



Electrotechnische Vereeniging

Christmas star

October 11, 2021

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Klushok - Electrotechnische Vereeniging





1 Introduction

Hey there!

Thank you for buying this christmas kit! We (the klushok committee) hope you will enjoy building and displaying this christmas star!

The project you're about to get started on was designed by the klushok committee. It is intended to be used as a gadget and makes use of existing open source firmware. This firmware will be discussed in more detail in section 3.

This manual will guide you through the required steps required to assemble your star and get it up and running. Before you get started, ensure you've received a complete kit. The required components can be found in figure 1, these are not drawn to scale so keep this in mind when verifying the contents of your kit. You will additionally need the PCB (Printed circuit board) shown on the cover of this manual. When you've verified the contents of your kit, proceed to the next section.

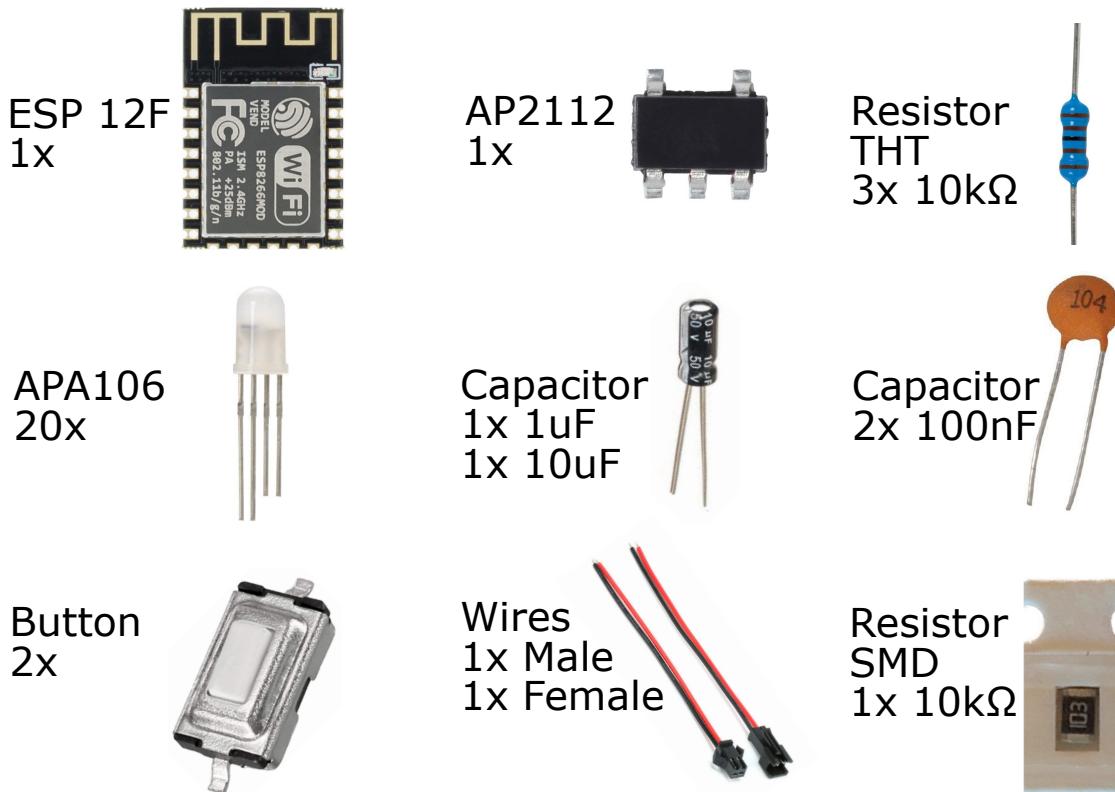


Figure 1: Components included in the kit



2 Assembly

To assemble the star, you'll need to be familiar with soldering. Although most components are THT (through hole technology), there are some SMD (surface mount devices):

- The ESP12F
- The reset and program buttons
- The LDO (low dropout) voltage regulator
- A pulldown resistor between GPIO15 and GND

Soldering these components requires a good pair of tweezers so make sure you have those nearby.

2.1 Preferred order

The preferred order is based on how easy solder pads are to access after other components have been soldered in place. It highly depends on personal preference and since this order does not influence functionality of the star, feel free to choose your own order.

1. ESP 12F
2. The SMD resistor between GPIO15 and GND
3. The AP2112-3.3V LDO
4. The THT resistors and C1 C2 and C3
5. Optionally (see subsection 2.2) C4, C5 and the SMD buttons
6. Solder all the APA106 in place
7. Finally solder the male connector to the GND and 5V pins.

Hint: If you don't plan on adding an additional string to the hole just above the GND and 5V pads, put the red wire through the hole before soldering it to the 5V pad. This will decrease the strain on the solder joint and reduce the chance of the wires breaking due to fatigue.



2.2 Optional components

Not all components shown in figure 1 are required: C4, C5 and the push buttons can be left out and the board will still function correctly. These buttons are connected to the reset and GPIO0. Both the reset and GPIO have to be pulled high for normal operation but can be pulled low for additional functionality: If the reset button is pressed, the ESP12F will be reset. The same effect can be achieved by turning the star off and on, which is why the button and associated capacitor are optional.

GPIO0 has to be pulled high when the ESP12F starts to boot from flash instead of programming mode. The button attached to this GPIO is required if you want to reprogram the ESP12F using just the RX and TX pads. After the ESP12F has booted, this button can be used as a regular input and could, for example, be used to toggle the star on or off or apply a different preset (see section 3).

Both the reset and GPIO0 are used when flashing the ESP12F, which is why they're broken out. When using the programmer supplied at the klushok, neither of these buttons is required to reprogram the star.

2.3 Component orientation

The orientation in which the resistors, buttons and ceramic capacitors can be soldered does not matter. This orientation does however matter for the electrolytic capacitors, the AP2112 voltage regulator, the wires, the ESP 12F and the LED's. The placement of the LED's will be discussed in detail in the subsection 2.4.

The orientation of the electrolytic capacitors is easy: the white stripe on the black cylinder should match the white pad on the pcb.

The orientation of the ESP 12F and the AP2112 voltage regulator are self explanatory: the pads should match. For the ESP this means that the gold zigzag pattern (this is the wifi antenna) should overlap the darker green part of the PCB. The AP2112 has 3 legs on one side and 2 on the other, the two leg side should point towards the label 'U2' on the PCB.

2.4 LED orientation

All but one of the 20 LEDs are soldered using the pads with holes in them. **When inserting the LEDs into these holes make sure to verify the orientation!** If you solder the led in a reversed orientation, it will break once you turn on the power supply. Figure 2 shows the easiest way to deduct the orientation of the LEDs: The two longer legs should go to the square solder pad and its direct neighbour.

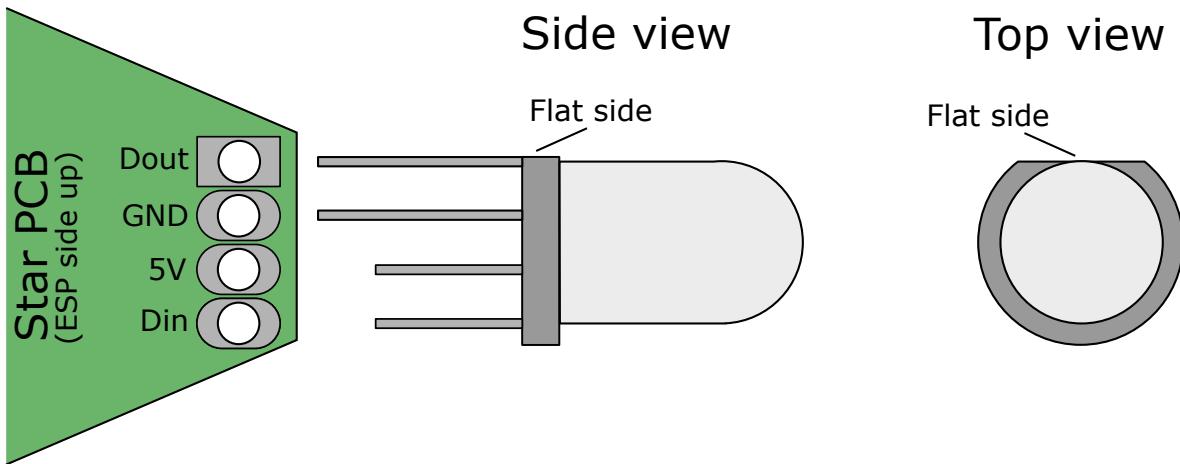


Figure 2: The square solder pad indicates where the data_out pin of the LED should go

After the LED has been put in its place, you can bend the LED to point away from the PCB as shown in figure 3.

The LED marked with label 'D12' has to be soldered without the use of any holes. The orientation is the same as shown in figure 2: the square pad indicates the Data_out pin. The easiest way to solder this LED is to first cut the legs to size, then apply solder to 1 pad. Verify the orientation of the LED using its flat size and then solder the first leg onto the applied solder blob. The location of the LED can at this point easily be adjusted by melting this one blob and moving the LED around. Once every leg matches its pad, apply solder to all of them to firmly attach the LED.

Warning: LED D12 is attached using surface pads only, don't try to bend this LED or you might rip the pads from the PCB!

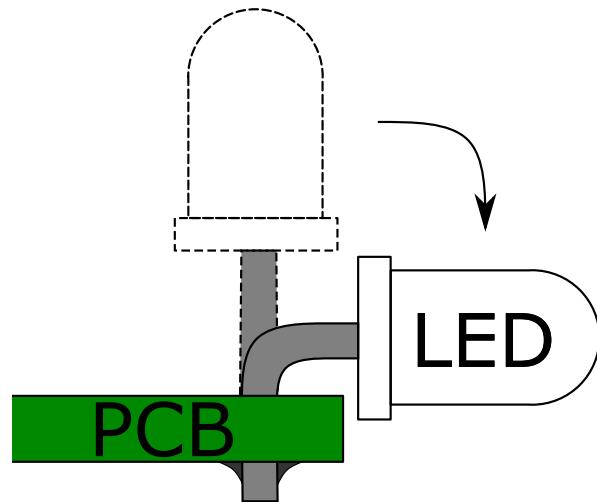


Figure 3

2.5 Verification

Now that every component has been soldered in place, the connections have to be checked. This is a very important step since the ground and 5V pins are very close to each other in the footprint for the APA106. If these pins are accidentally connected, this will short the power supply. The easiest way to check this is by using the continuity setting on your digital multimeter and measuring the resistance across the 5V and GND pins.

Note: When measuring continuity across a capacitor, a continuity will be measured for a short period of time. This is due to the charging of the capacitors and is expected (and thus correct) behaviour.

3 Firmware

The recommended firmware for this project is an open source firmware project called WLED¹. WLED contains many options and built-in effects in addition to integrations into popular programs like Home Assistant. Control of a WLED device can be done using the web interface or the app available for both IOS and Android.

This section will shortly discuss the required configurations to get the star running, provided WLED has already been flashed to the ESP 12F. Kits bought during Christmas 2021 will have their firmware flashed before being sold.

¹<https://github.com/Aircoookie/WLED>



Since development of WLED is ongoing, any information provided in this section can be deprecated. This manual is written for firmware version 0.12.0. A more detailed and up to date description of WLED can be found on its website: <https://kno.wled.ge/>. Newer versions can easily be installed using the WLED web installer: <https://install.wled.me/>.

3.1 Initial connection

When a WLED device can't connect to a known network, it will deploy its own wifi network. By connecting to this network the device can either be controlled directly or be configured to connect to an existing wifi network. The default network name is "WLED-AP" with password "wled1234".

3.2 Configuration

The star contains a total of 20 LEDs. This must be entered at the top of the "LED & Hardware setup" config page. Although these are APA106 LEDs, the LED type must be set to "WS281X" with color order "RGB". Figure 4 shows the correct settings. The maximum current setting is up to you and depends on the 5V source you used. The warning to keep the maximum current below 1A can safely be ignored.



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LED & Hardware setup

Total LED count: 20

Recommended power supply for brightest white:
5V 1.5A supply connected to LEDs
(for most effects, ~0.5A is enough)

Enable automatic brightness limiter:

Maximum Current: 850 mA

Automatically limits brightness to stay close to the limit.
Keep at <1A if powering LEDs directly from the ESP 5V pin!
If you are using an external power supply, enter its rating.
(Current estimated usage: 351mA)

LED voltage (Max. current for a single LED):
5V default (55mA) ▾

Keep at default if you are unsure about your type of LEDs.

Hardware setup

LED outputs:

1: WS281x Color Order: RGB
Pin: 2
Start: 0 Count: 20
Reverse: ■

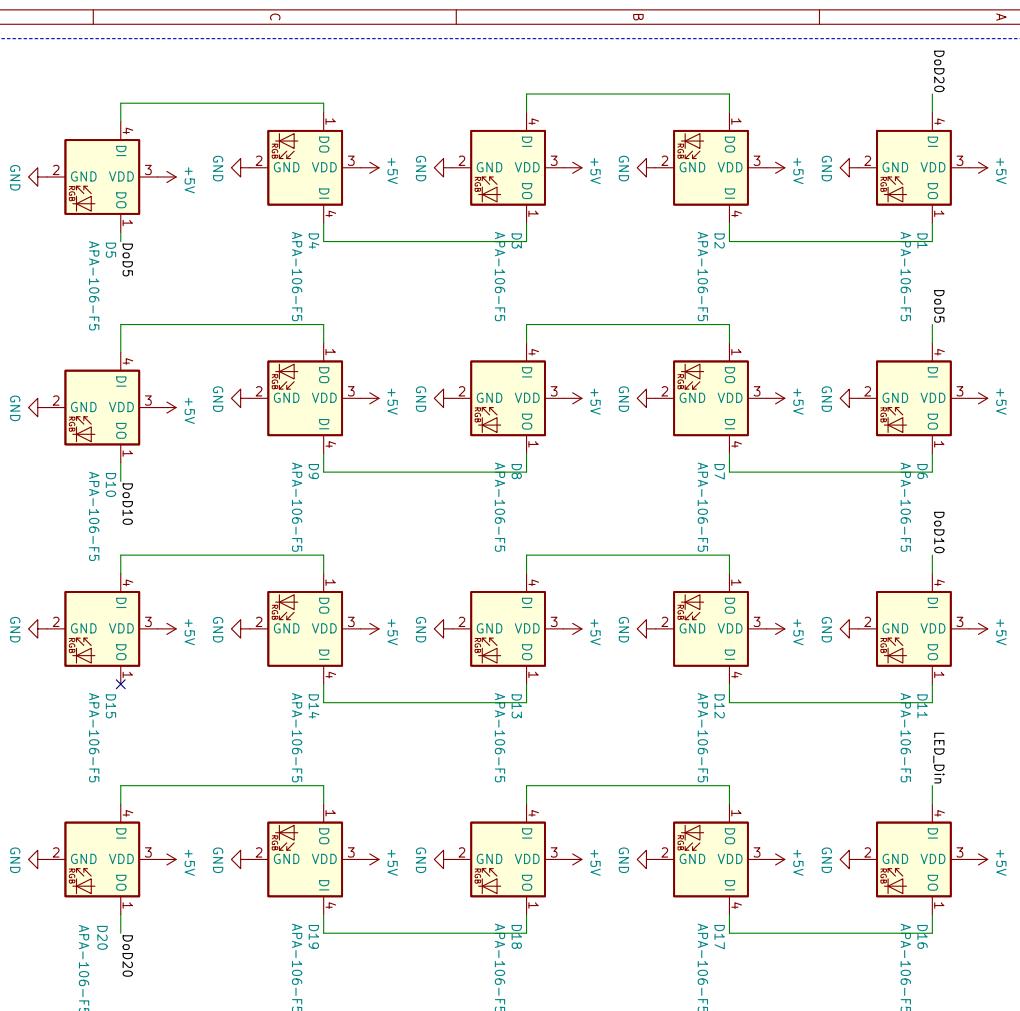
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Figure 4

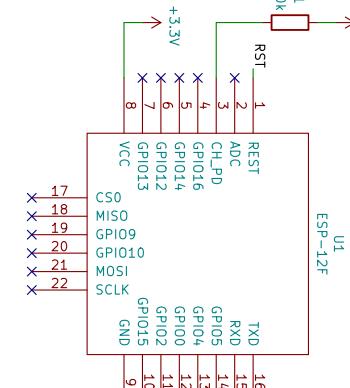
20x apa106 LED

ESP12F microcontroller

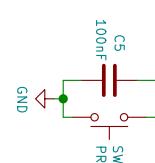
Reset button



Programming connectors



Flash button



Title: Christmas star

File: star.sch

Rev: 1

Sheet: 1/1

Author: B. den Ouden

Date: 2021-09-02

KiCad EDA, kicad (5.1.9)-1

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