Christmas Project 2023

basic version

November 2023

Klushok - Electrotechnische Vereeniging

For readers with experience and little time

If you have little time available and experience regarding SMD soldering, first off check if the contents of your kit match the items listed in section 3. After that, continue assembly according to Table 2. Otherwise if your skills and knowledge can use some improvements, please continue reading.

1 Introduction

Hey there!
Thank you for buying this Christmas soldering kit! We (the Klushok committee) hope you will enjoy building and displaying this Christmas project!

The project you are about to get started on was designed by the Klushok committee. It is intended to be used as a Christmas decoration.

This manual will guide you through the steps required to assemble your star and get it up and running. Before you get started, ensure you have received a complete kit. The required components can be found in section 3. The images are not to scale, so keep this in mind when verifying the contents of your kit. When you have verified the contents of your kit, proceed to the next section.

During assembly will also need the tools listed in section 4. Most tools are available at the Klushok.

This kit does not include a power adapter. Since phone chargers using USB-C are very common, this method is used to power the project.

2 Features

- The circuit is based on an analog three stage ring oscillator circuit, implemented by NMOS transistors.
- A choice for green or blue LEDs (depending on the set you bought).
- Real gold plating.
- USB-C connector.
- Switch for turning the lights on or off.

3 Kit contents

Please verify that your kit contains one PCB[1a] and the following components.

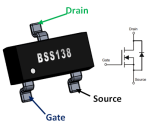
Table 1: BOM

Component	Value	Quantity	Designator
Side LED [1e]	Blue or Green	12	D(1-12)
0805 Resistor [1b]	1 kΩ	1	R1, R2, R3
0805 Resistor [1b]	220 Ω	0(green) or 1(blue)	P5
0805 Resistor [1b]	220 kΩ	3(blue) or 6(green)	B(1-3), R(4-6)
0805 Capacitor [1h]	1 µF	3	C1, C2, C3
SMD Can Capacitor [1b]	4.7 µF[1]	1	C4
SOT-23 MOSFET [1d]	BSS136	3	Q1, Q2, Q3
SMD Micro Switch [1g]	-	1	SA1
USB-C breakout [1f]	-	1	J1

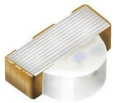
(a) Christmas ball PCB

(b) SMD Resistor[2]

(c) SMD Capacitor[2]



(d) N channel MOSFET



(e) SMD angled LED

(f) USB-C breakout

(g) SMD switch

(h) Aluminium can capacitor

Figure 1: Images of parts included in KIT

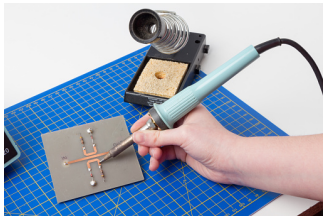
[1]The actual capacitance when measured may be different from the stated capacitance due to tolerances. This capacitor is only used to filter power fluctuations, so the exact value is not critical.

[2]Actual components are not labeled 0805. See section subsection 3.1 on how to read value from SMD resistors.

3.1 How to read SMD resistor markings

Most small SMD (Surface-Mounted Device) resistors are labeled with a 3 or 4 digit code. The first digits indicate the significant digits, the final one a multiplier. The format ABX should be read as $(10 \cdot A + B) \cdot 10^X$. The format ABCX should be read as $(100 \cdot A + 10 \cdot B + C) \cdot 10^X$.
For example 224 is 22 Ω multiplied by 10^4 = 220 kΩ. For reference, you can navigate to https://www.digikey.com/en/resources/conversion-calculators/conversion-calculator-smd-resistor-code.

4 Tools



(a) Soldering Iron (do not hold it like this)

(b) Solder (recommended thickness 0.7mm)

(c) Isopropyl Alcohol for cleaning the PCB (recommended)

(d) Tooth brush (recommended if using Isopropyl Alcohol)

(e) Soldering Flux (optional)

(f) Teezers or small pliers

(g) PCB frame

Figure 2: Tools and other supplies

5 Assembly

This section is a systematic guide for getting the Christmas decoration up and running. This includes the ring oscillator, LED's, switch and USB-C port.

5.1 Introduction to SMD soldering

This is a beginner's guide to SMD soldering. If you already have worked with SMD components, you can skip reading this section.

SMD soldering may be different from soldering you may have done in the past. Everything related to placing one component is done on the same side of the PCB. There are no holes in the PCB that keep the component in place. You need to position the component and solder it in place at the same time. This may take some practice. The following steps help you get started.
The first step is to inspect the PCB. In case that dirt or oxide is present in the pads, you can clean the PCB with some Isopropyl Alcohol. The PCB for this project has gold plated pads, so corrosion will be minimal. If you need to clean, give the pads a light rub using some cloth or a cotton swab.
Decide which hand you want to use for positioning the components. You need to hold the soldering iron in your other hand. For two terminal components, orient the PCB in a way that the component is oriented left to right. Put a small amount of solder on the pad closest to the hand you are going to use for holding the soldering iron. To do this, heat up the pad using the soldering iron and feed a small amount of solder. The solder should form a small dome attached to the pad, not extending outside the pad.
Now get the component. You can use tweezers to lift the plastic covering the component. Now pick up the component using tweezers. Use the soldering iron to melt the solder on the pad. At the same time, place the component on the pads. Remove the soldering iron, leaving the component in place.
The component is now fixed in position. The last step is to solder the remaining terminal. Position the soldering iron at the unsoldered terminal and apply some solder. The solder should connect the component to the pad. Repeat for all terminals and components.

5.2 Recommended order of assembly

The order of soldering components does not matter for the functionality. Because installing components limit the available working area, some components can best be installed before others.
Lay the PCB flat and start with all components on the back.

It is advised to start with the smallest components, in this case the transistors. Work your way out from there, as placing components will limit the work space. You can follow Table 2 from top to bottom in order for placing all components in the correct locations.
Note that you do not have to place components at all open locations. See Figure 3 for the locations that should not be used for placing components.
The connector is tricky to solder. First, apply some solder to the power and ground pads on both the main PCB and the connector breakout board. Next line up the pads on the connector breakout board with the main PCB. Now it should be possible to drag the soldering iron between the connector and the main PCB to form a bridge. This may take a few attempts. When you start, just try to get a solid connection on both terminals. You can always clean up the connection after the part is secured in place.

If you have not soldered the LEDs yet, you can do so now. Please see subsubsection 5.3.2 for more information about orienting the LEDs.

Table 2: Recommended order when soldering the circuit.

Designator	**Part**	**Value**	
Q1-Q3	N-FET	BSS136	
C1-C3	Capacitor	1 µF	
B1-B3	Resistor	220 kΩ	
R1-R3	Resistor	1 kΩ	
R4-R6	Resistor	220 kΩ	Note: Only when using green LED. Otherwise leave open.
P5	Resistor	short/220 Ω	Note: Solder SHORT when using green LED. Otherwise place 220 Ω.
SA1	Switch	micro-switch	Note: Both rotations are acceptable.
C4	Capacitor	4.7 µF	See subsubsection 5.3.1
J1[3]	Connector	USB-C female	
D1-D12	LED	green/blue	See subsubsection 5.3.2

[3]Designator is not printed on the PCB. See Figure 5 for the connector location.

Figure 3: Footprints not used for the basic circuit

5.3 Component orientation

All passive components except the 4.7 µF capacitor can be soldered in both directions. For the resistors, it is recommended to put the black side up, so that the markings stay readable.

5.3.1 Capacitor orientation

The 4.7 µF capacitor is polarized. The black area on top of the can indicates the negative side. The base of component should match with shape indicated on silkscreen.

5.3.2 LED orientation

Seen from the front, the green dot/stripe on the led should be pointing in counterclockwise orientation. It is recommended to mount the led with the lens pointing towards the center of the PCB. This does require some tricky soldering. If you are using small tweezers, you can grab the LED on the flat area at near the terminal. When using this orientation, the green dot should be located on the right with the PCB oriented led side up.

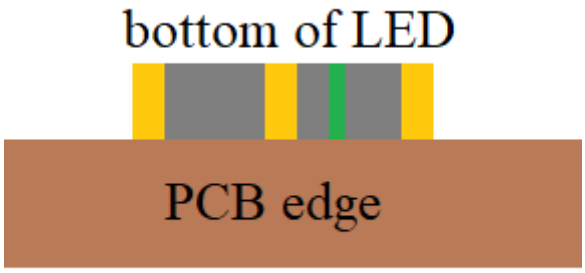


Figure 4: Side view with correct led orientation

5.4 IBOM

IBOM or interactive bill of material is interactive webpage where you can view each component and its designated location.

klushok.etv.tudelft.nl/christmas/ibomb

6 Verification

After all components are in place, start by visually checking if all terminals are soldered. Fix any missed connections or loose components.

Next, slide the switch in the direction of P5. Now check for continuity between power and ground. The easiest way to check this is by using the continuity setting on your digital multimeter and measuring across the test points labeled Vcc and Gnd near the power connector. If these lines are accidentally connected, this will short the power supply.

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.*

Figure 5: Final circuit (It should look like this)

7 Enjoy

Now you can hang the decoration in a visible place and connect a power adapter. You can use the large hole near the power connector for a more secure mounting option. Enjoy the dancing lights and show your friends.

Happy Holidays on behalf of the Klushok committee.

A Schematics

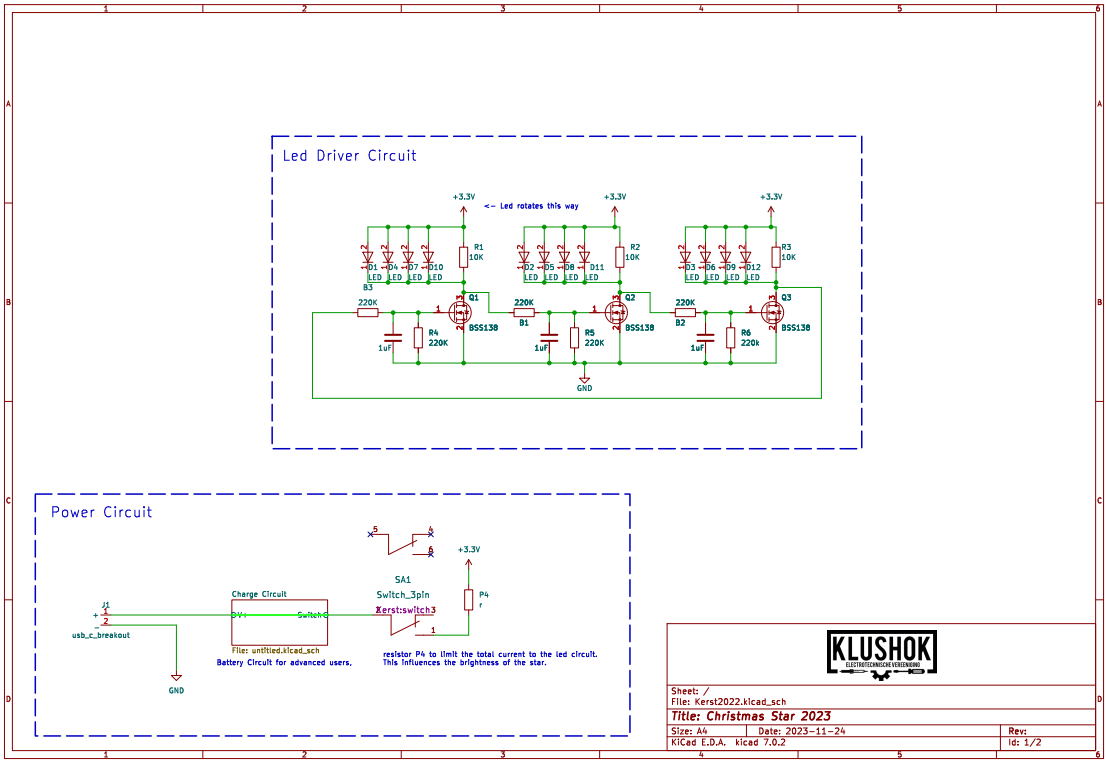


Figure 6: Circuit schematic

B PCB routing

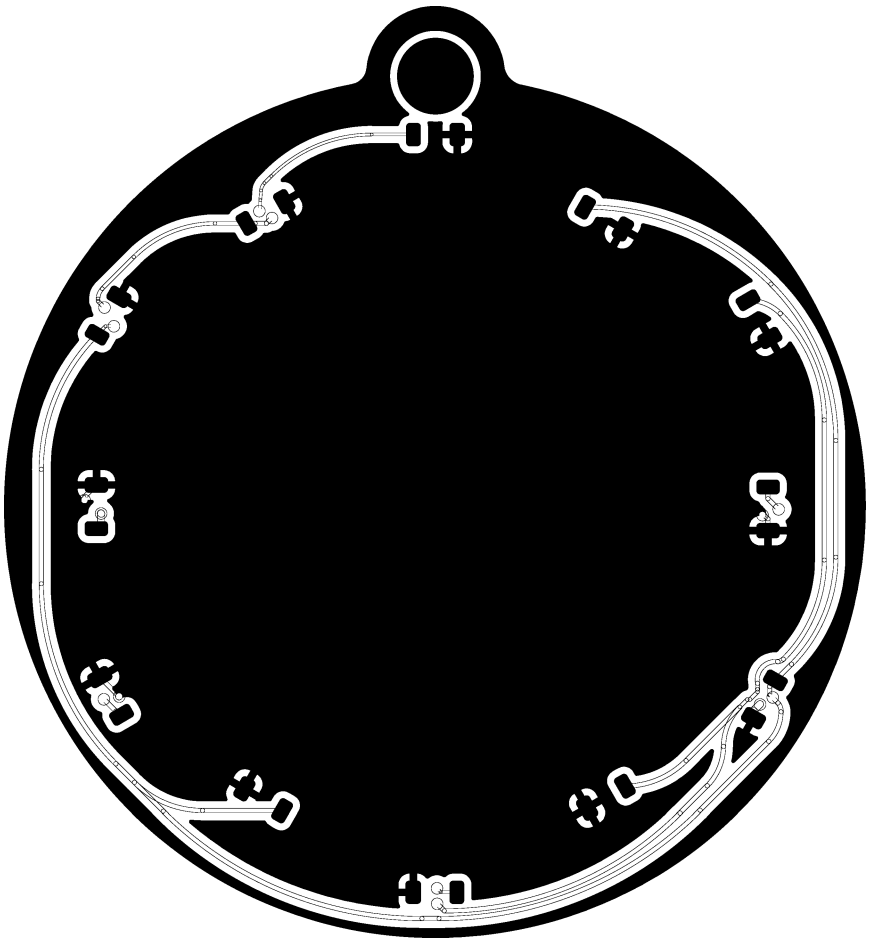


Figure 7: Front Routing

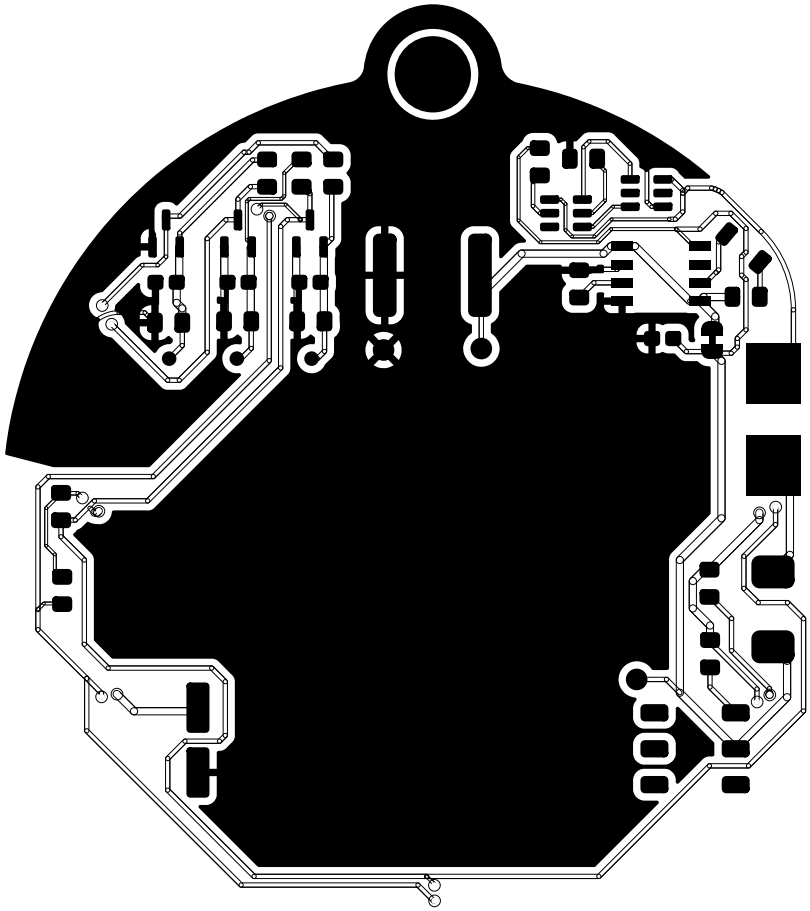


Figure 8: Back Routing