

# Hardware Manual

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## Contents

<b>1</b>	<b>Introduction</b>	<b>2</b>
<b>2</b>	<b>Components</b>	<b>2</b>
2.1	Raspberry Pi 4 . . . . .	2
2.2	Capture card . . . . .	2
2.3	HDMI splitter . . . . .	2
2.4	HDMI cables . . . . .	2
2.5	LED strip . . . . .	2
2.6	Power supply . . . . .	2
2.7	Power switch . . . . .	2
2.8	Custom PCB . . . . .	3
2.9	Enclosure . . . . .	3
<b>3</b>	<b>Assembly</b>	<b>3</b>

# 1 Introduction

The following user manual contains all important information about design decisions and component selection for the Ambilight project. In the subsequent part, all components are listed individually with relevant information. In the last section you will find a setup plan for the complete system.

## 2 Components

### 2.1 Raspberry Pi 4

The RaspberryPi 4 is used as the single board computer. Minimum requirement for the RAM is 4GB. This demand is based on the used capture card. If you use a different capture card than recommended, you can also use another model of the Raspberry Pi family that supports the requirements of the capture card. As memory card for the operating system we recommend a SD card class 10 or higher. This ensures the shortest possible boot sequence.

### 2.2 Capture card

When selecting the capture card, you should mainly pay attention to the maximum desired frame rate. In our case 60FPS. Another important point is the system requirements for the single-board computer. For example, the recommended capture card requires 4GB of RAM. Make sure that this system requirement is met.

### 2.3 HDMI splitter

When choosing the HDMI splitter, pay attention to the maximum desired picture quality on the screen. The splitter must be able to pass this quality from the input to the output. Likewise, a power supply via 5V USB should be considered, since this is provided by the specific PCB.

### 2.4 HDMI cables

3 HDMI cables are required for the complete system. Input, output to the TV, and output to the capture card. The lengths of the cables can be freely selected as desired. For the output cable to the capture card, we recommend a 0.25m cable so that everything fits into the housing. Again, the maximum desired picture quality must be taken into account.

### 2.5 LED strip

The LEDs used are from the well-known WS2812 series. They are easy and cheap to get and can be easily controlled via software library. The length of the LED strip can be freely adjusted to the TV size. Also the number of LEDs per section can be adjusted as desired. The larger the number, the better the color gradient. However, with the recommended 30LEDs / meter can already achieve a very good result.

### 2.6 Power supply

A 5V power supply with standard DC plug is required as power supply. It is important that the voltage carrying part of the plug is on the inside. (mostly standard). The minimum requirement for the provided current depends on the number of LEDs. A rough estimate can be calculated with the following formula:  $I_{min} = 2.5A + 20mA * \text{number of LEDs}$

### 2.7 Power switch

When selecting the on/off switch, attention must be paid to both the maximum voltage and current compatibility and the mode of operation. The switch must be applicable for 5V DC and must be able to switch the maximum current of the powersupply. As a mode of operation we need a switch that keeps its position. (so no push button)

## 2.8 Custom PCB

In order to have the least possible cabling effort, a custom PCB was developed for the project. This mainly provides the power supply for all components (Raspberry Pi, HDMI splitter, LEDs). Also the conversion of the data signal (3V3) from the Raspberry Pi to a higher level, which is understood by the LEDs (5V), is done here. For this task a 2-channel level shifter from TexasInstruments is installed. The PCB was designed with the software Altium Designer 15, for which all production and development data is available. During the production of the PCB the following features are considered:

- Format: 104.07mmx57.47mm
- Material: FR4 1.55mm 35 $\mu$ m Cu
- Surface finish: chemical Gold ENIG (HAL lead-free would be sufficient but harder to solder by hand)
- Board outline layer: Mechanical1

## 2.9 Enclosure

The enclosure was designed for the recommended components using the Autodesk Fusion 360 program. It consists of 3 layers held together with two self-tapping screws. The bottom layer contains the HDMI splitter, as well as the capture card. The HDMI cables also find their place here. The middle layer holds the Raspberry Pi including the specific PCB. Last but not least, the case is closed with a lid. Here there is the possibility to integrate an optional 25mm fan.

## 3 Assembly

1. Connect the input HDMI cable to the input of the HDMI splitter.
2. Connect the output HDMI cable to the output 1 of the HDMI splitter.
3. Connect the HDMI cable to the video grabber with output 2 on the HDMI splitter.
4. Connect the HDMI cable to output 2 to the input of the video grabber.
5. Put the custom PCB in front of you in the orientation of the picture below.
6. Connect the Raspberry Pi with the backside facing up to the connector A on the custom PCB. Hereby the USB ports face to the left.
7. (optional) Connect the reset button pins of the Raspberry Pi to connector F of the custom board.
8. Plug the USB connector of the video grabber to one of the USB 3.0 ports of the Raspberry Pi.
9. Connect the USB power supply cable of the HDMI splitter to connector C of the custom board.
10. Connect the On/Off switch to connector D of the custom board. The switch must be connected between the left two pins and the right pin. (optional) If you don't want to use a switch you have to bridge all pins of connector D.
11. Connect the LEDs to connector B of the custom board. The left pin carries the 5V supply voltage, the middle pin carries the data and the right pin is the ground potential.
12. Connect the power supply to connector E of the custom board.

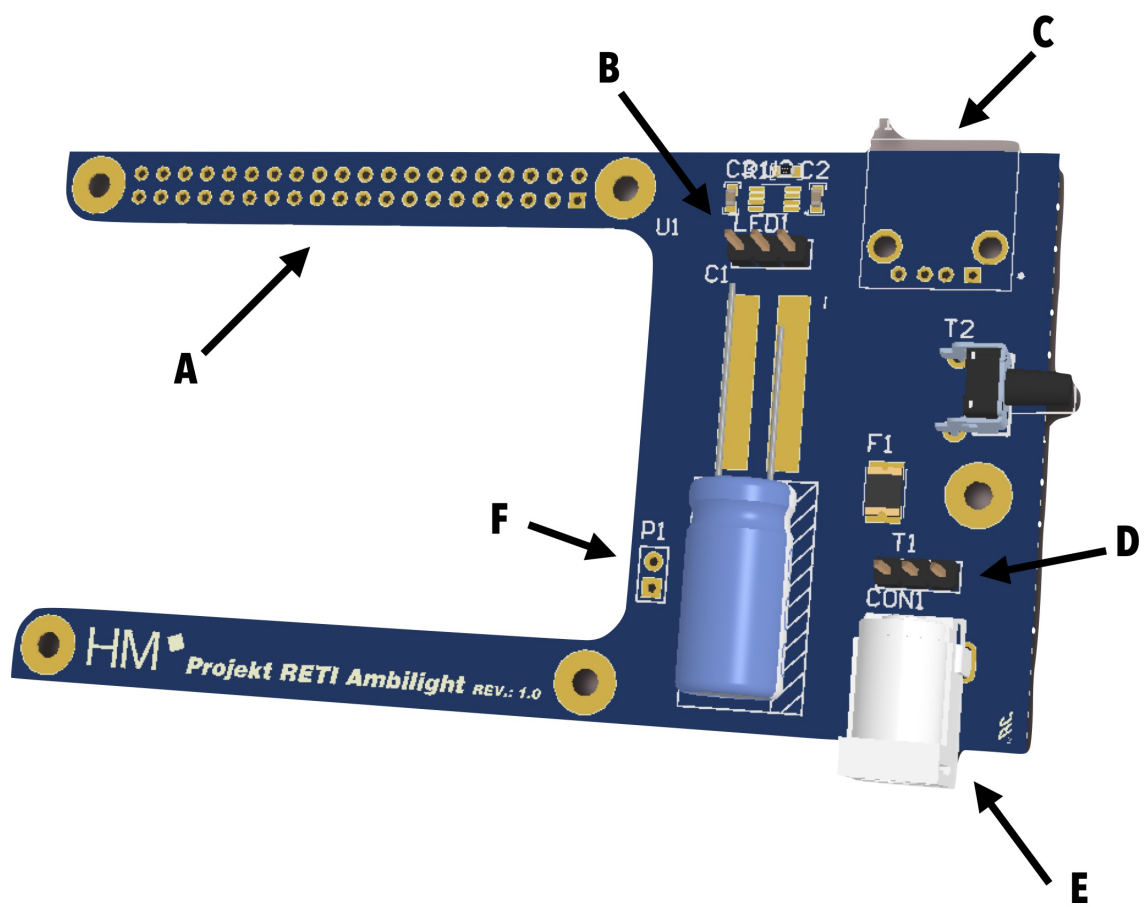


Figure 1: Custom PCB