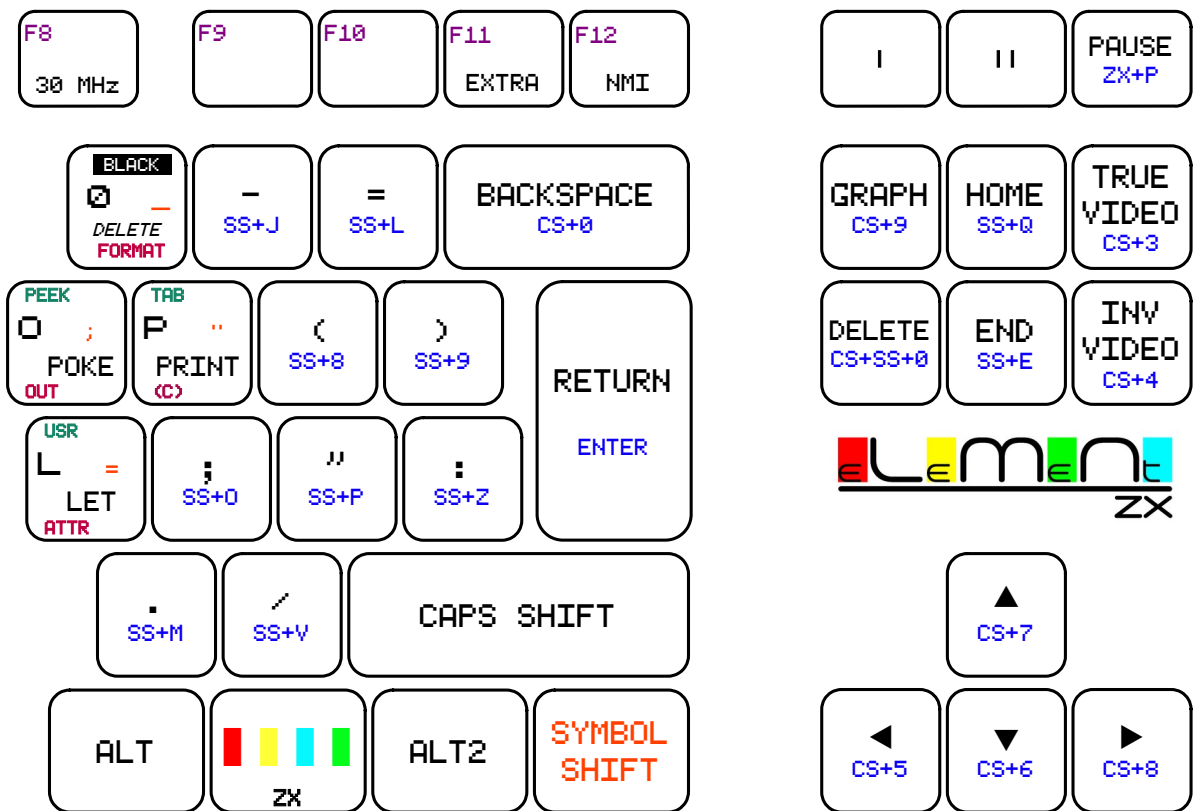
Caps Shift	Shift	:	(colon)	SS+Z	\	(backslash)
Symbol Shift	Ctrl	Left		CS+5	Left	
Extend mode	CS+SS	Tab		Down	CS+6	Down
Edit	CS+1	`	(accent)	Up	CS+7	Up
Caps Lock	CS+2	Caps Lock		Right	CS+8	Right
True Video	CS+3	Page Up		Graph	CS+9	Insert
Inverse Video	CS+4	Page Down		Delete	CS+0	Backspace
<=	SS+Q	Home			CS+SS+0	Delete
>=	SS+E	End		Break	CS+Space	Escape

**CPU speed control keys** (3.5 to 30 MHz, incl. 1T ROM Delay and Overclock) are mapped to the **ZX** key + **F1** to **F8** function keys.

**Machine type switchers** (48, 128, +2A and Pentagon memory layouts and contention) are mapped to the **ZX** key + **ALT** key + **F1** to **F7** function keys.

**esxDOS reboot:** push **reset** while **holding the Space** key or pres and release **Symbol shift + Alt** keys while **holding the Space** key

On smaller keyboards **without a separate numeric block**, the numeric keys usually take up part of the main block. In this case, after turning your eLeMeNt ZX on, press the **NUM lock** key to switch the numeric block off.



**ZX Basic colours in extended mode:**

EXT +	keys 0 to 7	key 8	key 9
no caps	paper colours	no brightness	brightness
Caps shift pressed	ink colours	no flashing	flashing

Note: Every key has a **unique (PC) scancode** and can be read in the same way as the ZX-Uno does. More details you will find in the Programmer's Reference Manual.

**Extended and shifted keys** may have different meanings in various programs, especially in numerous Pentagon/Scorpion software.

## SetUp, part II

### Scan line effect

The digital image might be too perfect for a **true retro-feeling**. Here you can choose 7 levels of a blurred quality, similar to old TVs/monitors.

**Scan Line (old CRT/TV) effect**  
none (disabled)  
1/2 1/4 1/8 1/16 1/32 1/64 1/128

### Digital video

Set **enable legacy DVI** when using an old LCD/TV. However, this option does not include a sound stream. You have to **disable** it if you want **to hear a sound** through a modern digital video output.

**Digital Video Interface**  
enable legacy DVI  
enable ULTIMATE sync.  
- only for some TVs

The ULTIMATE sync performs the best synchronization between DVI and ZX, however, this is still experimental.

### DMA

**DMA** provides a supplementary Z80-DMA chips that speeds up memory and I/O transfers. Several demos use the DMA and some games were patched for it (*Elite*, *Int. Karate A & B*, *Visitors*). Leave this option enabled for the esxDOS.

### LIFO

**IO LIFO** is a hardware (data) stack, that, among others things, improves a speed of the operating system. Leave this option enabled for the esxDOS.

### Real Time Clock, Time Zone

„Batteryless“ version of the **RTC** works till the computer is switched off. If you have previously made a Wi-Fi connection, date and time are always set when the SetUp starts.

**RTC**  
none (disabled)  
internal batteryless

### DivSD and Z-Controller (SD slots)

You can switch the esxDOS **boot** process from the Flash (ROM) memory to the unbrickable FPGA memory (Core). This is the safest way how to start the esxDOS, when something goes wrong and Rescue ROMs in memory Areas do not work. Many programs support only one SD slot. To avoid having to shuffle SD cards, there is an option of **changing the logical order of SD slots** (making a switch between SD cards no. 1 and no. 2).

**divSD**  
select esxDOS ROM: 0-FPGA (rescue), 1-FLASH  
swap order first/second SD

In addition to the divSD, it is possible to have the **Z-Controller** enabled. This is another SD interface that can be simultaneously attached to one of the SD slots. The Z-Controller is supported by

**Z-Controller SD**  
none (disabled)  
on first SD slot  
on second SD slot

great programs like *Wild Player* and *Wild Disc Copier*. Although we have only two physical SD slots in the eLeMeNt ZX, some programs can detect 3 drives (2xdivSD and one Z-Cntrl.).

### Expansion Pack A (extra RAM)

Various expansion modules can be inserted between the FPGA board and the motherboard. Still installed, they can be turned off by software and in the SetUp, so that the system does not recognize them.

The **AA-SRAM 2048-8 2MB expansion pack** increases the memory to total 4 MB. The paging mechanism is compatible with the MB03+ interface. The extra memory enables 2 MB RAM in the great *LnxCopy* tool and is also utilised in the Pentagon 4096K.

```
Expansion pack A
none
2048KB expansion memory 2MB (AA-RAM)
```

### Expansion Pack B – UART (Wi-Fi)

You can choose between three serial/UART connection types for the **ESP8266 Wi-Fi module**, from the fastest MB03+ type, through the ZX-Uno (and Karabas Pro) in the middle, to the old ZX128 serial interface.

```
Expansion Pack B – UART (Wi-Fi) & USB3
UART MB03 via USB2 to PC
UART MB03+
UART ZX-Uno
UART ZX128-AY / USB3 disabled
```

With the **USB2 to PC** option, connect the eLeMeNt ZX to a PC computer and transfer files via the USB cable. A good transfer utility is the *.SERCP* dot-command.

### Flash ROM Area (motherboard v2 only)

The eLeMeNt ZX contains a 512KB flash memory chip for firmware. Only a quarter of it, a block of 128KB can be used at once, the so-called **ROM Area**.

```
Flash ROM Area (motherboard v2)
Area 0
Area 1
Area 2
Area 3
```

**Every Area holds a whole set of ROMs**, more than a ZX BASIC interpreter. Next the BASIC ROM is the esxDOS ROM, the RescueMode ROM and free space for diagnostic software or other firmware. This allows 4 different sets of ROMs, for 4 different machines.

Every ROM Area has the same layout:

64KB	ROM0 – ROM3
16KB	esxDOS
16KB	reserved
16KB	Rescue Mode ROM
16KB	EleMeNt ZX SetUp

Recommended ROM Areas are as follows:

Area	
0	ZX128/+2 set
1	ZX128+2A set
2	ZX48 set
3	patched ROMs or DiagROMs set

Note: It is recommended to backup your original +2/+2A ROM to the one Area of the FLASH ROM.

### Diagnostic

**Diagnostic** serves for testing purposes, for visualising hardware settings and signals, shown them on the edge (in a wider area) of the border.

```
Diagnostic
none (disabled)
Video sync.
Audio level
CPU speed
Status info
Video test text pattern
Video test color moving pattern
```

# Technicals

## Rescue Mode

The Rescue Mode is a safe way to restore the system, because every Area has its own Rescue ROM. Activated by pressing both NMI and Reset buttons, while the DIP-switch no. 3 is on, the **border goes pink** and this special ROM is started. Use this mode with a misconfigured SetUp or a damaged ROM, or when you want to flash other system that does not contain a classic ROM, like the *SE4 BASIC*.

## ESP/Wi-Fi module installation

Before placing the ESP/Wi-Fi module on the expansion board, make sure that small yellow DIP switches, located in the center of the module, are in the OFF position. These Dial switch DIPs have the OFF position towards the right.

The outline of the ESP/Wi-Fi module printed on the expansion board shows the direction in which to place the module. The blue plate on the module is directed towards the edge of the eLeMeNt ZX motherboard.

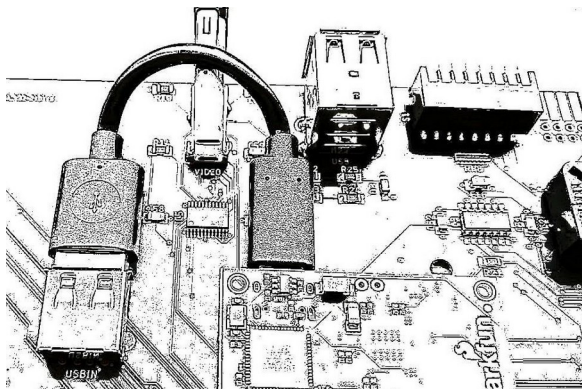
The ESP/Wi-Fi module used in the eLeMeNt ZX is a "devkit" unbrickable type, which has its own USB connector. A firmware update of the ESP/Wi-Fi module firmware can be done by an AT command or by an USB cable.

## DIP-switching to the legacy mode

The eLeMeNt ZX is equipped with a series of four small switches (DIP1 - DIP4), accessible on the back of the case, next to the expansion slot. Only one of them is currently used, other switches are intended for development purposes. Switched to the **upper position** means a DIP-switch is **OFF**. Move a switch down to set it on.

**DIP3** – legacy mode – turn it on if you plan to plug an external ROM-based devices such as divIDE, MB02+, Betadisk, PlusD or other disk controllers to your eLeMeNt ZX. Also in the case of external divSD interfaces, e.g. the *DivMMC Sindikat Edition* (with a RTC, 2x SD slots and 512KB RAM), **move DIP 3 down**.

Note: Turning DIP-3 on (moving it down) is identical to disabling the entire divSD as well as the DMA.



Inside view, from left:

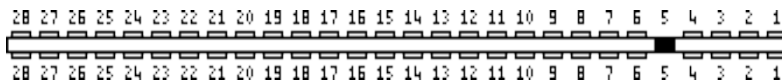
- digital audio&video output
- USB slots
- DIP switches

In the front:

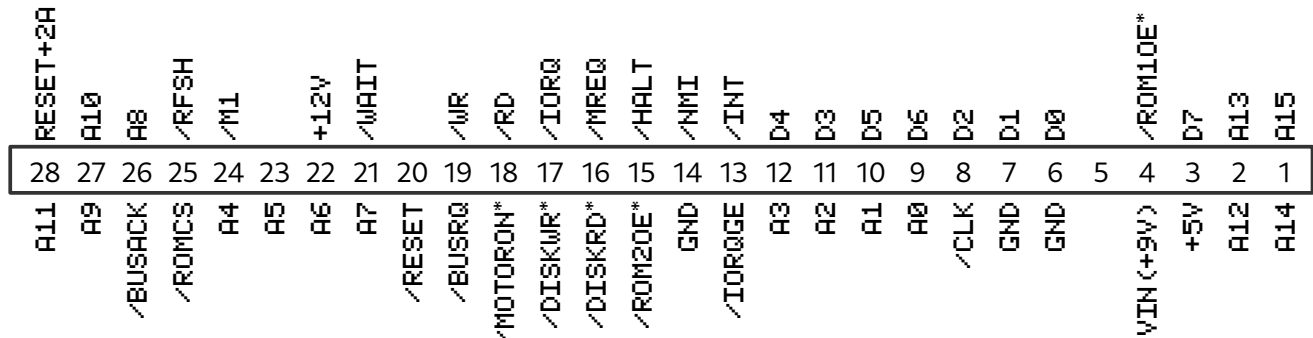
- USB power cable for the FPGA module



## System expansion bus



Upper (component) side



Lower (solder) side

Notes:

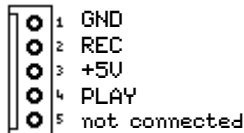
U22: +12V stabilized (max. 200mA) means you need 12V power supply to reach 12 voltage on this pin.

(\*) Signals are available only on the internal EXPO socket.

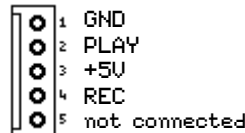
## Pinouts

View of the connectors coming out from the computer:

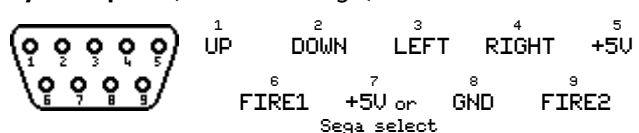
**Internal TAPE +2**



**Internal TAPE +2A**



**Joystick port (Atari and Sega)**



PLAY is IN (EAR), from tape to ULA, used for LOAD.  
REC is OUT (MIC), from ULA to tape, used for SAVE.

Pin 7: depends on Joystick type in the SetUp

## Motherboard versions

The previous version no. 1 of the eLeMent ZX motherboard has following differences:

- **two USB slots only**, the third slot must be installed via the Expansion Board B (version 2 has got the USB3 already installed)
- **microSD slots only** (two standard, bigger SD slots were added to version 2)
- **the Wi-Fi board** must be installed **with the Expansion Board B** (version 2 has a slot for an installation already prepared)
- **8 DIP switches** on the back of the computer (version 2 has only 4 DIP switches)
- **Memory Areas** cannot be switched via software, in the SetUp. **DIP7 and DIP8** were used to mechanically choose one of four Memory Areas instead.
- the **Rescue Mode** works with the DIP switch no. 5
- to **reset the ESP/Wi-Fi** module just by a reset of the computer, one wire must be soldered to the board v1 (this is an optional modification)

## Core and Firmware (SetUp) Update

Please note: you should always **update the firmware first!**

### How to flash Firmware

Flash a new firmware with the **FLASHSET(UP)** program (with a .TAP or .TAR extension). Before you start flashing, check the ROM Area. The firmware is always put into the activated Area, e.g. visible in the SetUp.

To avoid problems with a corrupted system, **do not re-flash the Area 0.**

If something goes wrong:

- goto to SetUp, section DivSD, and switch from Flash to FPGA
- or press NMI and hold a reset for 1.5 sec, the Firmware will be switched to Area 0
- or turn the computer off and on, to the Rescue Mode (see below)

### Changing ZX BASIC ROMs

To flash BASIC ROMs only, run programs named **FLASH48**, **FLASH128** or **FLASH2A** (with a .TAP or .TAR extension) in combination with a desired new ROM file. Use the **FLASHESX** for the esxDOS. To get know more, what and where to flash, study the ROM Areas, page 15.

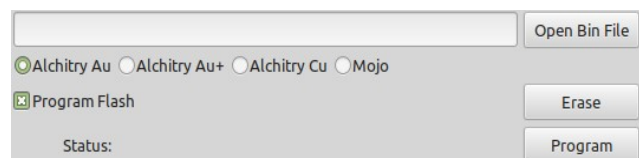
### How to flash FPGA Core

If you regularly **upgrade a FPGA Core** content, use the **ELCOREUP** program (with a .TAP or .TAR extension). This tool loads and flash a Core directly in the esxDOS, **from a SD card**. It automatically detects a FPGA module type and looks for an appropriate FPGA Core binary, named as „eL\_au.bit“ for the AU board with the Artix XC7A35T chip or as „eL\_au\_p.bit“ for the AU+ board with the XC7A100T.

Reset is not enough to run the freshly flashed Core. Power cycle the computer (off/on)!

An alternative method, **upgrade made from a PC** is still retained. Make a link between a PC computer and the USB2 (lower) port with an USB-A to USB-A cable and run the **Alchitry loader** for the Linux/Mac/Windows, from the webpage [alchitry.com/alchitry-labs](http://alchitry.com/alchitry-labs). This utility needs a Core-file named “darex.bin” (AU or AU+ version).

To flash a core, the **box „Program Flash“** must be always checked, otherwise a firmware will be stored temporarily, only until a reset of the computer.



Notes: You must upgrade with the USB cable, if you have the Core older than 2023/08. If the Alchitry loader doesn't work in Windows, please install [ftdichip.com/drivers/vcp-drivers](http://ftdichip.com/drivers/vcp-drivers)

## Troubleshooting

For each problem, a typical situation is described, followed by a hint. Please check the corresponding SetUp option (in the box).

### No sound in the digital audio

You have already checked a TV/monitor connection, the picture is brilliant, but no tune can be heard.

Turn **old DVI off**. `SetUp: Digital Video Interface / enable legacy DVI`

### esxDOS does not start after reset

The esxDOS welcome screen does not appear. Holding the SPACE key when you reset the computer (or pressing Symbol shift + Alt + Space on the external PC keyboard) does not make the esxDOS to detect a SD card.

Check, if the **DivSD is on**. `SetUp: Storage/Memory Interface / divSD 512KB`

Check the **order of SD slots**. `SetUp: divSD / swap order first/second SD`

Switch to the backup **ROM (FPGA)**.

`SetUp: divSD / select esxDOS ROM: 0-FPGA (rescue), 1-FLASH`

**Disconnect the TV/monitor cable.** Even if the computer is switched off, some TVs may still supply low power to the computer via a digital video connection. The SD is locked and needs to be totally switched off, cut off from any power.

### PC keyboard does not work

The keyboard was not initiated by startup, LED controls on the keyboard are off.

Check the keyboard compatibility. The keyboard with an USB connector should be compatible and handle the **PS/2 protocol**.

In case of a keyboard with a PS/2 connector, use a small, compact, "**passive**" **USB-PS/2 adapter** only, not a splitter-type converter for a dual keyboard and mouse connection.

The keyboard might be disconnected in the SetUp.

Perform a **long reset** (1.5 sec) while **holding down the NMI** button. After that, check the USB1 setting. `SetUp: External Keyboard/Mouse / Keyboard (USB1)`

### Start-up behaves strangely

The startup procedure is frozen. Some quirks or random colourful attributes have appeared on the screen instead of the standard welcome (ROM) message.

Flash the firmware again (see the previous page).

### Audio output is not clear

Sometimes old +2/+2A tape-recorders produce noise or audio peaks.

To avoid this issue, disable the tape input line. `SetUp: Audio output / Tape input`

## esxDOS

The esxDOS is an operating system for modern storage media, so it is an ideal system for **divSD** slots in your eLeMeNt ZX. The esxDOS has a built-in tape and betadisk (TR-DOS) layer and does all load- and save- operation within TAP, TRD and SCL files. The built-in file browser helps to access and run files stored on SD cards easily.

To re-initialize the esxDOS, press the **reset button and hold the SPACE key** while resetting. If the SD card cannot be detected this way, power off/on the eLeMeNt ZX.

### BASIC commands

The esxDOS provides a set of BASIC keywords with a customized syntax in order to support a file-handling to/from SD cards. Currently are implemented these commands:

*drive* means: \* (current drive), hd0 (main SD slot) or hd1 (second SD slot)

<b>change directory</b>	GOTO [ <i>drive</i> ] " <i>path</i> "	GOTO hd0"games"
	GOTO <i>var</i>	LET name#="games/gyron": GOTO name#
<b>list directory</b>	CAT [ <i>drive</i> ]	CAT hd0
	(or DIR in some ROMs)	
	fast dir:	CAT
	detailed list of current drive:	CAT*
<b>load file</b>	LOAD <i>drive</i> " <i>path/filename</i> " [CODE]   [SCREEN#]	
		LOAD */progs/editor.bas"
		LOAD *;name#
<b>merge file</b>	MERGE <i>drive</i> " <i>path/filename</i> "	
<b>save file</b>	SAVE <i>drive</i> " <i>path/filename</i> " [LINE]   [CODE]   [BIN]   [SCREEN#]	
	save screen picture:	SAVE *"filename" SCREEN#
	save „raw“ file without +3DOS header:	SAVE */DAT/filename" BIN 40000,25000
<b>delete file</b>	ERASE [ <i>drive</i> ] " <i>path/filename</i> "	

To recognize ZX filetypes, the esxDOS adds ZX-headers (metadata compatible with +3DOS) to a beginning of each file. However many data files can be used, saved and loaded as "raw" files, without headers. For example, a **screen picture** can be saved into a **standard SCR file** with the command `SAVE *"name.SCR" BIN 16384, 6912`

### Dot-commands

Dot-commands are system commands located in the /BIN directory on the SD card. These are executed directly from BASIC by typing a command with or without parameters.

Many basic dot-commands are quite self-explanatory, typing them without any parameter will print a short instruction. Most of them may use a syntax known from modern PCs, e.g.

```
.LS .CD .RM .MV .MKDIR .CP .MORE .FILE .TAR .CAL .DATE
```


## NMI Menu or File Browser

The esxDOS provides the simple **NMI Menu**, which serves as a filebrowser, that recognizes the most popular file formats and helps to run files. You can also make a system snapshots (store all memory to a SD).

An advanced **File Browser and Viewer** can display **long filenames** (LFN) in directory listings. Moreover it can display or play many audio and video file formats.

If needed, you can return to the original NMI menu with **CAPS SHIFT+N**.

```


Navigation: + prev page
             ↓ cursor down
             ↑ cursor up
             ↓ next page
EDIT        UP directory
ENTER      enter directory

Loading:    U view screen
            SCR SNA CODE
            I,D TAP to tapein/out
            A,B,C,D TRD to drive ABCD
            ENTER load & run
            TAP SCR SNA Z80
            TRD BASIC

Other:      SPACE exit
            R reset
            S create snapshot
            H this help

```

```

.browse ZX-UNO/esxDOS browser HELP
↑ ↓ Up / Down      + → Page Up / Down
Select key:        Open folder / file

Caps Shift + Q:    Go to first entry
Caps Shift + R:    Go to last entry
Caps Shift + P / Delete: Parent folder

Caps Shift + X / Break: Exit browser
Symbol Shift + X:  Exit (Reset)

Caps Shift + R:    Show file information
Caps Shift + U:    Attach disk image
Symbol Shift + U:  Eject disk image
Caps Shift + I:    Open .TAP for Input
Caps Shift + O:    Open .TAP for Output
Symbol Shift + I:  Eject .TAP for Input
Symbol Shift + O:  Eject .TAP for Output
Caps Shift + T:    Tape Browser

Caps Shift + H:    Show these help pages

```

```

.browse ZX-UNO/esxDOS browser HELP
Caps Shift + E:    Erase file
Symbol Shift + R:  Rename an 8.3 file / folder
Caps Shift + D:    Create an 8.3 folder

Symbol Shift + C:  Copy file to clipboard
Symbol Shift + T:  Cut file to clipboard
Symbol Shift + P:  Paste file from clipboard

Symbol Shift + F:  Toggle fullscreen mode
Caps Shift + F:    Find files in folder

Caps Shift + Z:    Create folder cache
Symbol Shift + Z:  Delete folder cache

Sym Shift + 1 - 9: Launch defined speed dials
Symbol Shift + 0:  Make selection a speed dial

Caps Shift + U:    View file as hex
Sym Shift + U:     View file as text

```

```

.browse ZX-UNO/esxDOS browser HELP
Caps Shift + N:    Launch default NMI.SYS
Caps Shift + S:    Save .sna file 48/128
Caps Shift + K:    POKE memory

Symbol Shift + L:  Lock 128k memory paging

[ ZX-Spectrum 128k NMI Browser ]
Please refer to manual for more details.

```

## Configuration files

There are two text files ESXDOS.CFG and TRDOS.CFG in the directory /SYS/CONFIG, for setting up the esxDOS itself and for the TR-DOS emulation. All options are already set so that software runs to the best user's satisfaction, here are some examples to check:

- |            |                       |   |
|------------|-----------------------|---|
| TRDOS.CFG  | <b>AlwaysBoot</b>     | if a boot-file is missing, TR-DOS Navigator starts with TRD/SCL files |
| ESXDOS.CFG | <b>AutoBoot</b>       | a way the /SYS/AUTOBOOT.BAS file starts                               |
| ESXDOS.CFG | <b>AutoLoadColour</b> | depends on BORDER colour you like                                     |
| ESXDOS.CFG | <b>DMA timings</b>    | in the eLeMeNt make the best transfer speed ever available for ZX     |

## How to prepare a card for the divSD

SD cards must be FAT16 or FAT32 formatted (depending on the size, less than 2GB or more). A suitable tool is the **SD Formatter**, [www.sdcard.org](http://www.sdcard.org). An easy point-and-click tool for Linux is the **Gparted**.

To get the best performance, copy to a new formatted card **SYS and BIN folders first!** Please also note, that the system will give you quicker responses with bigger clusters of the SD card.

## Compatible system ROMs

These patched or improved ZX BASIC ROMs were tested and work with the esxDOS and its NMI system: **Pretty** (Colour) ROM, **64Char** ROM, **GAMA81** ROM, **GW03** ROM and **ZXDIR** ROM. Nowadays, new esxDOS commands can do the same job as many functions in older patched ROMs did.

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## Useful links

<a href="http://128land.com">128land.com</a>	news, manuals, fpga core and firmware updates
<a href="https://t.me/eLeMeNt_forum">t.me/eLeMeNt_forum</a>	Telegram <b>info-channel</b> – help, news, beta-software
<a href="http://ilnx.cz/element-zx">ilnx.cz/element-zx</a>	<b>premium software</b> - copier, file (SD) manager, viewer, editor
<a href="http://esxdos.org">esxdos.org</a>	FAT-based <b>operating system</b> for DivSD
<a href="http://thefossilrecord.co.uk">thefossilrecord.co.uk</a>	LFN <b>file browser</b> and NMI menu for esxDOS
<a href="http://zxart.ee">zxart.ee</a>	great site with <b>zx-enhanced software collection</b> (and more)
<a href="http://vtrd.in">vtrd.in</a>	all <b>Betadisk</b> software collection
<a href="http://element.zxfiles.net">element.zxfiles.net</a>	eLeMeNt ZX resources
<a href="http://vym.cz/sercp/">vym.cz/sercp/</a>	USB- <b>PC link</b> utility, serial copier
<a href="http://sarah.speccy.cz">sarah.speccy.cz</a>	FTP manager for eLeMeNt ZX/MB03+
<a href="http://ilnx.cz/lxsp">ilnx.cz/lxsp</a>	LnxSpectrum <b>emulator</b>
<a href="http://www.dadither.com">www.dadither.com</a>	graphics PC <b>converter</b>

ZX BASIC: [worldofspectrum.org/ZXBasicManual/](http://worldofspectrum.org/ZXBasicManual/)  
[worldofspectrum.org/ZXSpectrum128Manual/](http://worldofspectrum.org/ZXSpectrum128Manual/)  
<https://zxspectrumvault.github.io/Manuals/Hardware/SpectrumPlus3Manual.html#chapter8>

The author of the eLeMeNt ZX would like to thank...

```
Chris Smith . ULA internals
Zbyněk Krajča . eLeMeNt logo design
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Milan Šťáva . testing
Miguel Guerreiro . esxDOS
Kamila Kučerová . eLeMeNt brand / support
Pavel Vymetálek . board production
Josef Prokeš . user manual / web
```

## How to control eLeMeNt ZX hardware in ZX BASIC

Apart from the SetUp, you can change any hardware setting quickly by sending a value to system ZXi ports. Speed up the system or switch to another machine (memory and timing) temporarily. Use the OUT command of the ZX Spectrum BASIC and type:

for machine:	OUT 30779,0: OUT 31035,0	48K
	OUT 30779,0: OUT 31035,1	128K/+2
	OUT 30779,0: OUT 31035,3	+2A
	OUT 30779,0: OUT 31035,6	Pentagon 512K
	OUT 30779,0: OUT 31035,7	Pentagon 1024K v2.2
for Wi-Fi:	OUT 30779,57: OUT 31035,1	MB03+
	OUT 30779,57: OUT 31035,2	ZX-Uno / Karabas Pro
	OUT 30779,57: OUT 31035,3	AY/128
for CPU speed:	OUT 30779,48: OUT 31035,0	3.5 MHz
	OUT 30779,48: OUT 31035,1	7 MHz
	OUT 30779,48: OUT 31035,2	14 MHz
	OUT 30779,48: OUT 31035,3	20 MHz
for joystick:	OUT 30779,3: OUT 31035,0	off
	OUT 30779,3: OUT 31035,1	Kempston
	OUT 30779,3: OUT 31035,2	Sinclair (left)
	OUT 30779,3: OUT 31035,3	Sinclair (right)
for Timex:	OUT 30779,16: OUT 31035,1	on
for ULA+:	OUT 30779,17: OUT 31035,1	on
for Z-Controller:	OUT 30779,28: OUT 31035,2	use SD slot no. 2
extra button (short press):	OUT 30779,32: OUT 31035,0	this holds a CPU only
	OUT 30779,32: OUT 31035,1	CPU speed switch
	OUT 30779,32: OUT 31035,2	machine type switch
	OUT 30779,32: OUT 31035,3	GigaScreen type switch
	OUT 30779,32: OUT 31035,4	warm reset
	OUT 30779,32: OUT 31035,5	joystick type switch

There are settings that not only do a switch, but set multiple options at once. Before you turn a particular option on/off, inspect a state of the relevant ZXi port:

```
OUT 30779,1: PRINT IN 31035
```

This example reads a value of the Audio output register. You can check now what audio chip is set on. From positions 0 to 4, single bits of the read number hold states of: ULA audio (beeper), AY/TurboSound FM, Monsterblaster/Soundrive AD, SID (C64 sound chip) and SAA1099 (Sam Coupe sound chip.). Type your new settings then, here is an example:

```
OUT 31035,9 ; turn beeper and SID on (bits 0 and 3 are set)
```

The order of SD slots can be changed by `OUT 30779,29: OUT 31035,3`

This assigns the SD slot no. 2 to the first SD position (used as HD0 in esxDOS).

See other hardware ports in the Programmer's Manual at [www.128land.com](http://www.128land.com). When OUTing, you have to know exactly what to do, otherwise you may freeze your system.