EN2160 - Electronic Design Realization

Universal LED Driver

Detailed Report

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200207U

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Abstract

LED lights are becoming more and more popular with the time due to its low power usage compared to fluorescent bulbs. We use a LED driver to turn ON a LED light by transforming the AC voltage to a limited DC voltage while also limiting the maximum DC current.

This project is developed to create a LED driver which can be used in several watt ranges. By this product the need of several LED drivers for each watt range can be neglected and this can be use as an universal LED driver.

1. Device Introduction

1.1 Existing Features

The existing LED drivers have three main features.

1. Ac to DC conversion
2. Voltage regulating
3. Current limiting

In common cases, a transformer is used to step down the AC voltage from 230V-250V to a lower voltage. Then a bridge circuit is used to convert AC to DC, and then a buck converter is used to step down the DC voltage to a lower level and regulates it.

A current limiting circuit will be used to limit the maximum output current of the LED driver. Therefore, we can use this driver to get a pre-defined watt value.

1.2 Proposed New Features

In addition to the existing features mainly we have developed several new improvements to the design.

1. AC to DC conversion and voltage regulation using a one component
    - HLK-10M12 is used to convert AC to DC and then regulate the DC voltage at the same time. By this we can obtain the best output because of the minimum usage of components.

2. Different output DC voltages can be chosen
    - By using a switch, we can change the output DC voltage of the LED driver, allowing it to operate in several watt ranges.

1.3 Device specifications

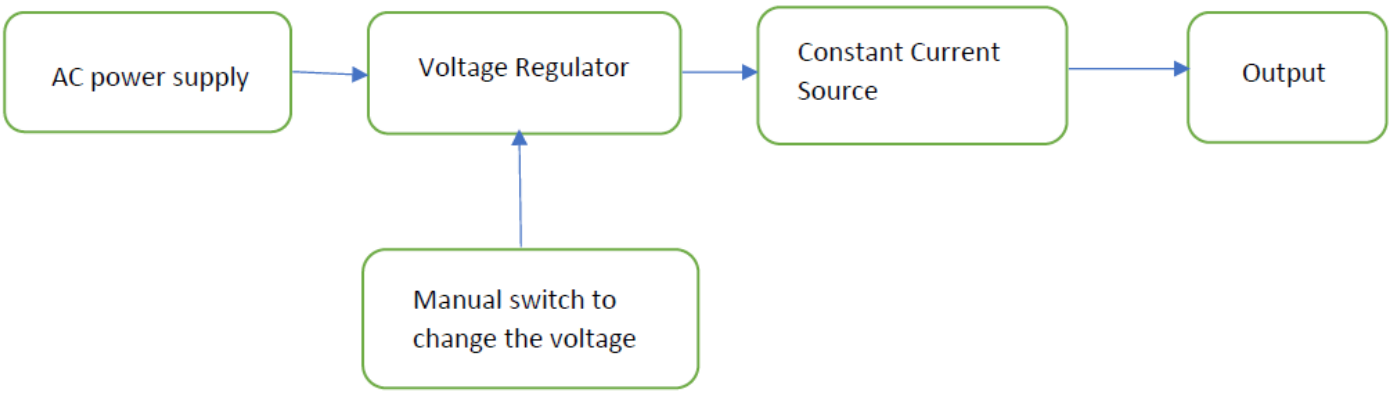
- Input voltage 90VAC – 265VAC
- Output voltage 12VDC – 30VDC
- Output maximum current 0.3 A
- Output wattage 3.6W – 9W

2. Design Process

Design process consists of several steps. The main steps are mentioned below.

1. Block Diagram
2. Component selection
3. Schematic Design
4. PCB Design
5. Enclosure Design

2.1 Block Diagram



2.2 Component selection

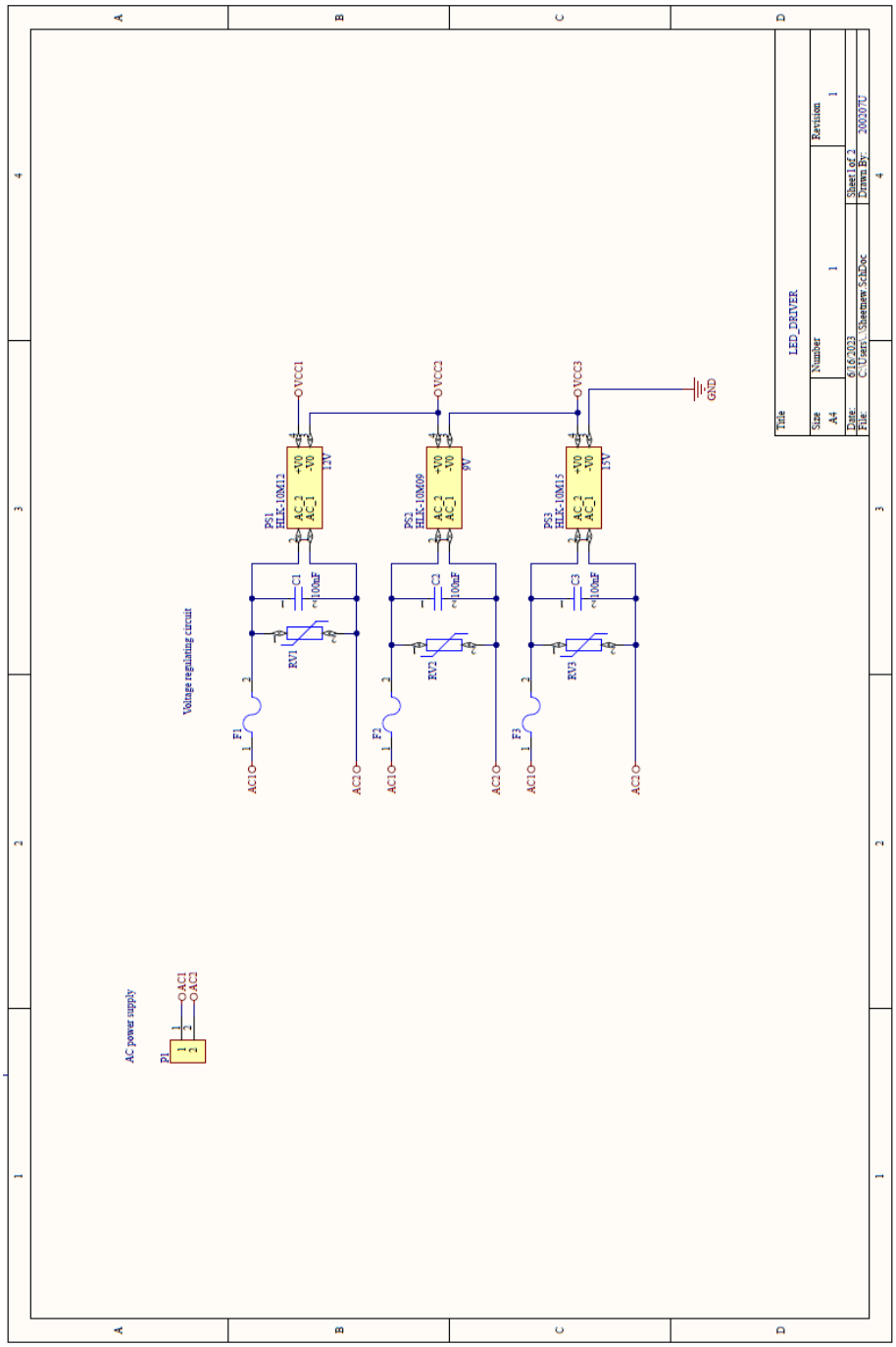
The components are selected in such a way that the interference between the components is reduced, and the number of components are decreased.

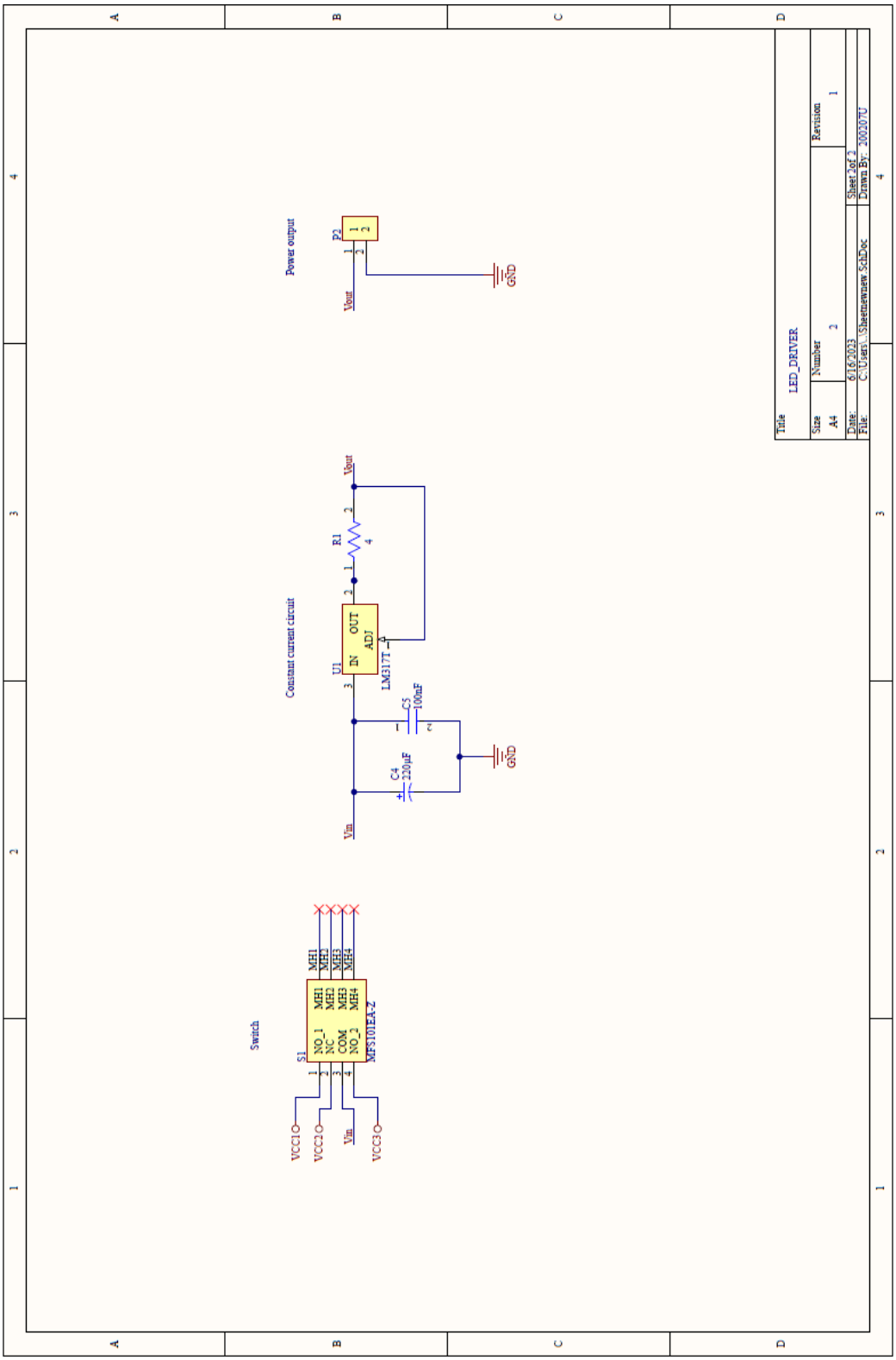
1. HLK-10M12
    - This component has two basic features. Firstly, it converts AC voltage into DC voltage. Secondly it outputs a regulated voltage. The LED driver needs both of these features to exhibit properly. Therefore, we are using this component to achieve both of the features at the same time.

2. LM317T
    - This is the main component of the current limiting circuit. A current limiting circuit can be constructed only using three components by using LM317T as the main component. Therefore, to reduce the number of components, we are using LM317T.

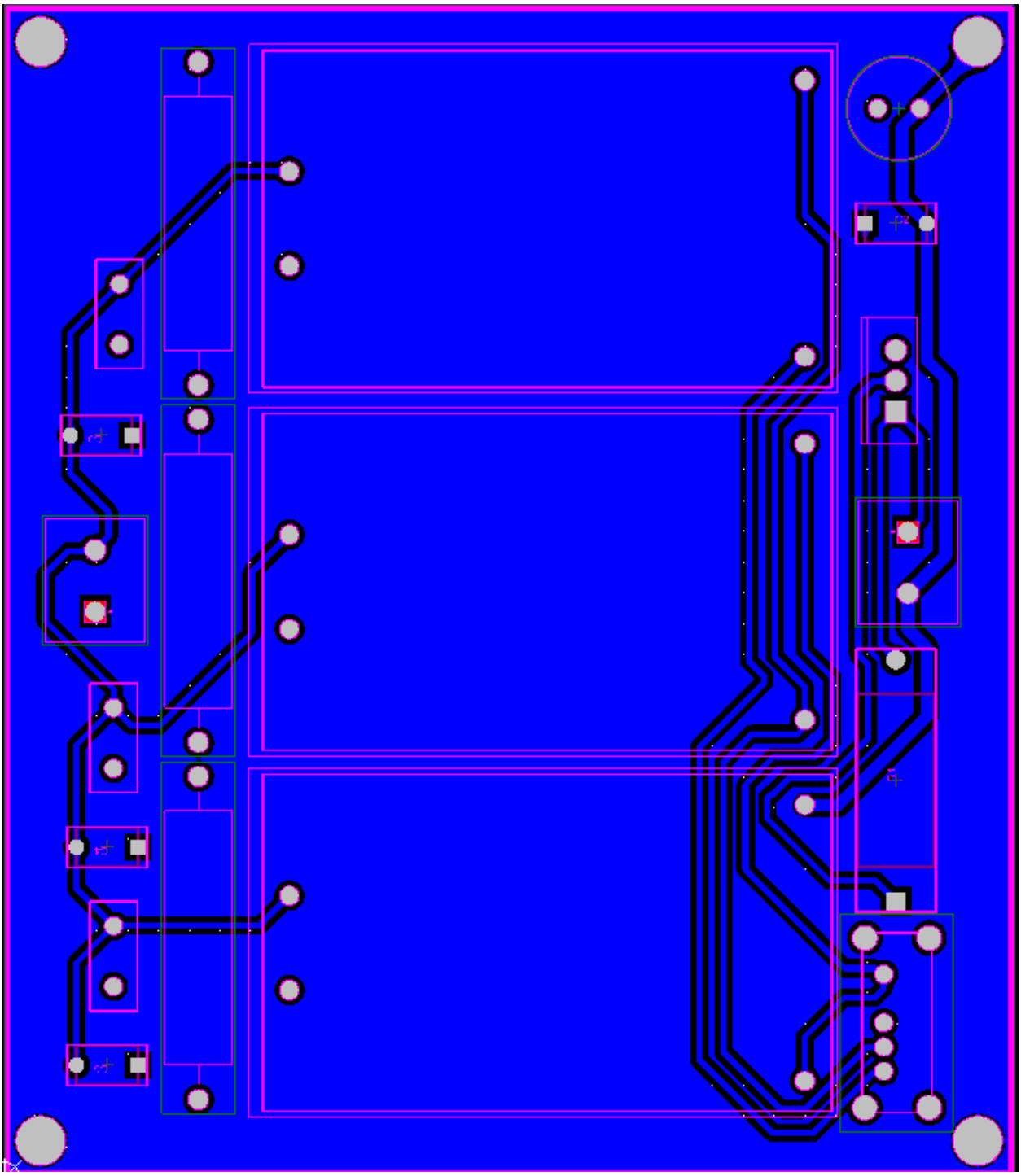
3. 4Ohm resistor
    - In the current limiting circuit, the limiting current is obtained using the constant voltage difference of the adj and output pin of the LM317T, which is 1.25V. Therefore, to obtaing approximately 0.3A as the maximum current of the circuit, we are using a 4Ohm resistor.

2.3 Schematic Design

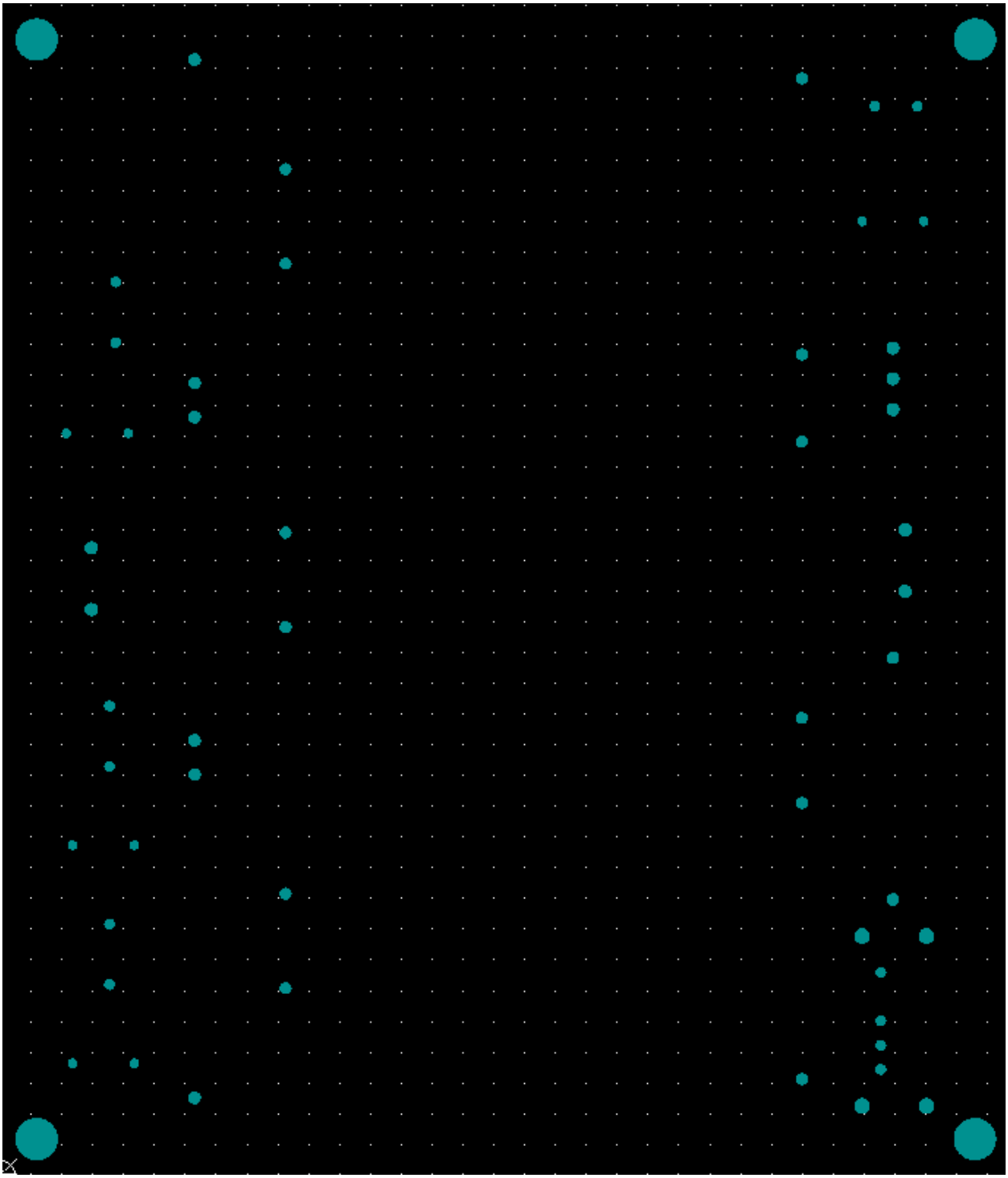



Power output
P2
Vout
GND
Constant current circuit
R1
U1
LM3177
IN
OUT
ADJ
C5
100nF
C4
220µF
Vin
Switch
S1
MFS101EA-Z
NO_1
NC
COM
NO_3
MH1
MH2
MH3
MH4
VCC1
VCC2
Vin
VCC3
Title
LED_DRIVER
Size
A4
Number
2
Revision
1
Date:
6/6/2023
File:
C:\Users\Sheetnewnew.SchDoc
Sheet 2 of 2
Drawn By:
200207U

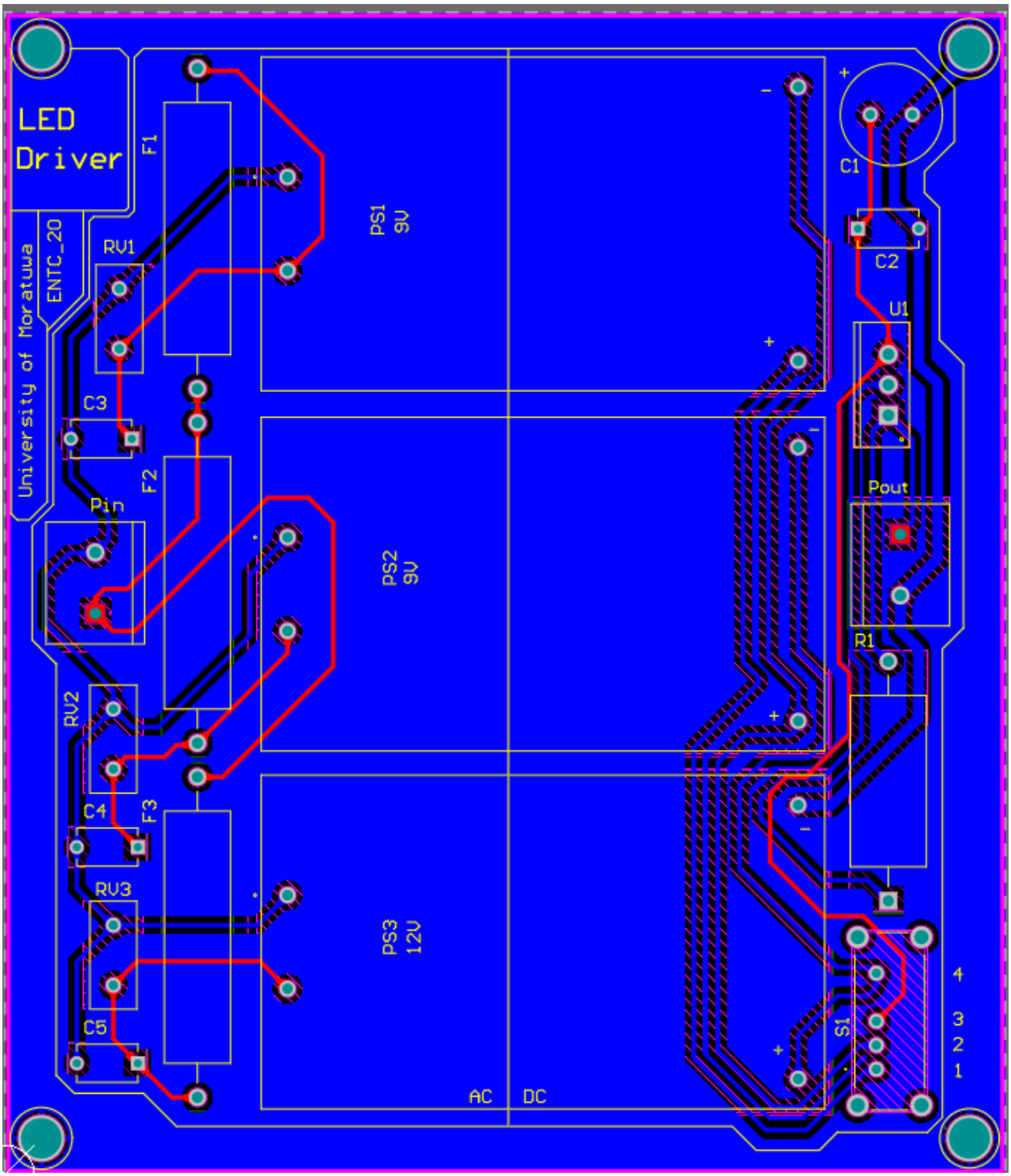
2.4 PCB Design



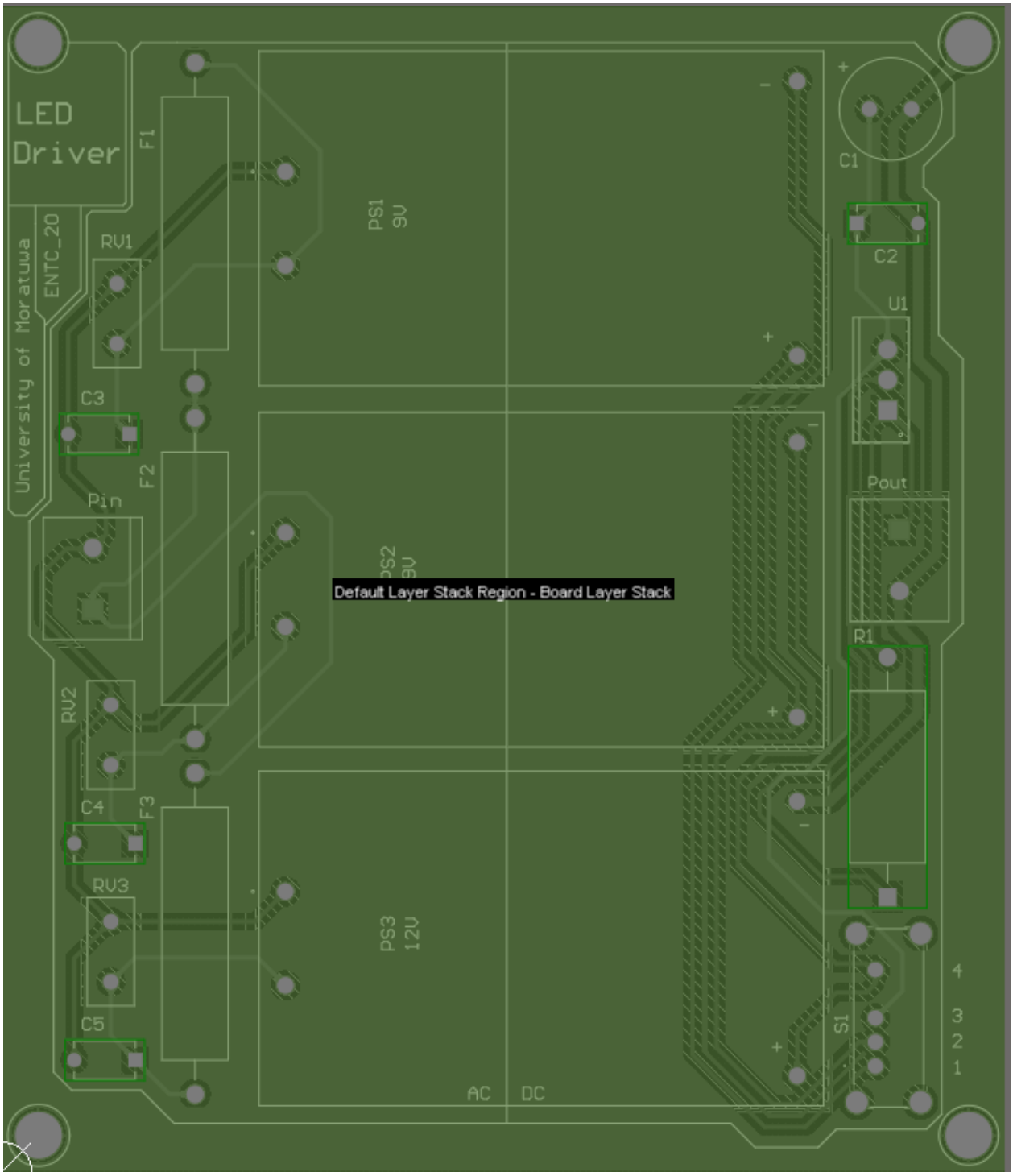
Gerber File



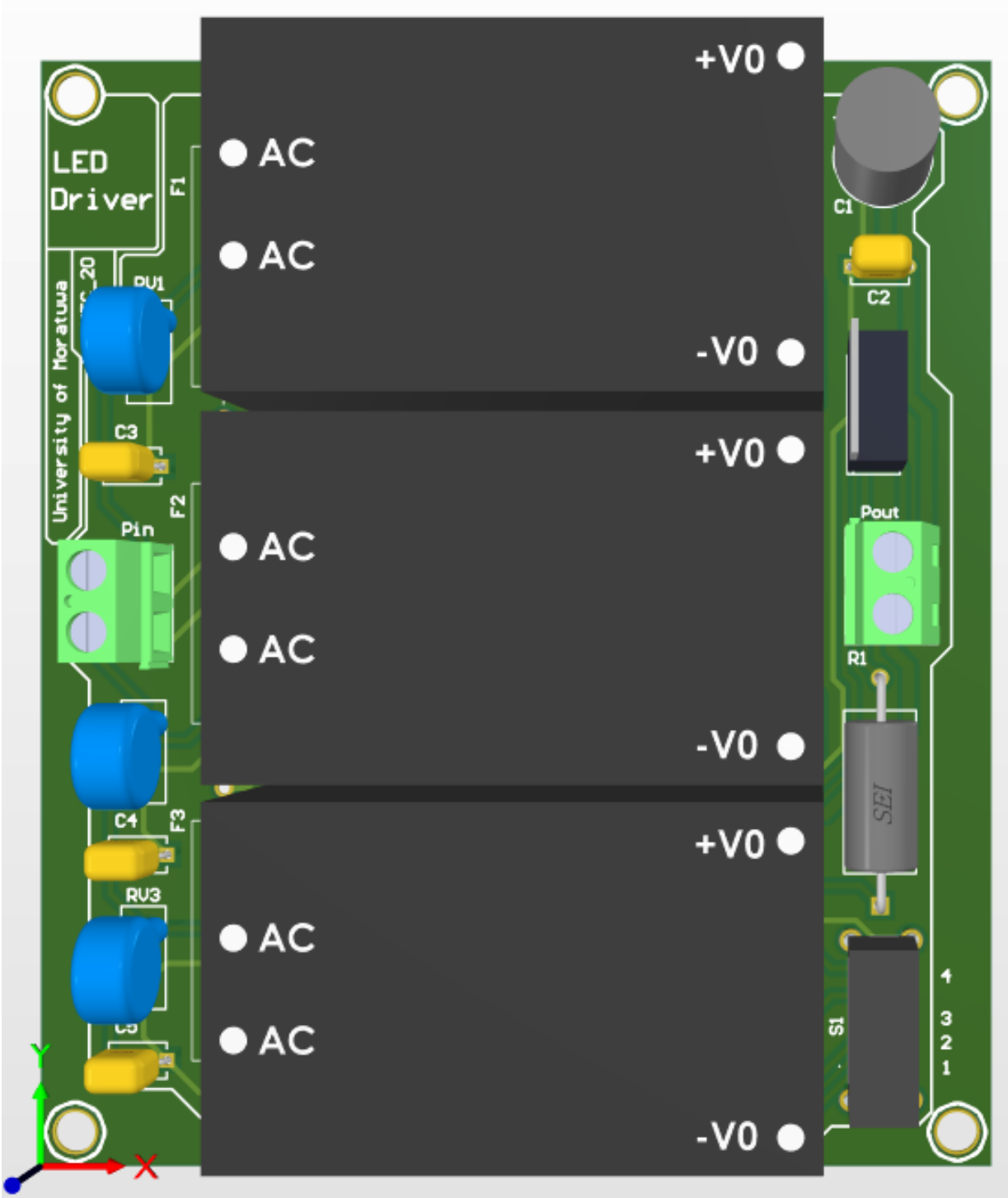
NC Drill File


LED
Driver
University of Moratuwa
ENTC_20
F1
F2
F3
RV1
RV2
RV3
C1
C2
C3
C4
C5
U1
R1
Pin
Pout
PS1
9V
PS2
9V
PS3
12V
AC
DC
S1
4
3
2
1

PCB Layout

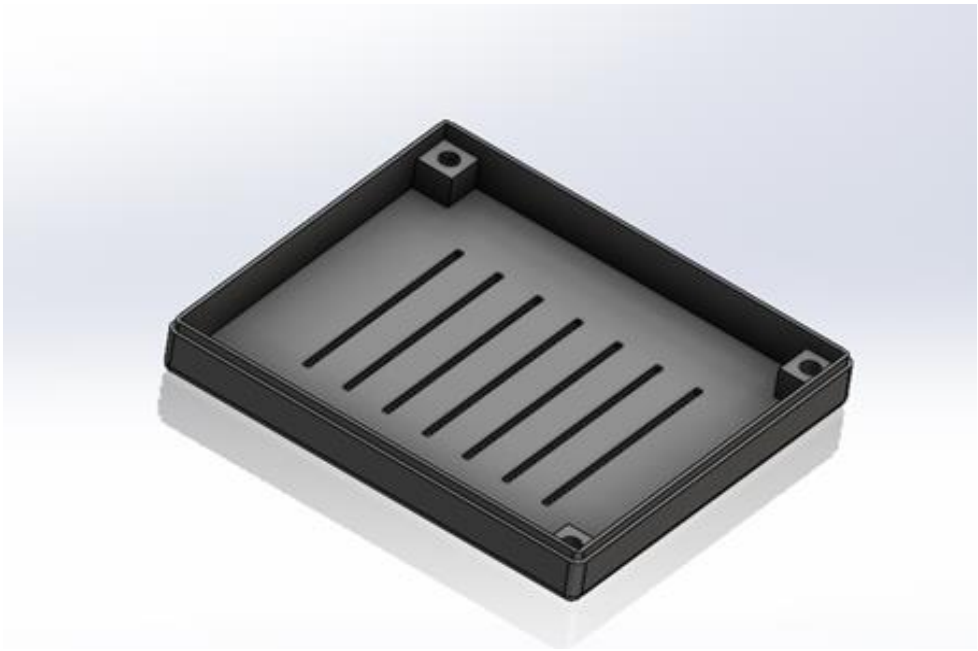

LED
Driver
University of Moratuwa
ENTC_20
F1
RV1
C3
F2
Pin
RV2
C4
F3
RV3
C5
PS1
9V
PS2
9V
PS3
12V
Default Layer Stack Region - Board Layer Stack
AC
DC
C1
C2
U1
Pout
R1
S1
4
3
2
1

Board view


+V0
AC
AC
-V0
+V0
AC
AC
-V0
+V0
AC
AC
-V0
LED
Driver
University of Moratuwa
F1
F2
F3
RV1
RV3
C1
C2
C3
C4
C5
Pin
Pout
R1
S1
1
3
2
1
Y
X

3D View

2.5 Enclosure Design

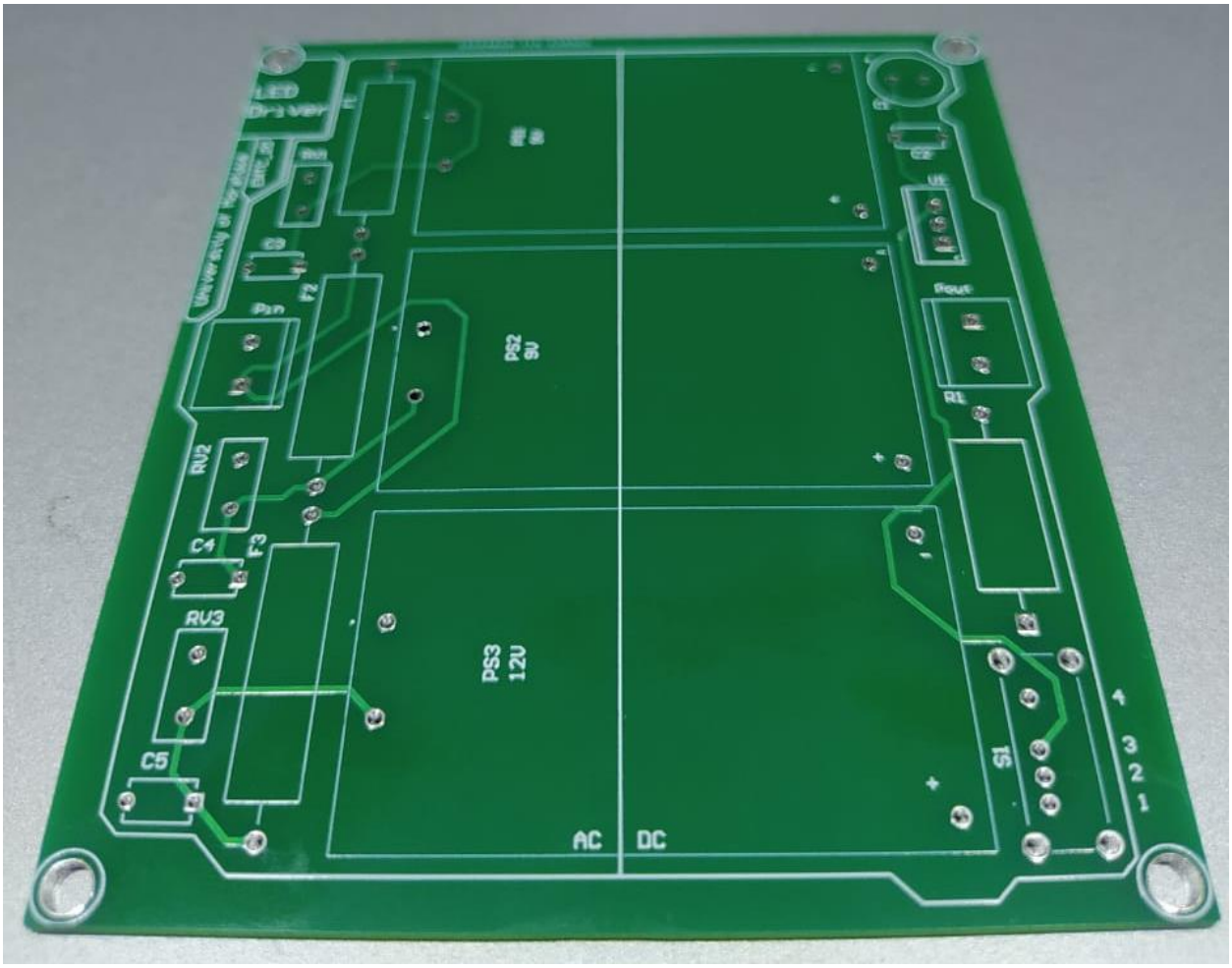


3. Bill of Materials

Comment	Designator	Quantity	Price per one	Total Price
220UF capacitor	C1	1	0.2	0.2
0.1UF capacitor	C2, C3, C4, C5	4	0.1	0.4
Fuse	F1, F2, F3	3	0.1	0.3
Terminal blocks	Pin, Pout	2	0.1	0.2
HLK-10M12	PS1	1	2.98	2.98
HLK-10M09	PS2, PS3	2	3.79	7.58
4 Ohm resistor	R1	1	0.39	0.39
Varistor	RV1, RV2, RV3	3	0.12	0.36
Switch	S1	1	1.89	1.89
LM317T	U1	1	0.37	0.37
Total Price				**14.31**

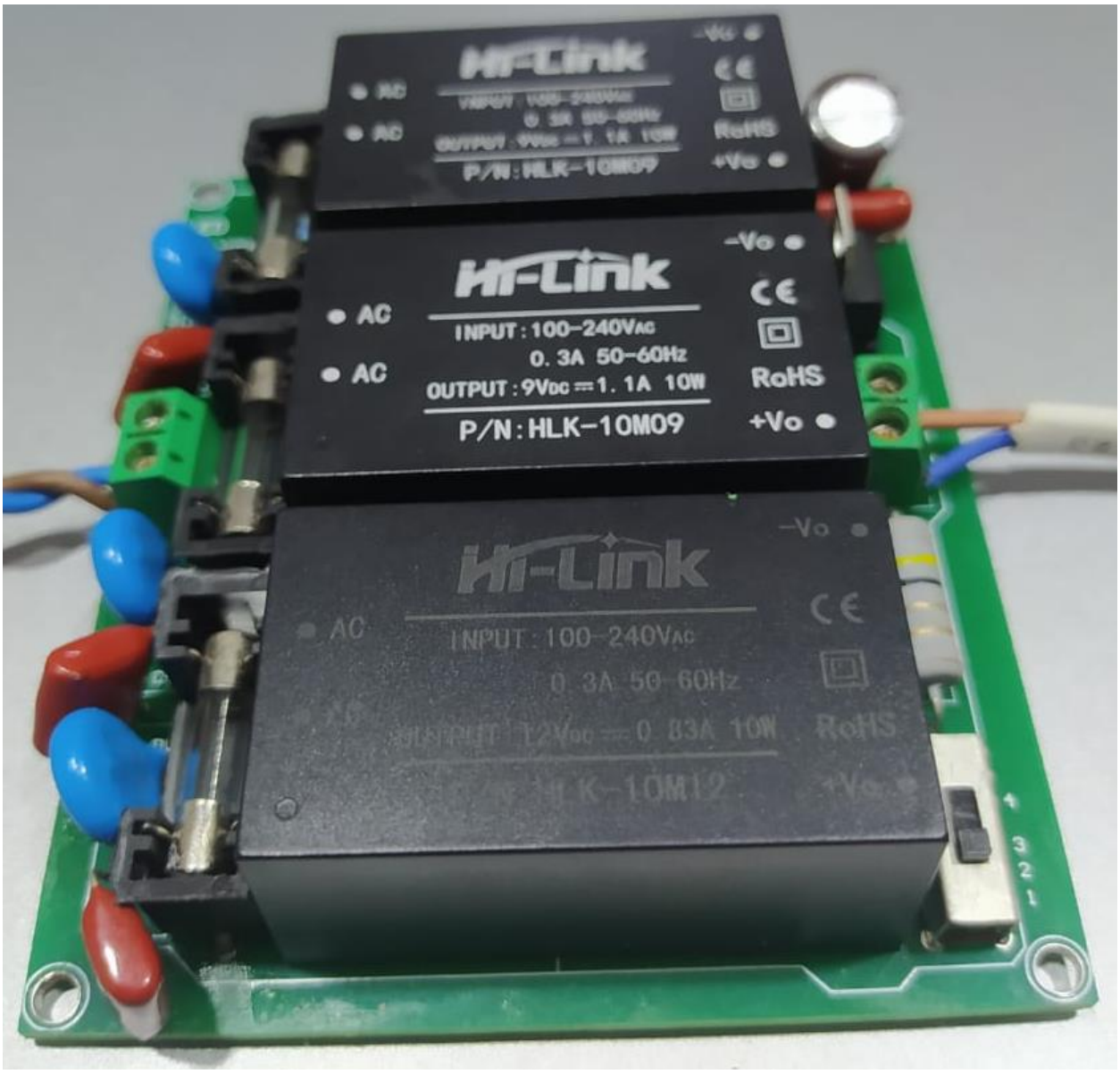
4. Soldering and Mounting the PCB

4.1 Before soldering

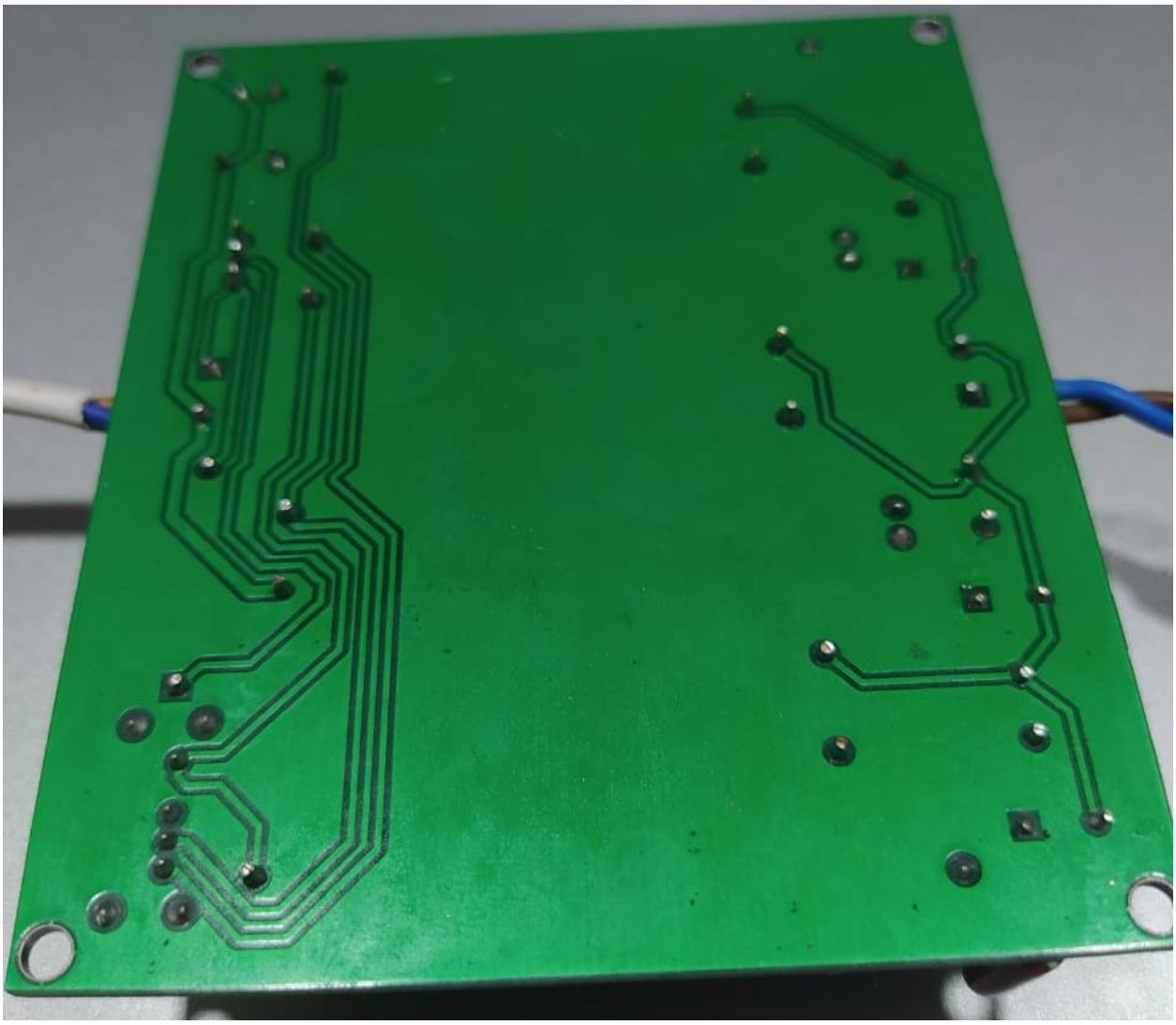


- The PCB was designed using Altium software.
- After that the Gerber files were sent to JLC PCB manufacturing company to print the two-layer PCB.
- The unsoldered state of the PCB is shown in the above picture.

4.2 After soldering



Top Side



Bottom Side

- The components were placed on the top side of the PCB board.
- The soldering was done on the bottom side of the board.

There are several important steps while soldering the components to the PCB.

1. Plug the soldering iron and heat it to a temperature which is suitable for soldering.

2. Then touch the PCB and the pin of the component using the tip of the soldering iron and heat for about two seconds.

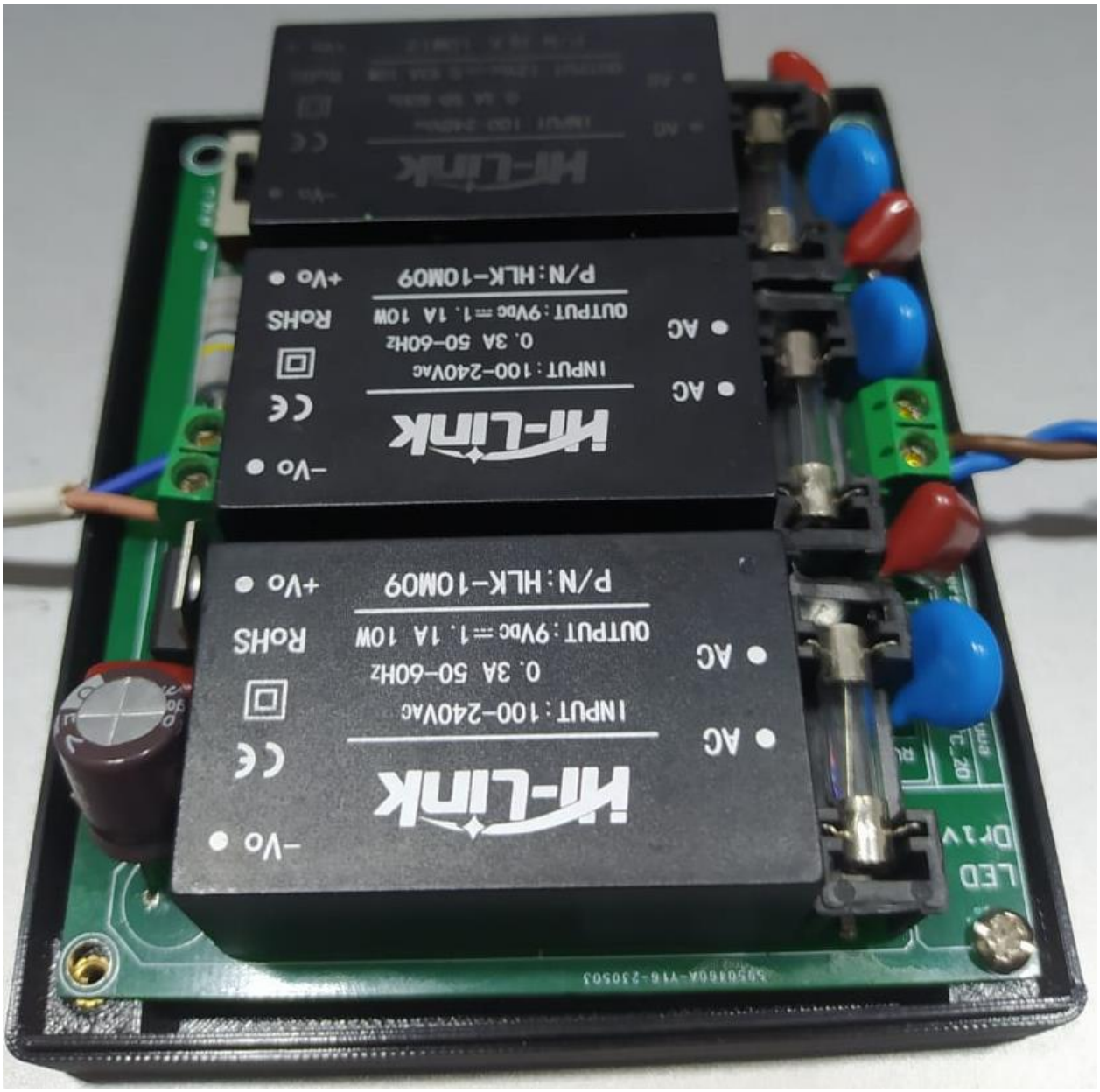
3. Then place the solder on the other side of the pin.

4. Remove the solder and heat the pin for few seconds using the soldering iron.

5. Remove the soldering iron and let the joint cool down and continue soldering.

- When soldering the components, the maximum temperature of each component must be considered in order to secure the lifetime of them.
- This can be done be referring the datasheets of each component prior to soldering them.
- When desoldering the components always use a proper method to avoid any damage to the components and the PCB.

4.3 Mounting the PCB



- The PCB then can be mounted to the lower part of the enclosure using screws.
- The PCB is also supported using bosses to support its weight.

5. Testing

The main function of the LED driver is to provide the DC voltage and the current to the LED light to function properly. Therefore, for functional testing we can check the driver simply using a LED light. Let us consider a 9W LED light and connect the LED light to the LED driver.

- First check whether you have switched to the 9W mode using the switch.
- Then connect the LED light to the driver using the output cable attached to the LED driver.
- After that connect the input wire to the AC power line.
- The LED light must be turned on.
- Now you can check the output voltage of the LED driver using a multimeter from the output ports.

You can check the other output wattages using the same method mentioned above using LED lights accordingly.

6. Assembling

6.1 Assembling the PCB to the enclosure

After manufacturing the PCB and the Enclosure follow these steps to assemble the PCB to the enclosure.

- Firstly, place the PCB on the bottom part of the enclosure in a stable state.
- Then use screws to mount the PCB to the enclosure.
- Connect the input wires to the input terminal block. Use AC wires for this, as AC voltage will be given to the product using these lines.
- Connect the output wires to the output terminal block.

6.2 Assembling the top part and the bottom part

Place the top part of the enclosure on the bottom part while maintaining the contact between the lip and the groove of the two parts.

After that use screws to connect them together.

6.3 Packaging and finishing

Put the LED driver in a polythene cover and put it inside a suitable box. Label the box with the specifications of the LED driver and forward for distribution.

Final Product

7. Appendix

7.1 Component suppliers

- Mouser
- LCSC

7.2 PCB Manufacturing

- JLC PCB Manufacturer

7.3 Enclosure Printing

- Xydder Labs