



ZX-HD

The **HDMI interface** for the ZX Spectrum
With **64 color ULAplus™** support!



Manual

ZX-HD firmware v1.4

***Read this manual before using the
ZX-HD interface!***

Manufactured by Ben Versteeg

BYTEDELIGHT

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The manual is intended to provide the user with detailed information adequate for the efficient installation and operation of the equipment involved. 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.

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

The ZX-HD requires to solder a pin header block to a Raspberry Pi Zero yourself, and to assemble the ZX-HD. ByteDelight assumes no liability with defects resulting from errors in this process.

**Send your feedback to this manual or the ZX-HD to:
zx-hd@bytedelight.com**

Introduction

The ZX-HD - the first HDMI interface for any ZX Spectrum!

Connect your ZX Spectrum to a modern TV through HDMI

– no more composite video or antenna!

ULTRA SHARP + 64 colours on your ZX Spectrum!

Main features

- Totally transparent - no change needed to your ZX Spectrum
- Crystal clear and ultra-sharp picture!
- ULAplus™ – enjoy games with 64 colours!
- ZX Spectrum 128 video memory support: works with any software that uses both video buffers!
- Synchronous to ULA timing – software with border and multicolour effects run as it should!
- Colours have been thoroughly calibrated to keep the unique feel of the ZX Spectrum

Compatibility

The ZX-HD is fully compatible with all Sinclair ZX Spectrum models:

ZX Spectrum 16K, 48K, 48K+, 128K, +2, +2A, +2B, +3, Harlequin kits and some clones.

Check the ‘Troubleshooting’ paragraph if you do not get video from your ZX-HD.

In the box

The box contains:

- ZX-HD circuit boards
- ZX-HD front shell and back plate and set of 4 screws
- Micro SD memory card with micro SD to SD adapter
- Mini-HDMI to HDMI cable
- This printed manual

Other required parts and tools:

- A small Philips screwdriver to assemble the case
- A Raspberry Pi Zero, with soldered 2x20 pin male pin header block*
- A soldering iron to solder the pin header block to the Raspberry Pi Zero (if not yet done)#

* HDMI licensing rules prevents selling the ZX-HD with Raspberry Pi Zero.

You can buy a Raspberry Pi Zero at e.g. Pimoroni.com or Pihut.com.

Make sure you order the Raspberry Pi with 2x20 pin male pin header block.

Also make sure to solder the pin header block at the correct side of the Raspberry Pi Zero!

See the paragraph “Assembling your Raspberry Pi Zero” for detailed information

#ByteDelight offers a free service of assembling the pin header block to the Raspberry Pi Zero.

Check out zx-hd.bytedelight.com for more information.

Known limitations

- The ZX-HD is not compatible with the (Eastern European) Pentagon ZX Spectrum clone;
- The ZX-HD is 99.99% synchronous to the ZX Spectrum ULA, but some very fast so-called ‘border effects’ may be just a bit out of sync;
- The ZX-HD does not have audio over HDMI – check the “Adding sound” chapter for more info;
- Although the latest ULApplus™ status register can be read, it is currently not possible to read the ULApplus™ palette values, but there is no software that uses that feature (the games that use ULApplus™ only set the 64 colour palette) - we will integrate the feature in the future;
- The ZX-HD ULApplus™ implementation currently does not yet support Timex modes and HAM256 and HAM8x1 modes (which are all optional ULApplus™ features);
- The ZX-HD synchronous ULA functionality has not yet been tested or adapted to NTSC models of the ZX Spectrum or Harlequin kits;
- The ZX-HD seems to have issues with an Interface 1 attached; we’re analyzing the problem.

Interlaced Mode

The ZX Spectrum 128 models (the ‘toastrack’, grey +2, black +2A and +3) have 2 video memory pages. The ZX-HD supports using these two video memory pages.

The ZX-HD even supports software that very quickly switches between these video pages to achieve a so-called ‘interlacing’ of two screen pages.

When the ZX-HD detects that screen pages change with every of 4 consecutive screen updates, it automatically switches to ‘Interlaced Mode’. If no screen page change is detected during four consecutive updates it will switch back to normal mode.

In the ZX-HD Interlaced Mode the number of displayed screen lines is doubled, hence the resolution of the HDMI framebuffer is doubled, and the odd or the even screen lines are updated one after the other. This results in the two different screen pages being displayed simultaneously.

One reason why the Interlaced Mode is not used permanently, is that the odd/even screen line updates only refresh half of the screen content at a time: if there is a quickly moving object on the screen, two different phases of the movement can be seen simultaneously which may result in a bit odd look.

You can override the automatic Interlaced Mode in the cmdline.txt file on the micro SD card of the ZX-HD containing the ZX-HD firmware. More information is found in that file.

DivMMC EnJOY! / DivMMC EnJOY! mini users

When connecting the ZX-HD with a DivMMC EnJOY! to a ZX Spectrum 128 ‘toastrack’, DIP switch 4 of the DivMMC EnJOY! needs to be switched OFF.

When connecting the ZX-HD with a DivMMC EnJOY! mini to a ZX Spectrum 128 ‘toastrack’, DIP switch 3 of the DivMMC EnJOY! mini needs to be switched OFF.

Keeping this DIP switch ON will prevent the system from starting correctly with this setup.

Prepare your ZX Spectrum

Make sure the ZX Spectrum's edge connector is clean!

It's important that your ZX Spectrum has a clean edge connector when connecting any add-on to it – many problems and even defects have been caused by dirty edge connectors in the past. Advised is to use cotton swabs with pure alcohol.

Connecting the ZX-HD

Always disconnect the power from your ZX Spectrum before connecting any interface!

Connect the ZX-HD to your ZX Spectrum carefully.

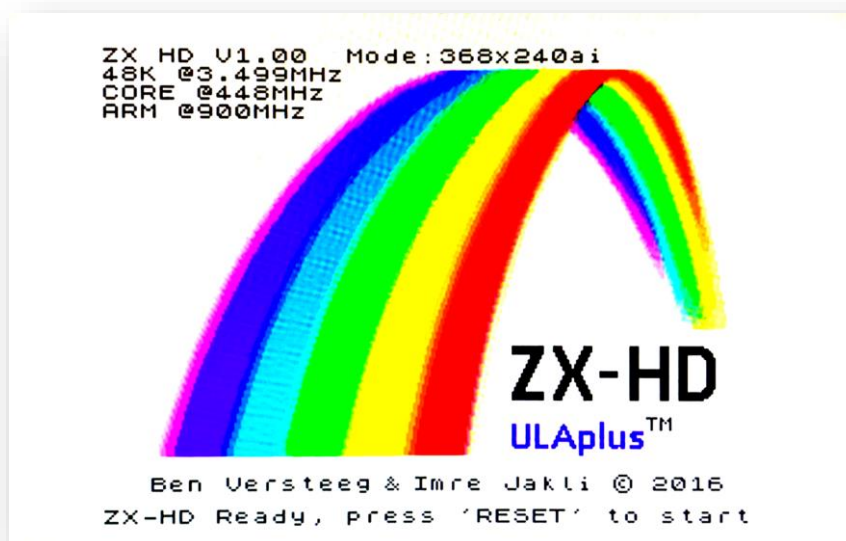
Connect the mini-HDMI plug from the HDMI cable, to the mini-HDMI socket of the ZX-HD.

Connect the other side of the cable to your TV.

Starting up the system with ZX-HD

Always first power on your TV before powering up your ZX Spectrum: the ZX-HD negotiates the HDMI output resolution with the TV.

Next you can power up your ZX Spectrum, which should result in this boot screen in a few seconds:



At the top of the screen you see information about the automatically detected speed of your ZX Spectrum which the ZX-HD calibrated itself to, and the Raspberry Pi speeds.

The "Mode:" shows the output resolution and the mode, either:

- ai: automatic Interlaced Mode (default)
- fi: forced Interlaced Mode
- fp: forced disable of Interlaced Mode

These options can be changed in the cmdline.txt file on the micro SD card of the ZX-HD.

At the bottom you see the message that the RESET button should be pressed to continue. The ZX-HD has a reset button at the front.

Adding sound

The ZX-HD currently does not have sound over HDMI.

Separate analog sound

Many TV's have the option of adding analog sound to an HDMI signal separately by a 3.5mm stereo mini-jack input socket. Check your TV's manual to find out if your TV has this function.

If so, you can use a mono or stereo mini-jack (some ZX Spectrums have a modified stereo output or external stereo soundcard such as the ZX-AY) to stereo mini-jack cable.

Adding sound using external speakers

Of course a great solution to add sound to your ZX Spectrum with ZX-HD is by using an external set of speakers.

Almost all speaker sets have a stereo plug. When using a mono audio output on your ZX Spectrum (such as the MIC socket), this may result in only hearing the audio from one speaker.

To solve this, you will need to use something like an adapter cable or modify the speakers cable.

Firmware upgrades

There are two types of firmware on the ZX-HD:

- The CPLD chip in the ZX-HD circuit boards
- The firmware on the micro SD card for the Raspberry Pi Zero

Firmware on the micro SD card for the Raspberry Pi Zero

To know which firmware version you are currently using, simply boot up your ZX Spectrum with ZX-HD and check the ZX-HD boot screen.

At zx-hd.bytedelight.com you can find the latest firmware version for the firmware on the micro SD card, including upgrade instructions.

The CPLD firmware

The CPLD firmware won't change quickly.

It's not possible to upgrade the CPLD firmware without additional programming hardware.

ByteDelight offers a CPLD firmware upgrade service in case there is a potential future CPLD firmware upgrade that creates new features.

If there is a new CPLD firmware version, it will be listed at zx-hd.bytedelight.com, including more information about the CPLD firmware upgrade service.

Customizing HDMI output settings

It's possible to modify the configuration of the ZX-HD by editing the configuration files on the included SD card.

The HDMI color output can be set by the user, with the choice of a vivid color set (default), or one that is calibrated to composite video output of the ZX Spectrum, or a custom set of colors. More information is found in the [cmdline.txt](#) file on the micro SD card of the ZX-HD.

The [config.txt](#) file on the micro SD card of the ZX-HD can be changed for these settings:

- To stretch the video output to the dimensions of your display, e.g. 16:9
- To remove the small black border around the video output (this may however result in pixels not having exactly the same width or height)

Troubleshooting

No picture and blue ZX-HD led stays off

It sounds as if there is a short-circuit: check the soldering contacts on the Raspberry Pi Zero.

No video output

Always first power on your TV before powering up your ZX Spectrum: the ZX-HD negotiates the resolution with the TV.

If you do not get video output of your ZX-HD, this may be caused by a display or other HDMI device that does not return EDID (Extended Display Identification Data) which is needed by the ZX-HD to determine the output resolution settings.

However there are some ways of solving this by adding one or more of the below configuration sets to the [config.txt](#) file on the micro SD card of the ZX-HD.

Try one set at a time and a combine them only if there is no result:

Set 1	# try to boot with maximum HDMI compatibility: hdmi_safe=1
Set 2	# ignore EDID/display data if your display doesn't have an accurate EDID: hdmi_ignore_edid=0xa5000080
Set 3	# force output resolution hdmi_group=1 # and only one of these: hdmi_mode=8 #240p hdmi_mode=9 #240p 16:9 hdmi_mode=12 #240p quadrupling hdmi_mode=13 #240p quadrupling 16:9 hdmi_mode=23 #288p 50Hz hdmi_mode=24 #288p 50Hz 16:9 hdmi_mode=27 #288p 50Hz quadrupling hdmi_mode=28 #288p 50Hz quadrupling 16:9

Other problems

Check the soldering contacts on the Raspberry Pi Zero.

Check zx-hd.bytedelight.com for more troubleshooting hints.



ULAplus™ is an extension to the original ULA specifications, developed by Andrew Owen. The main feature is the possibility of showing 64 colors on screen at a time.

ULAplus™ is a trademark of Chloe Corporation. ULAplus™ is a royalty-free open format. The official ULAplus™ specification is released under the Creative Commons Attribution-Share Alike License.

The official ULAplus™ specification is found at:

facebook.com/notes/cheveron-group/official-ulaplus-specification/1348777308496825

Basic ULAplus usage

ULAplus™ ports

ULAplus register port: #BF3B (48955)

ULAplus palette port: #FF3B (65339)

Enabling ULAplus™

OUT 48955,64: OUT 65339,1

With no palette set this will result in a black screen!

Disabling ULAplus™

OUT 48955,64: OUT 65339,0

Setting the 64 palette values

OUT 48955,[palette number 0..63]: OUT 65339,[palette value 0..255]

Find software with ULAplus™ colours

You can find a lot of software that takes advantage of the ULAplus™ features at these websites:

zx-hd.bytedelight.com

sites.google.com/site/ulaplus

abrimaal.pro-e.pl/zx/ulaplus.htm

These websites contain some very cool utilities, such as Image2ULAplus to convert e.g. JPG to ULAplus™ screen that can be shown on a ZX Spectrum with ZX-HD, or ZX Paintbrush to edit ULAplus™ screens.

Visit the ULAplus Facebook group

www.facebook.com/groups/ULAplus

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Manufactured by Ben Versteeg

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ZXspectrum.shop