In this article, we will help you create a custom DMD to use with Batocera. We are using ZeDMD as a basis as it's a cost-effective yet powerful solution, and now fully supported on Batocera 40+.

First, the final result

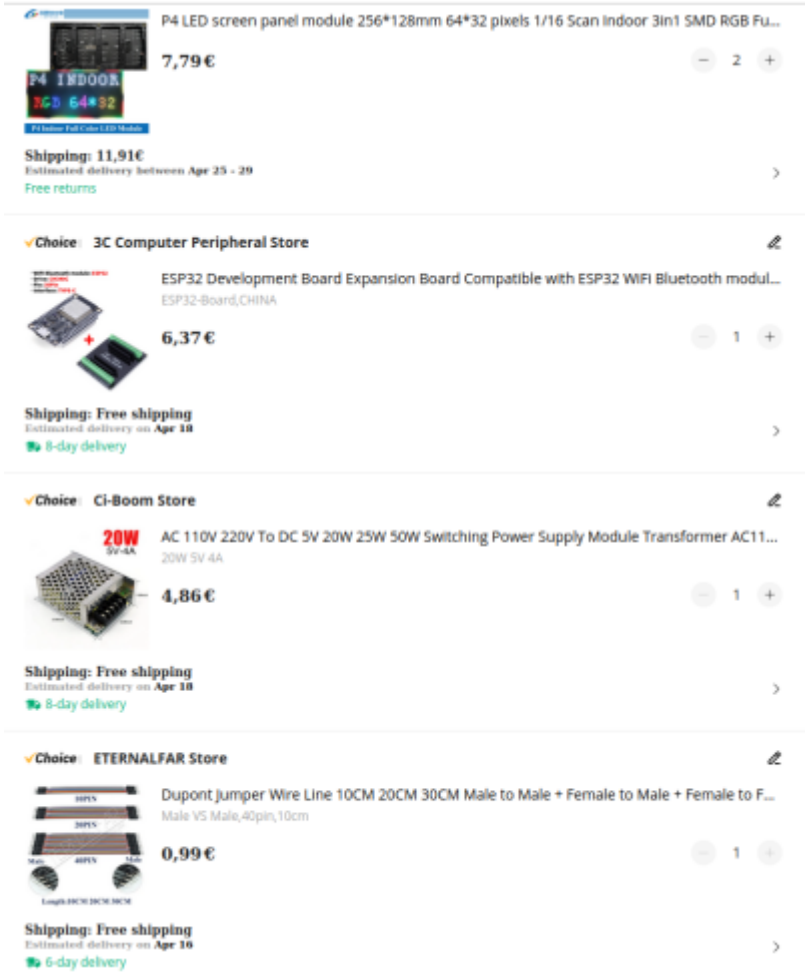
Step 1 : purchase the hardware

The shopping list:

- 2 DMD panels (don't forget to choose two of them) DMD Panels
- 1 ESP32 and its shield ESP32+shield
- 16 male/male 10cm jumpers Jumpers
- 1 power supply Adjustable power supply or Switch-mode power supply - **Note**: the power supply is optional if you build a 32×128 DMD (but is required for resolutions 256×64 and above).
- 1 plug Plug (only if you put a power supply)

You probably already have a plug at home.

Total cost including shipping: 39€ (on 2024 April 8).



Step 2 : Put the hardware together

Step 2.0 - external links

- ZEDMD project
- Original tutorial (en)
- Original tutorial (fr)
- Video tutorial (fr)

The original tutorials are not related to batocera.linux, but may be very useful to get some reference information.

The hardware part is the same for Batocera. However, the course of action for software configuration at the end is a little bit different.

Step 2.1 - Getting a power supply (for HD matrix)

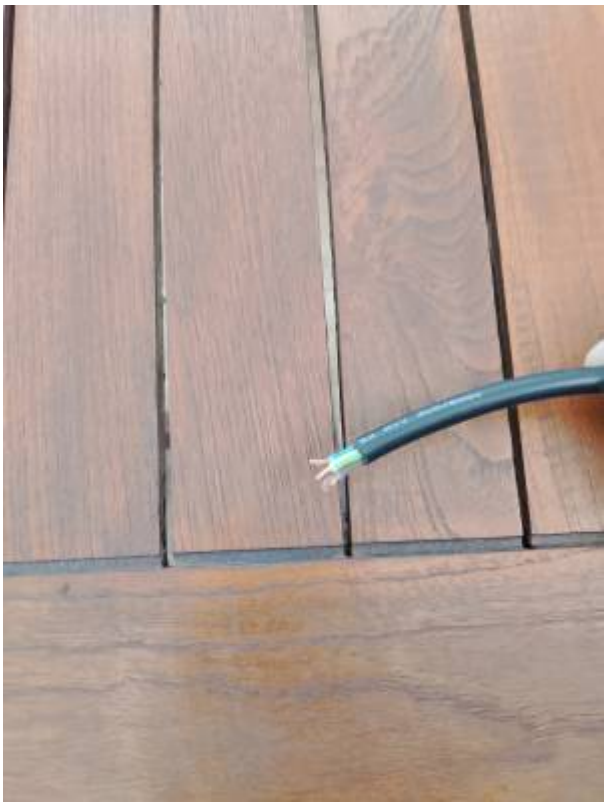
Based on the display being used, some pixels may be too bright (causing glare and artifacts) or too dark (not visible), so it is useful to have a power supply with adjustable voltage. A power supply with universal terminals and an adjustable voltage is preferred, with the ability to use voltages near 5 volts at 2 amps. The more finely you can tune the voltage the better for adjustment.

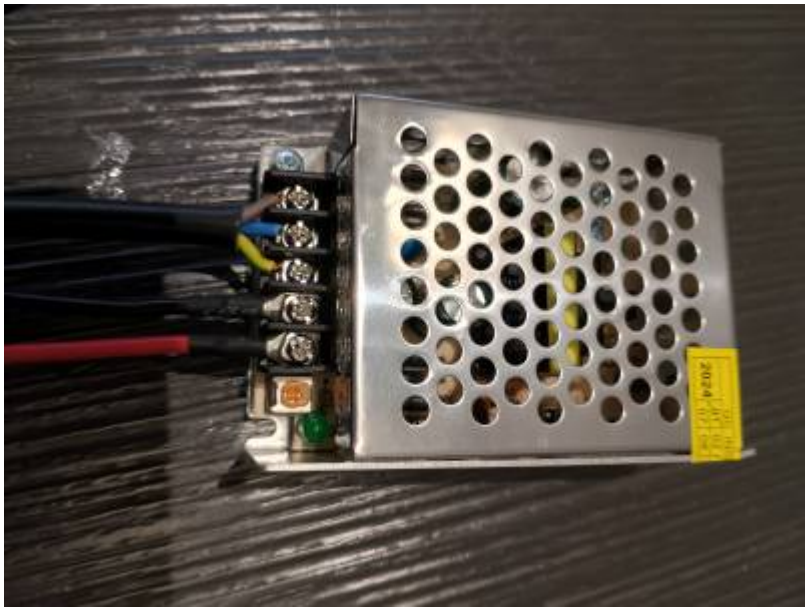
It's also possible to get a static power supply voltage and then reduce its voltage by use of diodes (be careful of heat if only using a small amount of diodes):
https://www.youtube.com/watch?v=x-p5LYgdEu4

Cut your own power wire

As an alternative to using a wall-wart power supply as pictured above, it is possible to splice a regular high-voltage power cable and connect that to a switch-mode power supply.

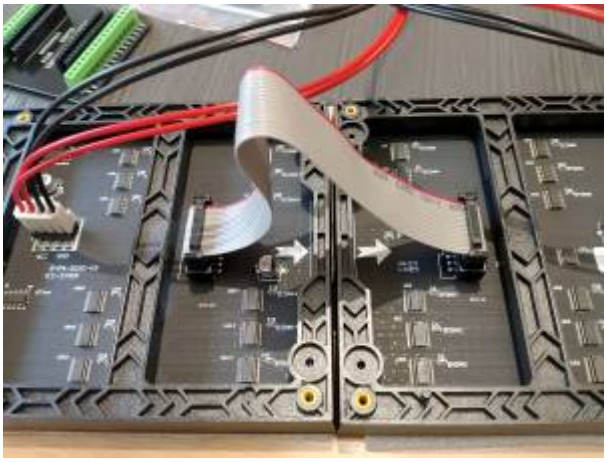
Incorrect wiring with power lines up to 240V can result in death by electrocution, exercise caution if choosing to go this route. If you have any concerns, use a universal power supply as specified above.

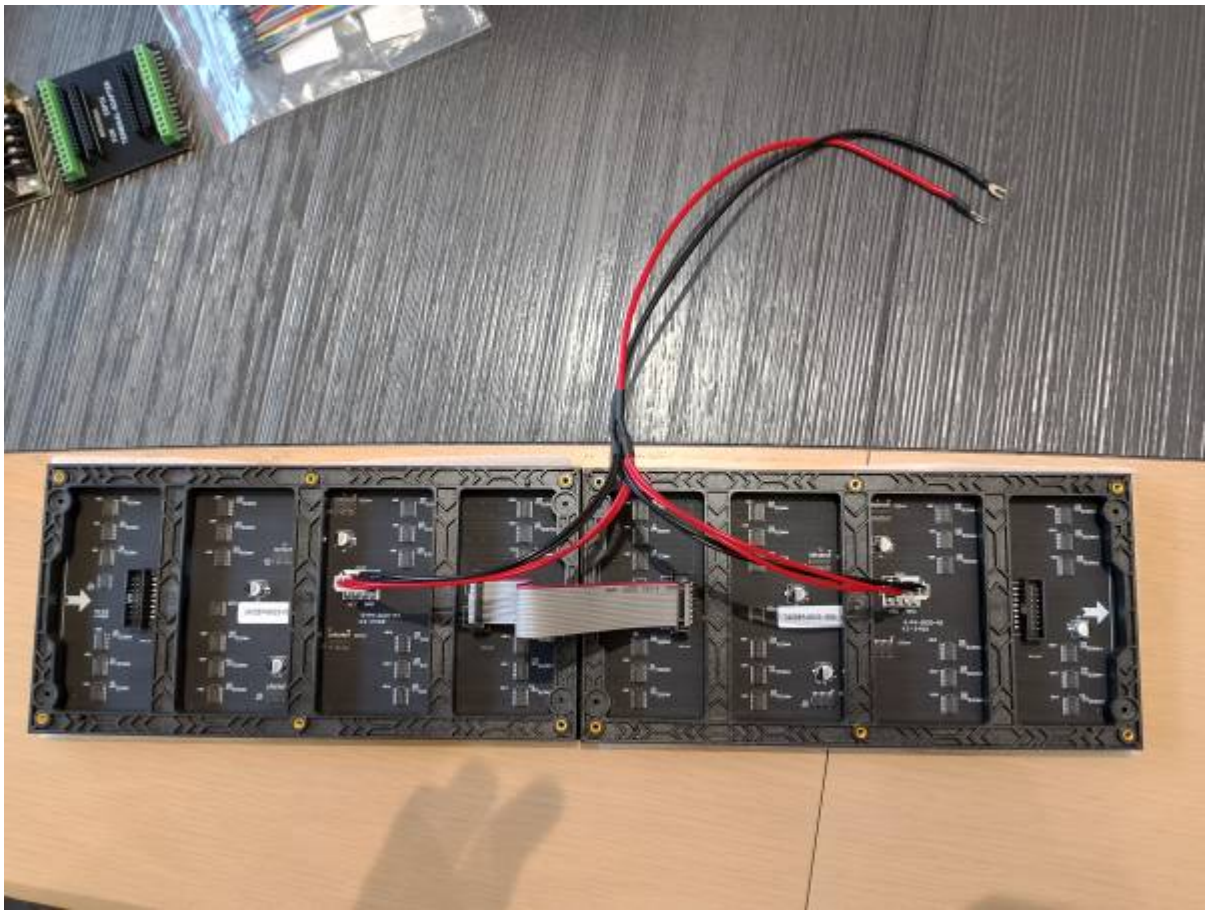




Step 2.2 - Plug LED matrices together with data and power wires

The data and power wires for the matrices are usually bundled with the matrices. Just plug them. Note that white arrows must go from left to right.



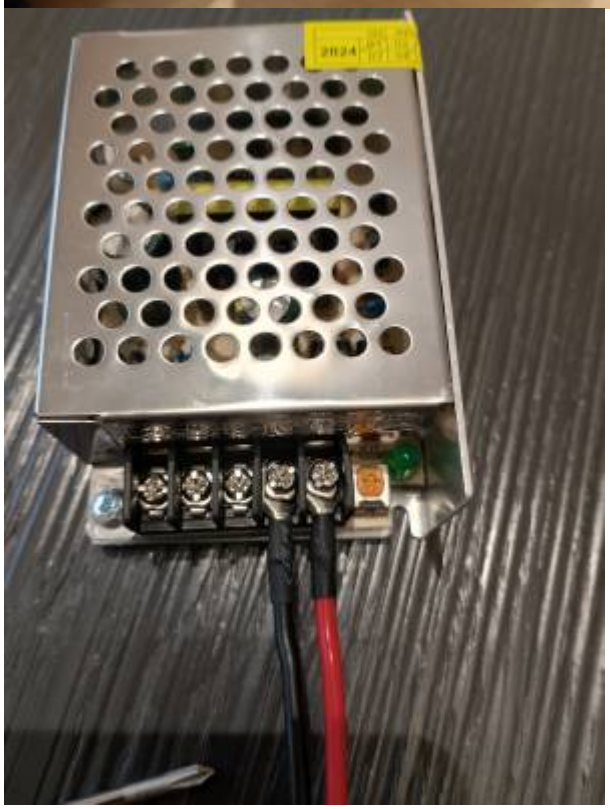


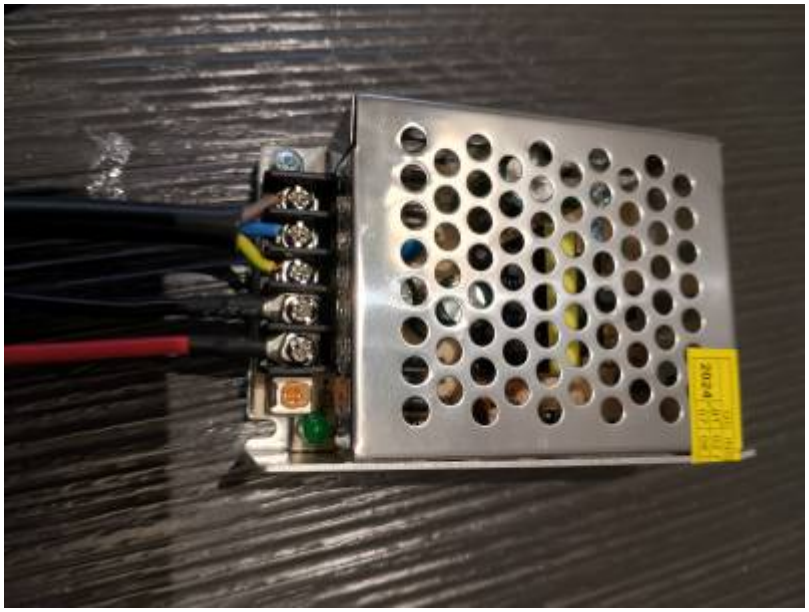
Step 2.2 - Plug the AC/DC power converter

Plug the 220V power on the AC (if you live in a 110V country, make sure you have the right AC/DC converter, and obviously the right plug). **Be careful** with the polarity of the wires, not all regions will use the same color-coding to indicate their polarity. Generally, the color code of AC wires are Phase (brown), Neutral (blue) and Ground (yellow/green).

Plug the 5V connector, and make sure you connect the correct polarity.

The orange screw on right of the AC/DC converter can be used to adjust the 5V voltage. It is necessary in case the image is not perfect, and the LEDs are “bleeding” a little bit. See the pictures below, in general, adjusting the screw to power down a bit the the voltage makes the image better.

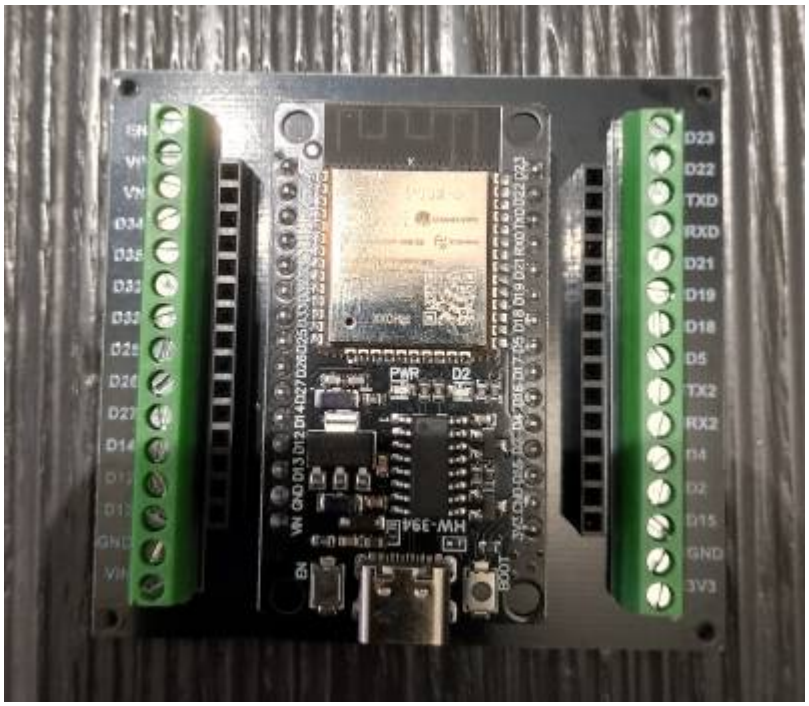




Note: If you build a 32×128 DMD (**not** a “DMD HD” with a higher resolution), you can skip the power supply, and use the ESP32 microcontroller to power the LED matrices. It will draw current from the USB connection to the PC, and if the PC provides USB 2.0 or higher, i.e. most PC built in the past 20 years, it should be sufficient to power both the microcontroller and the LED panels connected to it.

To do so, you need to connect the red power wire from the LCD panel to the VIN pin on the ESP32 (5V) and the black wire to the GND pin (ground).

Step 2.3 - Microcontroller



Insert the ESP32 in its shield. This will be an easier way to plug the jumpers, as this will be a required part of the setup at a later stage.

Before plugging in the ESP32 board into the computer (ideally a computer running under batocera.linux), run the following command:

```
ls /dev/ttyUSB*
```

The result can be an error (`no such file or directory`) or a list of files (`/dev/ttyUSB0` or `/dev/ttyUSB0 /dev/ttyUSB1` or ...)

Now, plug the ESP32 USB-C connecter to a USB port on that computer.

Run the `ls` command again the command, so that you can identify the device name the ESP32 microcontroller takes:

```
ls /dev/ttyUSB*
```

As a general rule, you would have gotten a `no such file or directory` error message before plugging in the ESP32, but now you should see a device name like `/dev/ttyUSB0` once plugged in. This means that the ESP32 can now be identified as a Unix pseudo-file `/dev/ttyUSB0`.

In case you had a `/dev/ttyUSB0` device before pluggin in, you would now get `/dev/ttyUSB0 /dev/ttyUSB1` once the ESP32 is connected. This means that the ESP2 can now be identified as a Unix pseudo-file `/dev/ttyUSB1`.

Execute the following command, and don't forget to replace `ttyUSB0` by `ttyUSB1` if necessary, based on the previous explanation.

For Batocera 42 and later (ZeDMD version 5.x.x required)

```
wget https://github.com/PPUC/ZeDMD/releases/download/v5.1.7/ZeDMD-128x32.zip
unzip ZeDMD-128x32.zip
wget
https://github.com/espressif/esptool/releases/download/v4.8.1/esptool-v4.8.1
-linux-amd64.zip
unzip esptool-v4.8.1-linux-amd64.zip
chmod a+x ./esptool-linux-amd64/esptool
./esptool-linux-amd64/esptool --port /dev/ttyUSB0 --chip esp32 write_flash
0x0 ./ZeDMD.bin
```

For Batocera 41 and earlier (ZeDMD version 3.x.x required)

```
wget https://github.com/PPUC/ZeDMD/releases/download/v3.6.0/ZeDMD-128x32.zip
unzip ZeDMD-128x32.zip
wget
https://github.com/espressif/esptool/releases/download/v4.7.0/esptool-v4.7.0
-linux-amd64.zip
unzip esptool-v4.7.0-linux-amd64.zip
chmod a+x ./esptool-linux-amd64/esptool
./esptool-linux-amd64/esptool --port /dev/ttyUSB0 --chip esp32 write_flash
0x0 ./ZeDMD.bin
```

The first line downloads the ZeDMD firmware for a 128×32 matrix. Note that batocera 42 requires ZeDMD 5.1.5 or over. And previous versions of batocera requires versions before 5.x.

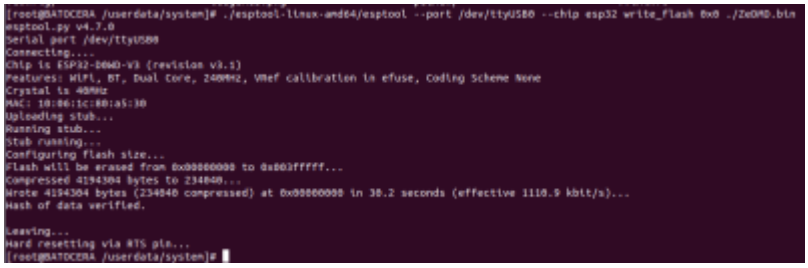
The second line unzips it.

The 3rd line downloads the tool we are going to use to flash the firmware on the ESP32 board.

The 4th line unzips that tool.

Th 5th line makes the tool executable.

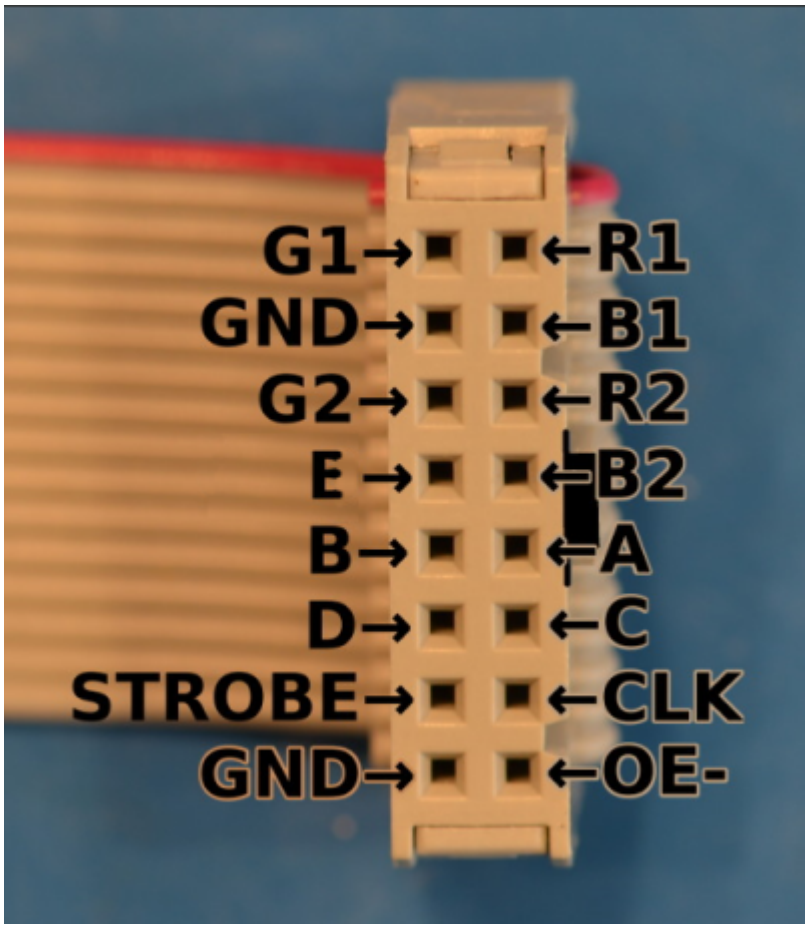
The last line flashes the firmware on the ESP32 device conencted as `/dev/ttyUSB0`.



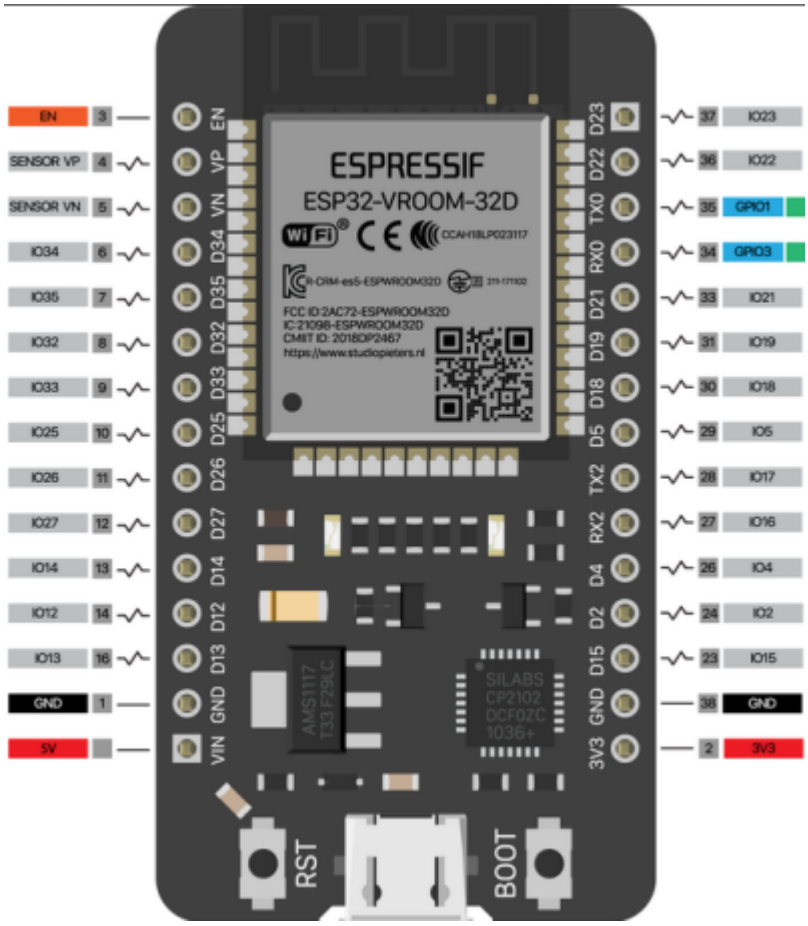
Step 2.4 - Plug the microcontroller

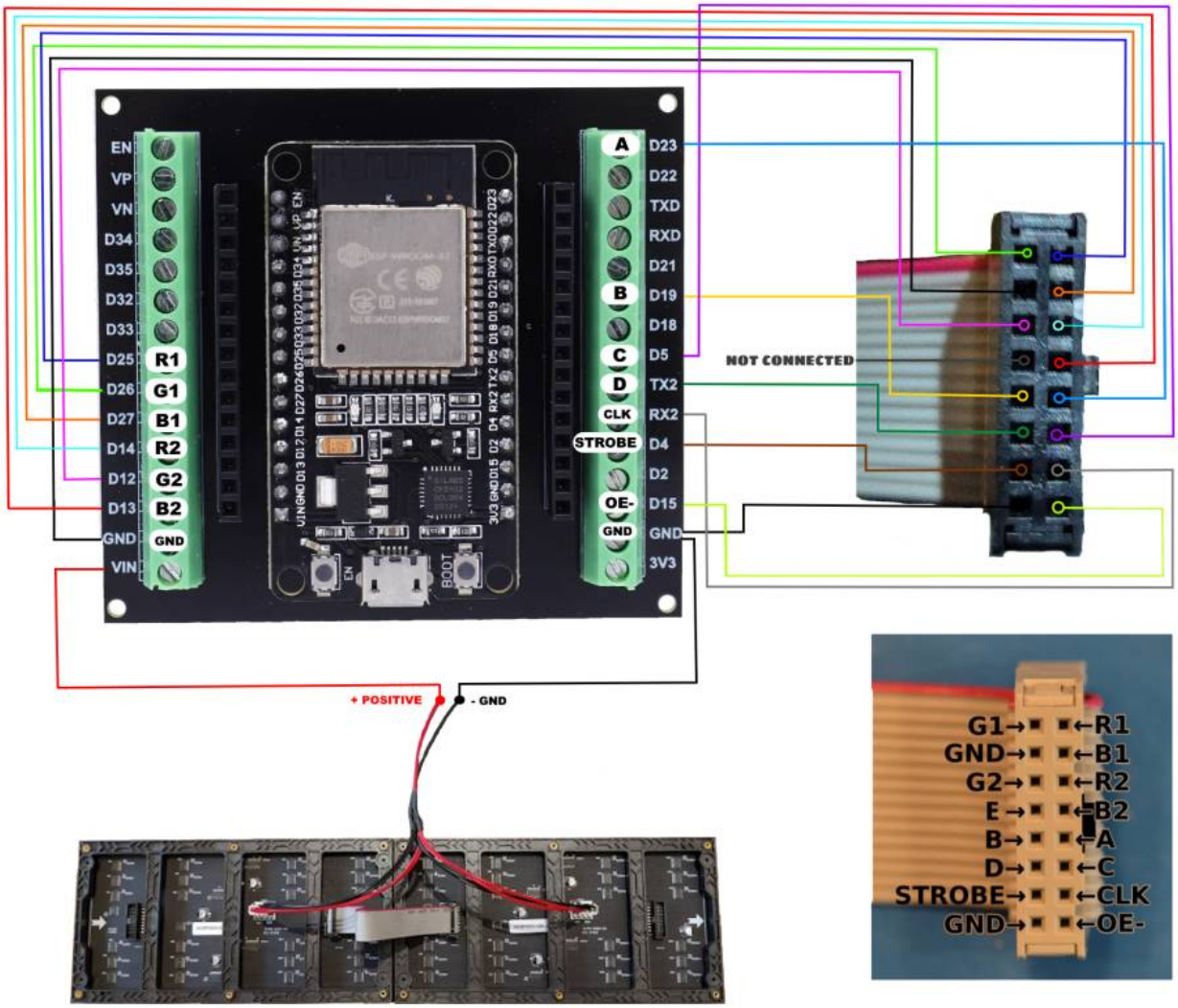
Check that your ESP32 is the 30-pin model (by counting the number of pins). There are several models, some with another number of pins, but this one seems to be the most common.

Now, you must plug the data wire to the ESP32 by respecting the pin codes as described in the following images.



```
#define R1_PIN 25
#define G1_PIN 26
#define B1_PIN 27
#define R2_PIN 14
#define G2_PIN 12
#define B2_PIN 13
#define A_PIN 23
#define B_PIN 19
#define C_PIN 5
#define D_PIN 17
#define E_PIN 22
#define LAT_PIN 4
#define OE_PIN 15
#define CLK_PIN 16
```





There are 15 pins to plug in total.

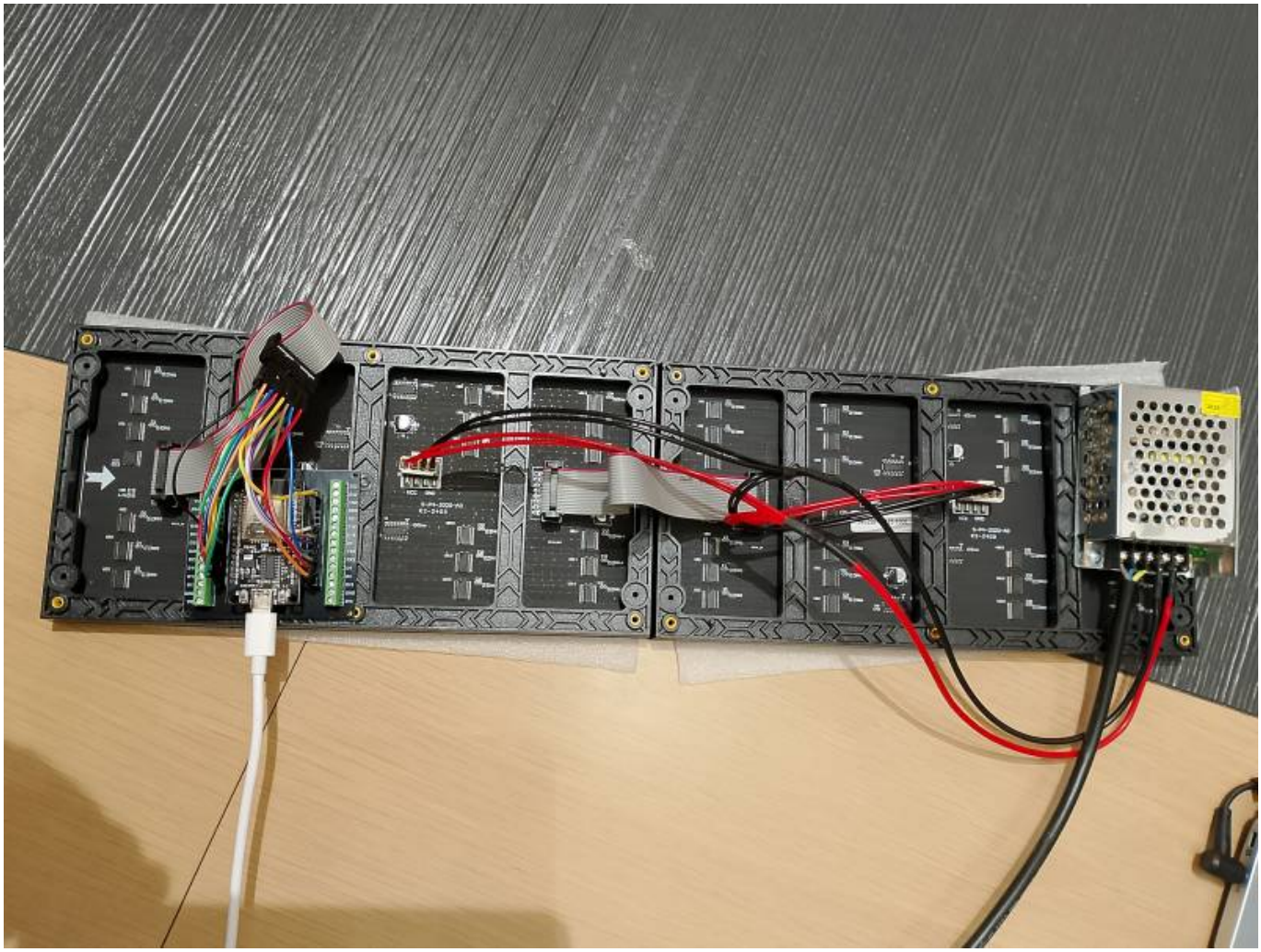
The pin E can be omitted.

The pin called LAT is the pin STROBE.

Example : plug a pin in the data cable on G1. G1 pin corresponds to pin IO26. Thus on the ESP32 side, plug it in the IO26.

Note: if you don't use a dedicated power supply, plug the red wire from the LCD panel to the VIN pin of the ESP32 (+5V) and the black wire to the GRD pin (ground).

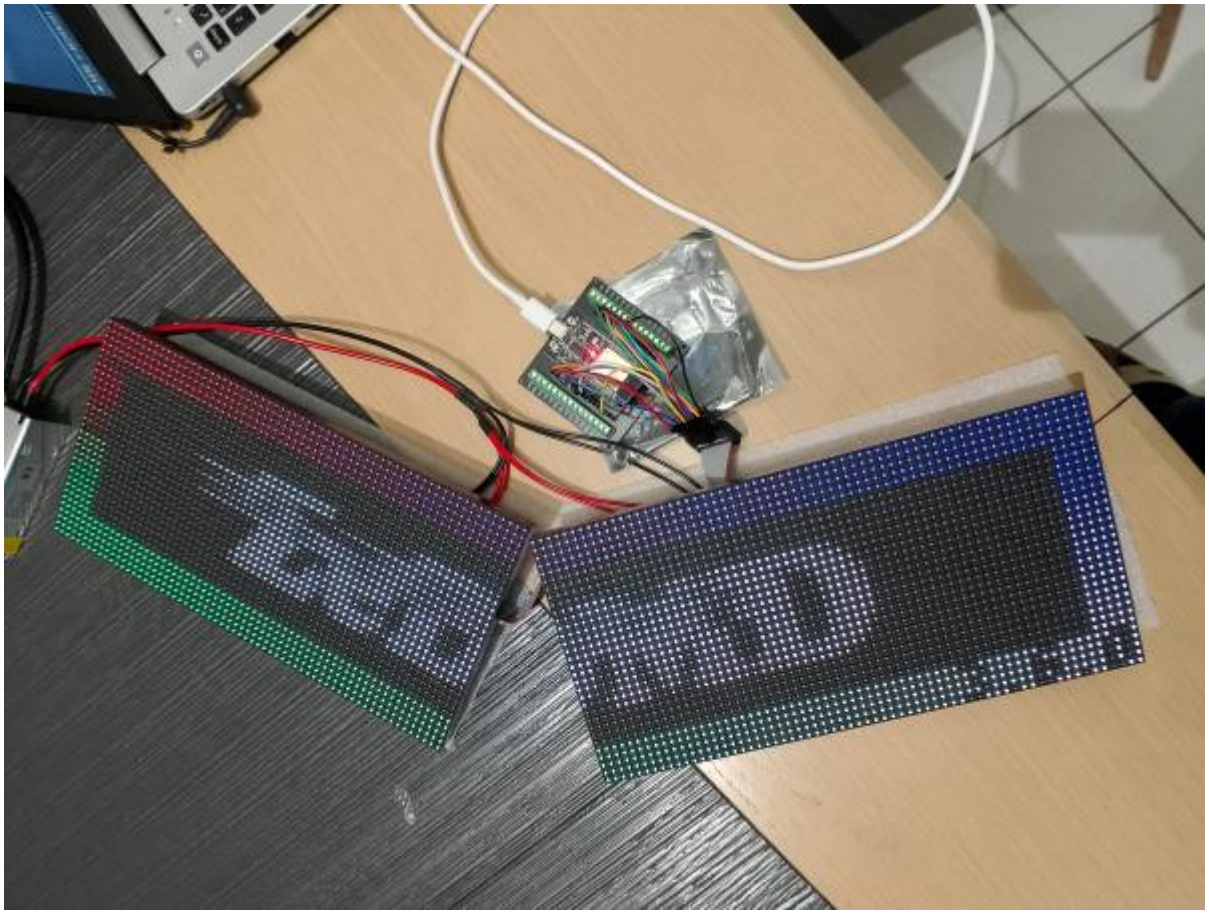
Step 2.5 - Final assembling



Step 2.5 - First boot

Plug your DMD the power wall socket. You should see the ZeDMD logo and the version.

The logo may be not perfect, as you can see on this picture, but no panic this is an easy fix: adjust the voltage to a slightly lower value to make it nicer (the orange screw on the power supply as explained at the beginning of this page).

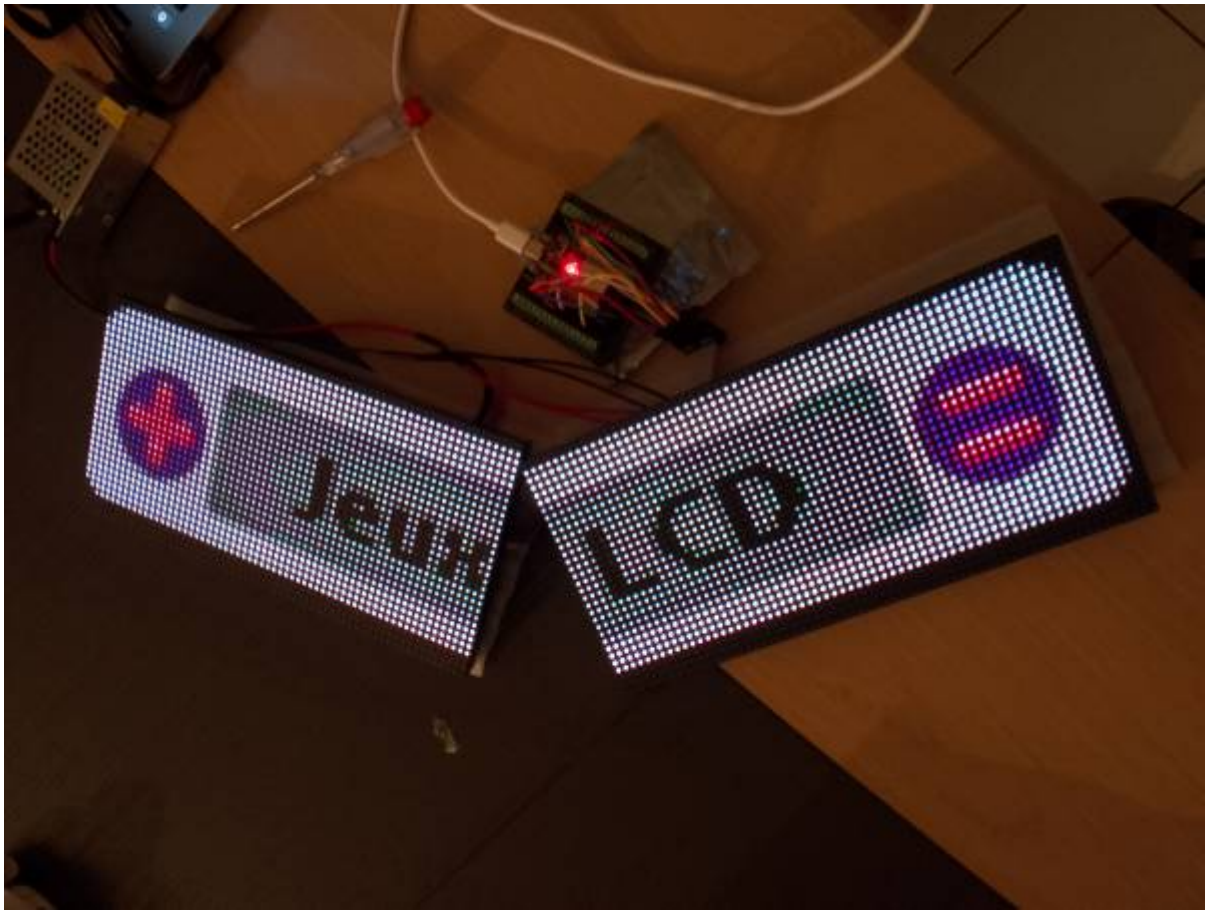


Step 3 - Batocera.linux software configuration

Plug your DMD with the USB-C cable to the Batocera box.

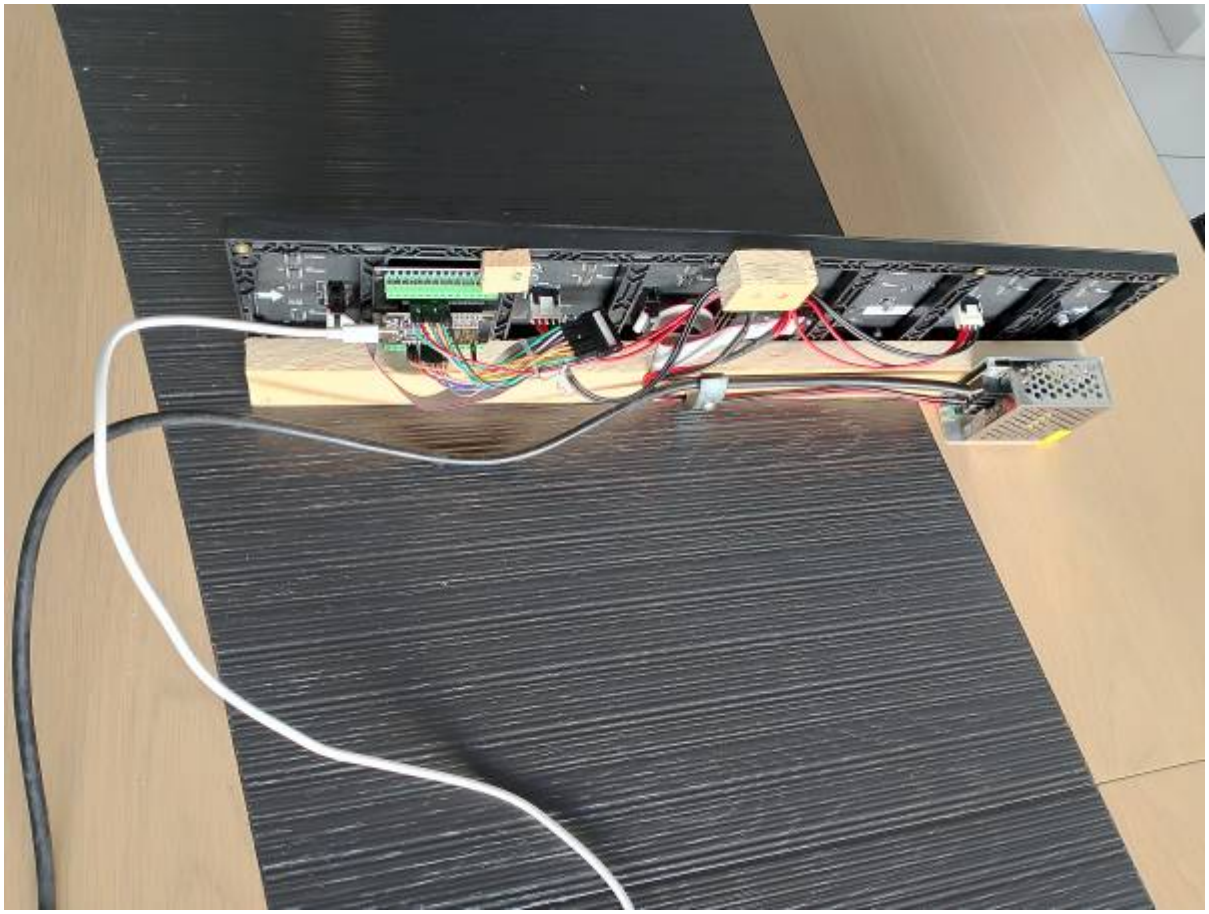
Go in **MAIN MENU → SYSTEM SETTINGS → SERVICES** and start (or stop/start) the `dmd_real` service.

Get back to the main menu, and switch to a different system, or select a game in EmulationStation. The images, or the names of the games (in case you don't have the right images) should appear on your DMD.



Step 4 : finalize the DMD hardware

Make sure you steadily lock the LED matrices, and if you're handy enough, make a nice case to wrap things up.



Create a case as you can.

ZeDMD configuration

If you've ZeDMD 5.x or higher (on batocera 42 or higher), by default, the rendering is not smooth. You need to configure the minimal refresh rate and the USB package size via the command line tool zedmd-client. You may need to configure the RGB order and the brightness.

First, shutdown the dmd_real service, then use zedmd-client -i to list your current dmd settings. After configuration, reboot batocera or just restart the dmd_real service

A usb package size of 1024 and a refresh rate of 60 is good on my device. Depending on the esp32 hardware, you may adjust values to get smoother animations.

```
# batocera-services stop dmd_real
# zedmd-client -i

ZeDMD Info
============================================================
ID:                          3904
firmware version:            5.1.7
CPU:                         ESP32
libzedmd version:            0.9.7
transport:                   0 (USB)
device:                      /dev/ttyUSB0
USB package size:            32
WiFi SSID:                   could only be retrieved via WiFi
WiFi port:                   could only be retrieved via WiFi
WiFi power:                  could only be retrieved via WiFi
WiFi UDP delay:              5
panel width:                 128
panel height:                32
panel RGB order:             0
panel brightness:            2
panel clock phase:           0
panel i2s speed:             8
panel latch blanking:        2
panel minimal refresh rate: 30
panel driver:                0
Y-offset:                    0

# zedmd-client --set-brightness=7
# zedmd-client --set-panel-min-refresh-rate=60
# zedmd-client --set-usb-package-size=1024

# batocera-services start dmd_real
```

Only the most common USB-to-serial chips used in various ESP32 boards supported by the auto-detection. Others are ignored to not break the communication to other devices, for example bluetooth headsets or game controllers. But if your specific ESP32 is not recognized, you can explicitly specify the serial device in the settings.

The best performance could be achieved by using an ESP32 S3 N16R8. Beside the fact that this one has more RAM which is actively used for rendering, it provides a native USB port. This native USB port supports much higher data transfer speeds.

To increase the compatibility with some USB ports or hubs or low quality cables, the USB package size became configurable. The default value of 32 bytes for the original ESP32 is very low. If you notice stuttering of the DMD frames, try to increase this value. If your hardware supports it, good values are 512 bytes for the original EPS32 and 1024 for the ESP32 S3. If ZeDMD doesn't work with these values, try a different USB port of your computer. In some cases not all of them and their driver chips are of the same quality.

Issues

Lines issues

Check the pins. Some bad quality pins may create interference.